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## **Some aspects of the British coking industry in the twentieth century: with special emphasis on plants in Yorkshire and Derbyshire**

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Some Aspects of the British Coking  
Industry in the Twentieth Century  
with emphasis on plants in  
Yorkshire and Derbyshire

by

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A Doctoral Thesis submitted in fulfilment of  
the requirements for the award of a Ph.D.  
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## P R E F A C E

'Coke' may be described as the cellular residue from the carbonisation of a coking coal in commercial ovens or retorts at a temperature of about  $900^{\circ}\text{C}$ ; and a 'Coking coal' as a coal which will yield a commercial coke when it is carbonised.

Some of the questions arising from these descriptions are:-  
What are the standards required of a commercial coke; what is the cause of coke-formation; what are the characteristics of coking coals and how may they be judged; and how can the quality of coke be improved?

It is not proposed to discuss these questions in detail but it is important to be aware of them in order to understand the way the coking industry has developed. These questions have been asked since coke has been used on a commercial scale and the answers to them have altered with circumstances as science and technology have changed.

The qualities which render a coke most useful, or most readily saleable vary according to the use to which it is to be put. For all combustion processes, which account for most of the coke used, it would be expected that the intrinsic 'combustibility' would be important. The manner in which a coke burns depends so much however upon such factors as, for example, the size of the pieces and the rate of supply of air to the fuel-bed, that differences in intrinsic combustibility may be masked. From observation of the various factors upon which the usefulness of a coke for particular purposes depends, it is possible to indicate those qualities of a coke which render it most valuable for all, or most, purposes.

Coke which has been heated to a temperature of about 900°C during its manufacture has a cellular structure, and contains only a small proportion of 'volatile matter'.

It consists mainly of carbon, with some mineral matter and moisture. The cells are usually from 1 to 3 mm in size and are roughly spherical; the cell walls are up to several millimetres in thickness. Most of the cells are open.

The combustion of coke is smokeless because it contains hardly any volatile hydrocarbons, and the products of combustion are carbon dioxide and carbon monoxide. Neither swelling nor coking occurs during combustion, so that coke can be used in a deep fuel bed without the necessity for frequent poking to cause it to settle, provided that the size of the pieces bears the correct relationship to that of the furnace to avoid 'arching'. When a bed of coke has been ignited it should soon attain a red heat and should continue to burn until it is almost all consumed.

The foregoing characteristics and properties of coke have been described in practical terms rather than in the terms used in the present day to show that people with little or no real knowledge of science could grasp an understanding of this material simply by empirical observations. The properties of coke and the demands made upon it are so far reaching that although in truth the production of coke is very much a science, it has for a long time been regarded as an art. Why did this misunderstanding persist through two world wars and afterwards? The answer lies in the fact that a coke oven manager whose coke was sought after was himself in demand. The coking industry was not renowned for its high academic standard but neither were the customers. Parochial preferences developed until after World War II, and indeed they were fostered to reduce



competition from other coke suppliers.

The principal combustion processes in which coke has been traditionally used are:

- (1) Domestic central heating, in open grates.
- (2) The convection heating of buildings, in enclosed slow combustion stoves.
- (3) Water heating and the heating of rooms by direct radiation as well as by convection in semi-enclosed 'domestic' boilers.
- (4) The central heating of houses in small enclosed boilers.
- (5) The central heating of large buildings, in large enclosed boilers.
- (6) Steam raising in large enclosed boilers.
- (7) Minor metallurgical operations such as forging in ~~h~~raziers or on hearths.
- (8) Metal melting in crucibles, in furnaces.
- (9) Metal melting in cupolas.
- (10) Gas making in producers.
- (11) Iron smelting in blast furnaces.

Demand for coke was such that the coking industry has played a significant role in the economy of the nation.

Uses for coke have varied over the years but the most important use - in blast furnaces and foundries, has remained the backbone of the industry throughout.

Although coke ovens were developed to produce coke their progress has been helped in various amounts by the demand for by-products, the most important being towns gas. Nevertheless the coking industry was for a long time the only supplier to

chemical industry. It was an important source of ammonia for agriculture and an essential supplier of tar for roads. It produced benzene, toluene and xylene, as well as motor spirit for use in the dyestuffs industry, for explosives, and for road transport.

## Importance of the Coking Industry.

The by-product coking industry reached an important state of development during the early 1920s by a rational process of evolution and improvement from the primitive practice of the carbonisation of coal in heaps. After this primitive method came the beehive oven, then certain forms of retort oven, with or without the beginnings of provision for recovering some of the volatile substances; and finally the stage of scientific carbonisation which has changed very little in the past sixty years. The overall result is that a satisfactory quality coke is obtained in much less time than by former methods and by-products which have formed the basis of other important industries, particularly until the late 1950s, are recovered.

For the early part of the twentieth century coke has been produced in Britain by direct and indirect methods. In the former process coke was the sole product, except that sometimes surplus heat was used for steam raising; while in the latter coke was obtained as well as tar, ammonia, benzole and coal gas. With the development of the manufacture of coal gas for town lighting etc. necessitating the removal of tar and ammonia from the gas in order to make it suitable for public use, attention was also directed towards the possibility of recovering these products from coal carbonised for the production of metallurgical coke, but, the design of the coke ovens then in use did not lend itself to adaptation for by-product recovery.

In 1861 the externally-heated oven first made its appearance - the retort oven of Coppee - and for many years this was the principal oven of its kind. The distinct separation of the heating from the carbonisation process; that is, the application of external heating,

was the foundation of the modern coke oven and therefore the first real step towards by-product recovery. The crude gas containing the by-products had to be processed separately, and it became only a matter of time and suitable methods for the recovery of by-products. The first recovery ovens were erected in France, and it was not until about the year 1881 that by-product coking was definitely established in this country. Naturally the development was slow at first, but as the working of the ovens in conjunction with by-product plant became better understood rapid development followed, and a large number of by-product ovens were erected.

In the 1920s by-product coking occupied a very anomalous position under industrial legislation. The ovens section came under the jurisdiction of the Government Inspectors of Mines; the general engineering section came under the jurisdiction of the Factory Inspectorate and the by-product plant was 'looked after' by Inspectors under the Alkali Act. Furthermore, where a coking plant was associated with a colliery, the colliery manager - although frequently quite ignorant of the principles and practice of by-product coking - was the responsible person legally in charge of the plant, while the actual manager of the works had in law, no locus standi. No doubt there were good reasons for the predominance of the colliery manager in the old days of beehive coking, but with the advent of slot-type ovens the system was quite wrong and it was quickly modernised.

The importance of the coking industry received great emphasis during both World Wars, for without by-product coke ovens neither our own forces nor those of our Allies could have been adequately supplied with high explosives, practically all of which were indirectly products of coal distillation. The German monopoly of



the dye industry at the outbreak of World War I needed quick response by the British chemical industry in order to provide khaki dyes for military uniforms.

By 1923 by-product coking plants existed in every important coalfield in the country, and the number in each district provided a general indication of the coking quality of the coal.

Although there were still a considerable number of beehive coking plants working they were gradually being supplanted by by-product ovens, and the old prejudices against by-product coke was dying.

The Coking Revolution was at an end and the changes which occurred in the next fifty years were simply developments of an established pattern.



## Sources of Information

The early coking industry suffered because of an absence of text books on the subject of coal carbonisation and by-product recovery. Although the author does not claim the list of text books directly related to the industry and presented in the bibliography is complete, it is almost certain that few books of any consequence have been omitted.

The early art of building and operating coking plants was the preserve of numerous contractors and coke oven managers. The process was so poorly understood that for the first twenty years of the present century control was left to colliery managers who had little interest and virtually no knowledge of the industry. Respectability came in the late 1920s when coking plants became largely independent of the parent colliery. At the same time, advent of by-product coking caused authors with a knowledge of science to write a few specialised books on some part but by no means all aspects of the process. For instance, technical information on battery heating was totally neglected; one reason for this may have been the failure to understand the fundamental principles of elementary thermodynamics or even heat transfer applied to a specific situation.

The small number of text books published after 1911 gained little momentum in the early 1920s and thereafter an almost total literary vacuum prevailed. The explanation for this is quite simple; senior staff in the industry were generally not interested in publishing because of the demands of their job, a lack of academic education, or both. Consequently authors of the handful of books written specifically for the coking industry were often engaged in an academic type of environment. Another handicap

was that the highly specialised industry was never really large enough to attract much attention from publishers. This problem was circumvented after World War II when two or three books published in between 1947 and 1961 received independent financial support. The Coke Oven Managers' Association has always been aware of the absence of adequate texts on the industry but it ~~was~~ only in 1980, when the industry had contracted to an output less than in 1923, that it was trying to fill the gap.

R.A. Mott, author of two books and numerous papers on the coking industry is typical of the above pattern. Although his work is strictly a secondary source, he was so close to his work that his publications may be regarded as primary sources. Mott graduated from Leeds University and started his industrial career as a shift chemist at Tinsley Park Coking Plant in 1922. In July 1923 he worked with the research staff under Professor J.V. Wheeler who was also interested in safety in mines. Partly because of Mott's experience in coke oven practice at a time when there was interest in the development of by-product coke ovens in Yorkshire and Derbyshire, the mining people became interested in the development of coke ovens. Grants from three Iron Masters' Associations, Lincolnshire, Yorkshire and Northamptonshire, were obtained to start the Coke Research Association in which Mott became Chief Scientist. Professor Wheeler died in 1939 and Mott became Director of the Midland Coke Research Committee which moved to a house known as 'Lynwood', situated in Clarkehouse Road, Sheffield in 1947. In 1959 the research activities were transferred to a purpose built research centre at Wingerworth, Chesterfield and Mott officially retired from the research centre in 1964.

Mott's academic and technical expertise was complementary to his interest in local history so that his work relating to Yorkshire and Derbyshire is especially authoritative. It is known that he reviewed past work and made corrections in later papers. Although The History of Coke Making makes an important contribution to the subject Mott pays attention to technical detail as a matter of fact rather than comment when describing plants from his personal knowledge.

Professional journals and contractor's brochures have provided the main source of technical information about many plants and both specific and general information has been obtained from Transactions of the Coke Oven Managers' Association. Another source of industrial archaeological evidence commonly used is archival records but in this instance a search proved unfruitful. It is unfortunately true that very nearly every site of coke oven activity referred to in the thesis has been changed beyond recognition by extensive redevelopment, sometimes as an open-cast site, by controlled tipping to raise the ground level, or simply by conversion for other use. Where possible site explorations have been undertaken to provide fundamental knowledge which would otherwise be lost in due course.

It is inevitable that any research which falls broadly within the scope of industrial archaeology in the present century must involve interviews with former employees in the industry and other local inhabitants. The coking industry is not well documented and the author has used personal interviews extensively in some instances. Care has been taken to cross check verbal information before it has been given in the thesis. It is rewarding to know that, by using this technique, at least something of the past coking industry will be saved for posterity.

Other primary sources of specific as well as general information include newspaper articles in Rotherham public library and a few documents retained by Sheffield City Library on behalf of the National Coal Board. Finally the author has been privileged to use hand written and typed records belonging to the late A.C. Middleton and L.N. Brewer, first and second managers respectively at Rotherham Main Coking Plant.



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## C H A P T E R   I

### GENERAL DESCRIPTION OF THE COKING PROCESS.

#### Introduction

Any study of the coking industry must necessarily demand a basic knowledge of the processes of coal carbonisation and by-product recovery. This chapter has been included to present a simplified description of the operation of a coking plant and the information given has remained essentially unchanged since the 1920s when by-product ovens gained popularity. In the few instances where departure from tradition has taken place in the light of modern knowledge and changed circumstances, alterations are specifically mentioned. A typical modern plant layout is shown in figure 1. In general terms it differs only in size from early plants although a detailed technical study would reveal many differences which are beyond the scope of this thesis.

#### Coal Blending

The supply of good coking coal is limited. Early empirical work, later substantiated on a more scientific basis, has shown that in many cases a poor coking coal can be intimately mixed with a good coking coal to produce coke of a satisfactory quality. By judicious coal blending the fullest use can be made of the limited supply of good coking coal, and coke of a uniform quality, particularly for blast-furnace use, can be produced. Only modest attempts at coal blending were made in the 1920s and 1930s and it was not until the large post World War II plants were built that blending became more important. This is illustrated in chapter V describing Avenue and Manvers Coking Plants which were provided with extensive blending facilities. Perhaps the greatest benefit from coal blending has been obtained at plants

in Durham but apart from superficial comment that falls beyond the scope of the thesis.

A typical coal blending plant consists of a number of hoppers, or bunkers, into each of which the respective coals to be blended are delivered. The coal in each bunker is then discharged in the correct proportions onto a common conveyor belt leading to the coal crusher, by this means it is traditionally accepted that coals are intimately mixed at the same time as they are crushed to the required size.

Though heavy expenditure has been incurred in the installation of blending equipment at the two large plants referred to, it has not always been possible to blend the coals properly, if at all, simply because the right coals have not always been available when required. The problem is aggravated at weekends and during colliery annual holidays. Indeed, in modern times there is often no blending carried out for weeks at a time. Such a situation was highlighted at Glasshoughton Coking Plant during Christmas and the New Year 1974 when about half the ovens in the battery refused to discharge and this caused considerable anxiety. The situation has recurred on a smaller scale at other plants from time to time since then. The problem is two-fold, a frequent shortage of coals, combined with plants operating at throughputs generally at 112 - 120% of rated capacity. The inevitable conclusion must be that events have overtaken schemes which, in their day were a big advance on traditional practice.

## Coke Ovens

'Modern coke ovens' are built in the form of rectangular chambers, about 40ft long, 12ft 6in. high and 16in. to 18in. average mean width. They are usually 2in. wider at the coke side than the ram side to facilitate the horizontal discharge of coke when the ram side and coke side doors are removed. They are often referred to as slot-type ovens in contrast to the bee-hive type. The ovens are usually built in groups of 20 or 30, known as batteries.

Heating flues are built in the walls between each oven; underneath, and extending the full length of each oven chamber are regenerators, filled with special bricks laid in a chequer pattern with spaces for the passage of air or waste gas alternately.

The regenerators are used to preheat the air required to burn the gas in the oven flues as follows:- the hot waste gas from the oven flues is passed through one set of regenerators giving up some of its heat to the brickwork while the air is heated as it is drawn through an adjacent set of regenerators. The regenerators are changed over from air to waste gas and back to air automatically at pre-determined intervals of 20 or 30 minutes. At any given time half the regenerators are being heated with waste gas and half are being cooled down by incoming fresh air. The hot gases leaving the regenerators are collected in the main gas flues on either side of the battery, and pass to the chimney which discharges them to the atmosphere at a height of 250ft which is enough to create sufficient natural draught through the system.

By careful control of the proportion of fuel gas to air at the point of combustion in the base of the flues the desired temperature of the oven walls can be obtained with about 45 per



cent of the gas produced, thereby liberating 55 per cent of the total for sale. This is the principle of the regenerative oven which has become universal since the early 20th century. Early problems in controlling combustion were many but improvements in oven construction played a large part in eliminating them.

Ovens are built with silica bricks to withstand working temperatures up to  $1450^{\circ}\text{C}$ . Because of the special properties of silica concerning expansion it is understood that a coke oven battery cannot be cooled down to ambient temperature and heated up again satisfactorily. For this reason coke ovens must work continuously through their life. In times of industrial dispute safety men have usually remained at work along with a small team of staff to maintain minimum throughput and thereby avoid closure of the plant. Chapter IV describes the first use of silica in coke ovens.

#### The Carbonisation Process.

After the coal has been blended and crushed it is delivered into the service bunker, which usually holds 2 days supply of coal, for charging into the ovens by a charging car (sometimes referred to as a larry car). The charging car is designed to hold enough coal for one oven - 12 to 18 tons. The actual amount of coal put into the charging car is determined by weighing the vehicle on a weighbridge situated on the battery top, underneath the service bunker, although early plants measured the coal volumetrically. It is important that the ovens are properly filled and the charge weight accurately recorded. The charging car transports the coal from the bunker and drops it into the oven through four charging holes in the oven top.

Some very early plants had only three charge-holes but for the last 40 years and more four charge-holes have been the norm.

The conical piles of coal inside the oven chamber are levelled by a long bar mechanically driven from the ram and introduced into the oven through a small door at the top of the coke side oven door. Coal levelling allows the easy escape of the gas along the top of the charge to an offtake or ascension pipe located at the ram side, coke side or both sides of the battery. Old plants had one ascension pipe per oven, sometimes unwisely located at the ram side where it could become blocked with coal if the oven was overfilled, this is typified by Rotherham Main, Staveley Coking Plant and the first plant at Manvers, and in post war times by Glasshoughton Coking Plant. All these plants and others are described in detail in chapters V and VI. The coal remains in the oven for a predetermined period until almost all the volatile matter has been removed - this is known as the net coking time and is usually between 16 and 18 hours.

At the beginning of the 20th century coking time was generally about 50 hours and chapter V describing Holmewood Coking Plant is typical of the 1910 period. Chapter VI describing Rotherham Main shows that the coking time had been reduced further to about 16 hours. These plants are typical and illustrate the trend to improve throughput by increasing the flue temperatures to enable the coke to be carbonised in a shorter time. It is important to note that the major increase in throughput by this means occurred in the first 30 years of the 20th century because of the introduction of high grade silica in the ovens' construction. The chapter V describing

Glasshoughton Coking Plant shows that high grade silica was introduced to the coking industry in 1923. Modern practice is to operate the flues at a temperature of  $1400^{\circ}\text{C}$  -  $1450^{\circ}\text{C}$  which is within  $200^{\circ}\text{C}$  of the softening point of silica. This gives a carbonising rate marginally less than the traditional 1in. per hour which has been nominally applied since the 1930s until the late 1960s. The rate of carbonisation implies that modern ovens with a mean width of 18in. will be carbonised in 18 hours or less. It can be stated therefore that a major contribution to oven throughput in the second half of the 20th century has been made simply by reducing the arbitrary safety factor of the oven chamber. At the end of the coking time the oven is isolated from the gas collecting main, the oven doors removed and the coke pushed out by the ram or pusher machine.

It is essential that air is not drawn into the oven during the carbonisation process since the coal would burn to ash and create excessive temperatures which in turn would damage the brickwork. Leakage at oven doors is a serious problem for the two present day plants, Manvers and Glasshoughton, but with the exception of the early plant at Nunnery Handsworth it was not generally a problem with older plants. There are a variety of reasons for this situation. Two ways in which oven doors can be made airtight are used. First the door can be sealed against the frame with 'lute' or 'daub', such doors are known as clay-luted doors, e.g. Smithywood Coking Plant, Nunnery Handsworth Coking Plant. Second, self-sealing doors may be used which, with thin sealing strips, make a metal-to-metal contact with the door frame. The sealing strips are fixed to the door frame in such a manner that tar from the carbonised coal near the door settles behind the strip to aid the seal.



The merits of each type of door have been debated over many years and this thesis shows that the majority viewpoint favours self sealing doors. Self sealing doors are used exclusively at the integrated plants belonging to British Steel Corporation. However, experience with these doors at Manvers and Glasshoughton over the last few years has caused the merits of clay luted doors to be reconsidered.

Arguably the author does not believe clay luted doors will be used when any new batteries are built in the future because of their increased demand on labour. This is in spite of the fact that these doors undoubtedly meet the minimal pollution conditions specified by the Alkali Inspectorate with less management supervision than do the self sealing doors.

Trials with mechanical aids for clay luting were carried out at Smithywood Coking Plant early in 1980 in the presence of the Alkali Inspector. Avenue is a good example of modern self sealing doors at a high output plant being perfect after more than 20 years continuous service. Rotherham Main is by far the best example of a plant working for 34 years without any problems from the self sealing doors.

It is the considered opinion of the author that the effectiveness of management is the key factor in deciding the efficiency of self sealing doors because it is so important to clean the seal and the frame each time the doors are removed. Over the last 20 years plants with labour problems generally have considerable emissions from the battery as a whole as well as the self sealing doors in particular. The source of the problem of poor sealing doors does not necessarily arise solely from ineffective management (see chapter V describing Glasshoughton Coking Plant).



## Coal Handling and Screening

Coke discharged from the ovens at about  $1000^{\circ}\text{C}$  into the coke car starts to burn furiously as soon as it comes into contact with air. It is therefore taken quickly to the quenching tower to be sprayed with river water. When the surplus water has drained away the car is taken from the tower and the coke is discharged by gravity onto the wharf.

The coke wharf is a long sloping bench lined with tiles on which the coke is allowed to cool before being discharged in small quantities onto the main screen conveyor by manually operated wharf gates. This system has remained unchanged for the last 60 years or more. The wharf is usually sufficiently large to accommodate the coke discharged from two ovens but by and large the batch rate of coke discharged onto the wharf must equal the continuous rate at which it is delivered onto the screening plant conveyor.

In the screening plant coke is graded into various sizes. The broad principles of primary and secondary screening have not changed in 50 years but screening efficiency has been greatly improved, particularly since the 1950s when much attention was paid to improving the quality of solid smokeless fuel for the domestic market. Up to this time little attempt to include de-breezing screens had been made to remove the coke below  $\frac{1}{2}$ in. known as breeze from the graded nuts but in the 1950s the de-breezing screens became very important.

The first, or primary screen, is the largest and removes coke which is greater than 2in. in size. This oversize coke is either sold as blast furnace coke or cut to smaller sizes. The undersize coke from the primary screen is then conveyed to the secondary screens where it is graded into sizes suitable

for domestic and industrial use. Typical gradings are 2in. to  $1\frac{1}{2}$ in.,  $1\frac{1}{2}$ in. - 1in and 1in -  $\frac{1}{2}$ in but chapters V and VI show variations from plant to plant in the early years to meet local preferences. Considerable standardisation of coke sizes took place in the 1950s but special large orders are made to different size gradings if called for. The thesis shows that domestic coke sizes were originally given horticultural names, for example, peas, beans, nuts, apples, etc. but these have been changed to doubles and singles in more modern times. The undersize through the  $\frac{1}{2}$ in. screen, known as breeze, finds a market for steam raising and sinter plants at blast furnaces. Economics have demanded that coke sizes should vary slightly from time to time and breeze, which attracts a low price, has sometimes been limited to coke below  $\frac{3}{8}$ in. rather than the long established upper size of  $\frac{1}{2}$ in.

#### By-Product Recovery

Gas evolved from the coal charge is drawn off through one or sometimes two vertical pipes known as ascension pipes on the ovens. The precise location of the ascension pipes, with respect to the ram side or the coke side of the battery or both at specific plants is dealt with later in chapters V and VI.

Each ascension pipe is lined with refractory material up to the point where it bends over at the top and enters a large diameter collecting main which runs the length of the battery. The temperature of the gas leaving the ovens is about  $900^{\circ}\text{C}$  and it is cooled by liquor sprays located in the bend of each ascension pipe in such a manner that the liquor flows along the bottom of the collecting main to the tar decantation tank. The sprays cool the gas to approx.  $90^{\circ}\text{C}$  and therefore

condense some water vapour from the gas which immediately absorbs some of the free ammonia. Another function of the sprays is to continually wash a flap valve in the ascension pipe which is used to isolate the oven from the 'main' when it is being charged or discharged. During the charging of an oven there is a tendency for dense brown smoke to escape from the chargeholes to the atmosphere. One or sometimes two steam jets are fitted to each ascension pipe and by turning them on during charging and opening the flap valve the gases are drawn into the collecting main instead of being discharged to atmosphere.

The suction main is joined to the collecting main at right angles and transports the gas to the by-product plant. This main, as the name implies, is under suction from the exhauster and draws the gas from the ovens.

The gas pressure in the mains is controlled by an Askania regulator. Every coking plant has at least two regulators, one is used to control the gas pressure in the oven chambers and the other is used to control the suction created by the exhauster. A third Askania is used quite independently of the two already mentioned to control the pressure of the fuel gas supply. This simple piece of automatic control equipment has been used since the advent of by-product recovery and the design employed more than 50 years ago continues to be used unaltered today. It has remained virtually unchanged since its inception and it typifies the adoption of basic and reliable control equipment devoid of sophistication. This equipment has also been used for the past 50 years or more in other industries for the control of large volumes of gas.



The first stage of by-product recovery is to cool the gas down to near river water temperature in the primary gas coolers. These generally consist of rectangular vessels containing many vertical tubes through which cold river water is passed. The gas circulates between the shell and the tubes and is therefore cooled by the water without actually coming into contact with it. The cooler is therefore known as an indirect cooler.

Chapters V and VI describing Staveley and Rotherham Main Coking Plants show that vertically tubed indirect water coolers have not always been used for primary gas cooling but they are now preferred.

As a result of being cooled to as near to the cooling water temperature as possible the volume of the gas is considerably reduced before it enters the exhauster. Up to the exhauster the gas has been under suction, except at the batteries themselves and for the remainder of the journey through the by-product plant the gas is under pressure. It is essential that the exhauster should be kept running at all times for safety reasons, consequently every by-product coking plant has invariably been supplied with a stand-by machine. Exhausters are always steam driven and the pass out steam is traditionally used for indirect heating on the by-product plant. It is customary practice to alternate the exhausters on a weekly basis to ensure that both machines are in working order except when one machine is being overhauled - a task usually given to the manufacturer.

Exhausters at the old plants were driven by reciprocating steam engines. They were large diameter slow running machines which relied on a given swept volume of gas being displaced each



revolution, see chapter VI describing Rotherham Main Coking Plant for further details.

About the 1930s the Beale-type exhauster was replaced by a steam turbine driven centrifugal exhauster on the grounds of improved efficiency. The modern tendency is for them to operate at about 6000 r.p.m. (see chapter V describing Avenue and Manvers Coking Plants) but the description of Glasshoughton Coking Plant shows that exhauster has an untypically high running speed of 9000 r.p.m.

Considering that all coking plants since the 1930s have operated turbine exhausters, only two accidents with these machines are known and both occurred at Smithywood Coking Plant, near Sheffield.

#### Tar and Tar Extractors

Most of the tar and large amounts of ammonia liquor are removed from the gas by condensation in the collecting main and the suction main. This is removed before the primary gas coolers through a downcomer which permits the tar and liquor to leave the suction main without allowing the gas to escape. The remaining tar, other than the tar fog, and the rest of the liquor are condensed from the gas in the primary gas coolers. The whole of the tar and liquor from both these sources is sent to the decantation tank where the tar is allowed to fall to the bottom and is thus roughly separated from the liquor. The bulk of the liquor is directed back to the flushing pumps to keep the liquor sprays in the ascension pipes supplied. There is always an excess of liquor which is delivered to a stock tank and then distilled to recover ammonia.

The liquor sprays must be kept working at all times and the steam driven centrifugal pump is duplicated and an electrically driven pump is usually installed as well. In addition an emergency water tank is always installed in the top of the service bunker and this will usually supply the sprays for about 40 mins. Records of steam driven liquor pumps failing are known but much less frequently has the emergency water supply had to be used. There are no known records of a total liquor or emergency water failure leading to a total disaster but many years ago a temporary liquor failure on the 71 side ovens at Manvers caused distortion of the collecting main and this can still be seen today.

The tar which is taken from the bottom of the decantation tank contains too much water to be sold. It is pumped to a separating vessel in which it is retained until the excess of water has had time to settle out. It has been found that if the tar is kept warm in this vessel separation of the tar and liquor are facilitated and therefore low pressure coils are provided for heating with steam.

The moisture content of tar has not always been critical, particularly at plants built between the wars when they sometimes had their own tar distillation plants. After World War II when tar from most plants was sold to Yorkshire, Midland and Lancashire Tar Distillers - which eventually became Yorkshire Midland Tar Distillers - the moisture content became very important because of the economics of transporting and distilling this material. Tar was then sold on a sliding scale, increasing in price from a moisture content of 5 per cent downwards. When the tar distillation plant was built at Avenue their own crude tar and the tar from other plants near by and belonging to the N.C.B. was sold on a similar basis for transfer charge purposes.

Stemming from the early days of by-product coking the tar storage system has been a receptacle for unwanted oils, especially creosote or gas oil which were sometimes discarded in large quantities. This provided a solution for local problems at plants, particularly when oil regeneration equipment was not installed. Because of the problems caused at the tar distillery it has been discouraged for technical and financial reasons.

Before gas can be treated to remove ammonia and benzole, the tar must be completely removed. If this is not done the ammonia and benzole plants soon become contaminated with tar, and unworkable. All plants built after World War II and some before that date have been equipped with electrostatic tar precipitators to remove the last traces of tar fog. References are made in chapters IV and VIII to the early methods of removing tar fog. The most notable was the Pelouse and Auduin Extractor which was still in use after 1947 at some old plants.

The tar precipitator is usually situated in the gas stream after the exhauster rather than before to reduce any risk of air being drawn in through leakage and an explosion. Early electrostatic precipitators were situated before the old Beale-type exhausters because suspended tar droplets were detrimental to the exhauster; explosions through air leakage into the precipitator are known although arguably they may not have been due to the location.

The efficient and continuous operation of the tar precipitator is a pre-requisite for good by-product yields and efficient



battery heating, although not all modern plants have a stand-by precipitator and Manvers, which is more unfortunate operates both precipitators in parallel and at reduced load. Details are given in respect of the appropriate plants elsewhere. The electrical potential applied to a precipitator is of the order of 30,000 volts d.c.

#### Ammonia Recovery

The usual way of recovering ammonia is to pass the gas through a solution of approx. 5 per cent sulphuric acid in a saturator. The ammonia in the gas reacts with the sulphuric acid and precipitates crystals of ammonium sulphate, commonly referred to as 'salt' at coking plants. The crystals and some of the acid liquor are removed from the saturator by means of a steam ejector into a crystal separator - this is a conical vessel in which the crystals sink to the bottom and displace the acid liquor out of an overflow and back to the saturator as ejection continues. The crystal magma is then run batchwise into a centrifuge which may be a vertical or horizontal type. The centrifuged liquor is returned to the saturator and the 'spun salt' is passed to a drier. There have been a variety of driers used over the years and the chapters dealing with Avenue, Manvers, Rotherham Main and Glasshoughton indicate the types used.

Up to about 1950 the salt was ejected from the saturator onto a draining table before being centrifuged but after this date the draining table was superseded by a conical crystal separator.



The process described above is the 'semi-direct' process for ammonia recovery and the first plant of this type was installed at Holmewood in 1910, see chapter V. There are two alternatives known as the 'indirect' and 'direct' system. In the indirect process, which is the oldest of the two, the gas is sprayed with water in 'scrubbers' to absorb the ammonia, the resultant liquor containing 1 - 2 per cent ammonia is distilled and the vapours passed into the saturator. The liquor from the primary coolers and the collecting main is usually mixed with the liquor from the scrubbers so a relatively large still is required. Alternatively the still vapours may be condensed to produce concentrated ammonia liquor (C.A.L.) containing 15 - 25 per cent ammonia. C.A.L. was produced at some plants up to about 1960, after which the C.A.L. market became unattractive due to the development of the synthetic ammonia industry. The 'direct' process, also referred to in chapter VI describing early plants, dispensed with primary gas coolers and after removal of tar from the gas by mechanical means, the hot gas at about  $80^{\circ}\text{C}$  passed through a saturator containing sulphuric acid before it passed through the exhauster. Because of the high temperature of the gas a relatively large and therefore expensive saturator was required. For this and other technical reasons the direct ammonia recovery system was discontinued when the old plants became obsolete. Figure 2 shows diagrammatically the typical flow of gas from the ovens through the by-product plant of a semi-direct recovery system, and also the alternative positions in which various units are situated in the indirect process of recovery.

Both indirect and semi-direct plants have merit although with increasing fuel costs it may be arguably claimed that

the semi-direct plant has the advantage, although this is not proven. (see 'The gas flow diagram and by-product recovery' later in the chapter).

### Benzole Recovery

For maximum benzole extraction from the gas it is essential to cool the gas as much as possible. In the semi-direct process of ammonia recovery this is carried out in the secondary or final gas coolers immediately before the benzole scrubbers. In the indirect process of ammonia recovery the gas is reduced to the low temperature required at the primary coolers immediately before the exhausters.

The type of final cooler used is either the indirect water tube type, or the direct type, sometimes known as a shock cooler. In the 1950s there was a tendency to use direct coolers but in the 1970s the Alkali Inspectorate did not encourage this method because the water used in direct cooling is heavily contaminated with hydrogen sulphide etc., some of which is emitted to the atmosphere when the closed circuit water passed down a Bradford cooler. Because of the pollution problem in the vicinity of Manvers consideration is being given to installing indirect secondary coolers. At Smithywood direct cooling is less of a pollution problem because it is a much smaller plant.

Benzole is recovered from the gas in mild steel cylindrical absorption towers known as benzole scrubbers, fitted with wooden grids whose size and shape have not been changed in more than 50 years. There are 2 - 3 scrubbers, each about 80ft. tall at each coking works. At old plants two scrubbers were considered sufficient but post war practice has been to

use three scrubbers in series. The gas flows upward through each scrubber in turn and the creosote oil flows down in true countercurrent manner. The oil leaving the last scrubber is known as rich oil or benzolised oil containing 3 - 4 per cent benzole. Benzole is removed from the oil in a stripping still after it has been preheated by oil to oil heat exchangers and/or a tubular steam heater to about 130°C. Variations on the method of preheating or heating the oil are discussed in the chapter VI describing particular plants and it is sufficient to state that there has been no development in the methods used over the past 50 years. This indicates the sound practical basis on which benzole recovery was founded and does not in any way suggest refusal to innovate.

After the rich oil has been steam distilled it leaves the bottom of the benzole still as stripped oil and is cooled in banks of tubular rack coolers before being returned to the benzole scrubbers. The success of early benzole recovery and its continued existence without change is due to the fact that it has been known from the start that the more preheat given to the rich oil, the less open steam is required in the still. The rich oil cannot be overheated because the maximum temperature is governed by the available steam pressure which has always been kept below 20 lbs/sq.in. to restrict the insurance classification.

#### Gas Disposal

This thesis shows that some plants, such as Rotherham Main, sold unpurified gas to Area Gas Boards while Grassmoor, Glasshoughton and Blackwell for example reduced the hydrogen sulphide content down to stringent levels prior to sale.



In the former case the Area Gas Boards undertook to purify the gas prior to distribution. Chapter V describing Blackwell Coking Plant shows an arrangement between the plant and Derby Corporation for the purification of gas which is non typical. All plants have had final naphthalene washing equipment where the gas is scrubbed with gas oil, the naphthalene rich oil is distilled and the stripped oil re-used in the naphthalene washer. The main method of naphthalene disposal has been to discharge it into the tar storage. Some small plants in West Yorkshire departed from this practice between 1947 and 1955 when a firelighter factory was built at Crigglestone Coking Plant. The factory used sawdust and naphthalene as raw materials and it was very labour intensive. The firelighters found a ready market in Leeds, Wakefield and Bradford but they were not smokeless and the factory was later compelled to close when the product became unacceptable. Since then attempts have been made to up-grade naphthalene but the economics of the process have always been bedevilled by such small production quantities.

The traditional system of gas purification has been to pass the gas through trays of specially prepared iron oxide contained in cast iron boxes or towers. When the oxide has absorbed as much sulphur as possible, about 50 per cent by weight, it is replaced by new oxide and the spent oxide is sold for use in the manufacture of sulphuric acid. This process is also described in detail in respect of individual plants and the special circumstances of Blackwell Coking Plant should be noted. The development of gas purification by the Gas Boards and by Coking Plants has always been particularly closely related. (1)



In addition to the items of plant already mentioned there are normally two others which perform a useful service. First there is the gas holder which serves to take up variations in volume and pressure of the gas, especially during battery heating reversals. Following chapters show that not all the coking plants described had this facility. Secondly there is the gas bleeder, usually operated in conjunction with the gas holder. The bleeder is used for burning surplus gas which cannot be sold or used on the boilers. Every plant has a gas bleeder and over the years the height, location and method of lighting the bleeder have been changed. Manvers has the tallest gas bleeder situated on top of one of the service bunkers, all the others have been located at ground level. Dinnington and Nunnery Handsworth Coking Plants had bleeders which were lit by firing a burning arrow from a bow into the gas stream issuing from the top of the bleeder. This was imprecise and dangerous though its merit was simplicity. Rotherham Main Coking Plant was unusual in as much as it did not have a balancing gasholder so that every 20 minutes when reversal of the battery heating took place the gas not required during the 3 minute changeover period was burned at the bleeder.

#### The gas flow diagram and by-product recovery.

There are sound reasons why the recovery of by-products has remained unaltered in principle almost since the advent of by-product recovery. This subject is dealt with in chapter IV and it is sufficient to state that early workers were most successful, largely because the empirical work only required moderate knowledge of science and technology. Although the

science and technology of the industry are now understood in much greater depth the craft level knowledge required in earlier days has remained perfectly valid in most cases. Whether this was a coincidence is arguable. Clearly the finely divided tar droplets suspended in the gas should be removed as early as possible in the gas flow because of their hindrance to heat transfer and the contamination of by-products. It was already been stated that the method of removal of the tar 'fog' changed in the formative years, as did the location of the resultant tar precipitator change its position from immediately before, to immediately after the exhaustor for reasons of safety.

Ammonia is corrosive and it is desirable that this too should be removed at an early stage. It cannot be removed before the tar 'fog' because the presence of the latter would discolour the ammonium sulphate produced. A cross-reference for the two methods of ammonia recovery has already been given. No suitable alternative method has been developed and therefore the two systems remain unchanged. The following chapters show that, because of the often unattractive remuneration from this by-product, the profitability of which is dictated by the cost of sulphuric acid which in turn depends on the world demand and availability for sulphur, some plants have successfully produced ammonia liquor in concentrations ranging from 15 - 25 per cent. In later years concentrated ammonia liquor production ceased to be as economical as ammonium sulphate production because of the production of synthetic ammonia by Imperial Chemical Industries Limited. The advent of synthetic ammonia had a less marked effect on the economics of ammonium sulphate production.

It will be seen that crude benzole has always been recovered though the financial benefits have been variable. The most important impetus for the production of benzene and toluene was afforded by the advent of the second World War when all the small coking plants paid increasing attention to these products. After the war the industry attempted to meet the challenge of the petrochemical industry for the products by concentrating production at a few large refineries, and improving purity. For further details see the chapter describing Avenue and Manvers. Both crude production and refinery products lost some of their attractiveness when the Government removed the 2/6d subsidy per gallon of crude benzole produced several years after the second World War. As a result considerations were given to leaving the crude benzole in the gas but the risk of its liquifying and freezing in towns mains during cold weather forced its continued removal. The passage of time made the few large refineries inefficient in the light of the ever increasing scale of production by the oil industries and so one refinery was built to handle all the crude benzole produced from British coking plants. Details are given in the section describing Staveley Chemicals Limited in chapter V.

Like tar, hydrogen sulphide has a nuisance value but unlike tar its removal down to prescribed limits is demanded by law for the sale of towns gas. The limits of hydrogen sulphide content of gas sold to industrial undertakings as an alternative to Area Gas Boards are not quite so stringent. The economic viability of sulphuric acid production from spent oxide has rarely been good, see the chapter describing the Avenue plant for further details.



Finally, the traditionally attractive revenue from the sale of town gas has disappeared now that this market has gone. Instead coke oven gas is sold to industrial undertakings at a price which is quite variable but which has to be more attractive to the consumer than the alternative sources of energy available to him. (2)

### Summary

This chapter has described a typical coking plant from the late 1920s to date. It has shown examples of technical progress in some processes and illustrations of processes which have not changed for more than 50 years. The basic flow pattern is just as valid today as it was soon after its conception but the scale of operation has increased in some cases by a factor of 10 or more because of financial implications. Minor alterations to layout have been made to meet particular site limitations but major modifications are not called for because the system is so fundamental.

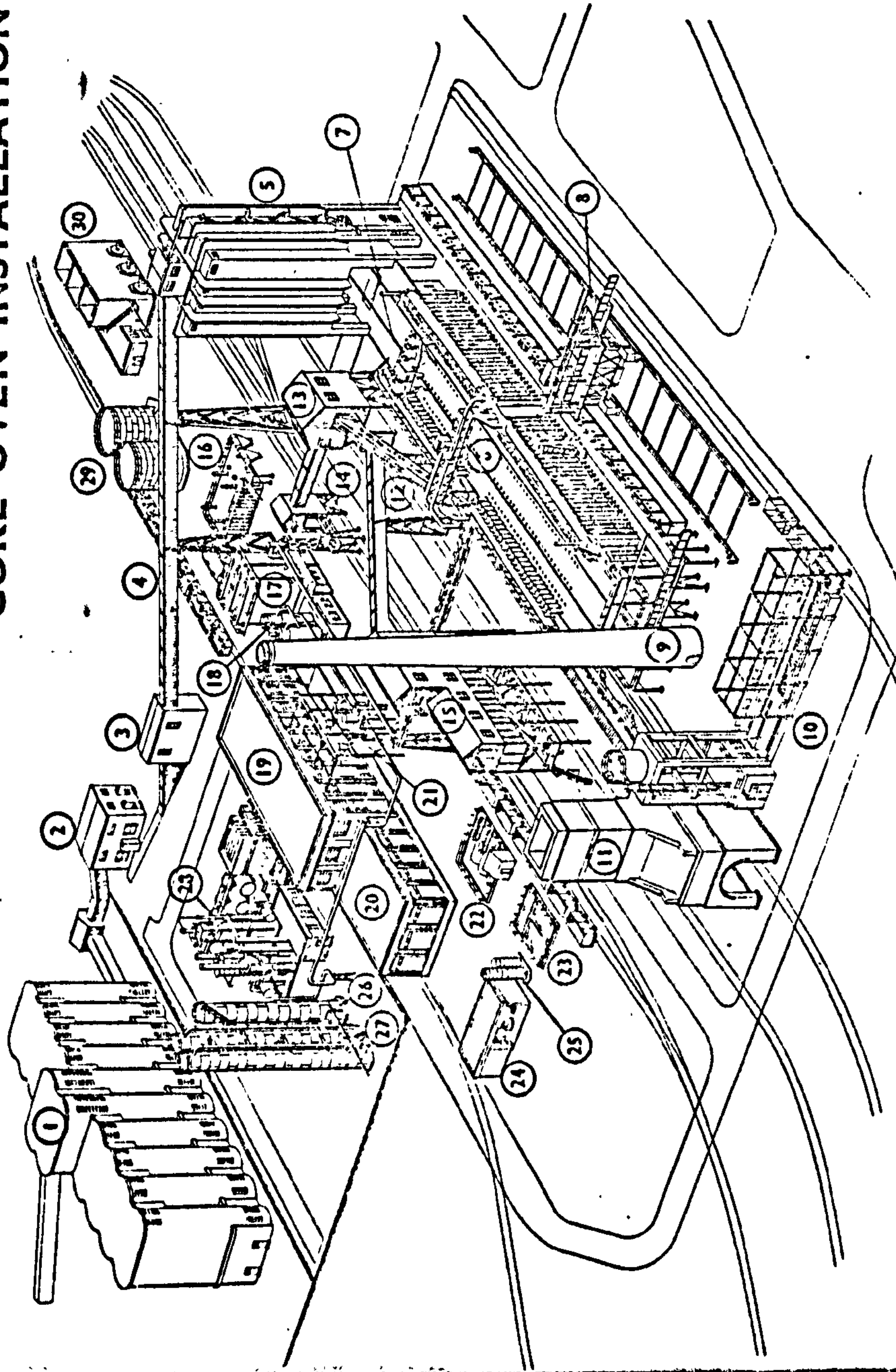
The coking industry is highly specialised and so it has not been possible, with one exception, to adapt chemical plant used widely in the chemical industry. It is reported that one of the crude benzole stills at Glasshoughton Coking Plant was purchased from a dye-works. This belief is supported by the fact that it was not identical to the stand-by still. If other exceptions exist they are minor and are not known to the author.



FIGURE 1

Modern Plant Layout

COKE OVEN INSTALLATION



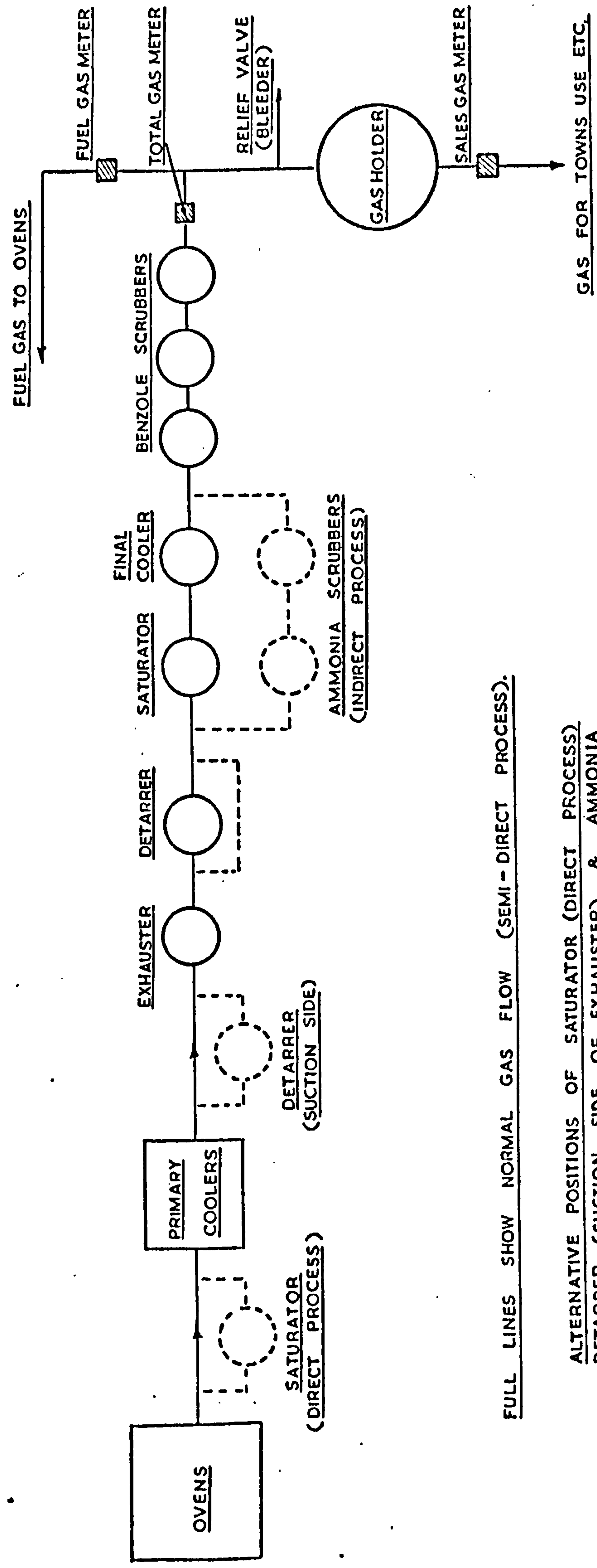
- |   |  |                                 |
|---|--|---------------------------------|
| 1 Coal Blending Bunkers                   | 16 Liquor Decantation Tank                 | 23 Waste Liquor Basin           |
| 2 Coal Crusher House                      | 17 Primary Coolers                         | 24 Lime Mixing Room and Store   |
| 3 Conveyor Drive House                    | 18 Electro-Detarrers                       | 25 Ammonia Still                |
| 4 Coal Belt Conveyor                      | 19 Exhauster and Sulphate of Ammonia House | 26 Final Cooler                 |
| 5 Ovens Bunker                            | 20 Sulphate of Ammonia Store               | 27 Benzole Scrubbers            |
| 6 Two Batteries each of 25 W-D Coke Ovens | 21 Saturators                              | 28 Crude Benzole Plant          |
| 7 Coal Charging Car                       | 22 Acid Storage Tanks                      | 29 Tar and Liquor Storage Tanks |
|   |  | 30 Water Cooling Towers         |

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FIGURE 2.

COKE OVEN & BY-PRODUCT PLANT.

GAS FLOW DIAGRAM.



FULL LINES SHOW NORMAL GAS FLOW (SEMI-DIRECT PROCESS).

ALTERNATIVE POSITIONS OF SATURATOR (DIRECT PROCESS) DETARRER (SUCTION SIDE OF EXHAUSTER) & AMMONIA SCRUBBERS (INDIRECT PROCESS) SHOWN DOTTED.

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## CHAPTER II

### SOME SOCIOLOGICAL AND TECHNOLOGICAL IMPLICATIONS OF THE

#### INDUSTRIAL REVOLUTION

##### Change of Ideas

##### General.

During the first half of the 18th century a new movement appeared in industrial society which had been gathering momentum almost unnoticed for nearly three hundred years. After 1750 industry passed into a new phase with, inter alia, a different source of power, different materials of construction, and different social objectives. The industrial revolution multiplied, vulgarized, and spread the goods produced. It was directed towards *improving* life and some writers suggest that its success be judged only in terms of size.

For a hundred years the Industrial Revolution was given credit for many of the advances which were made much earlier. In contrast to the supposedly sudden and inexplicable outburst of inventiveness after 1760 the previous seven hundred years have frequently been regarded as a stagnant period of small-scale petty handicraft production. How did this notion become popular? Perhaps one answer is bound up with the critical change that took place during the 18th century and overshadowed older methods. The main answer is probably due to change taking place first and most swiftly in Britain and the fact that observations of the new industrial methods were made by economists who lacked knowledge of the technical history of Western Europe, or who were inclined to belittle its significance.

Large scale opening up of coal mines meant that industry was beginning to live for the first time on accumulation of potential energy instead of upon current income. In the abstract mankind entered into possession of capital inheritance more splendid than anything ever known but in the concrete prospects were more limited. Exploitation of coal had penalties not associated with the extraction of energy from growing plants, wind and water. The extraction of coal is exploitation of reserves so that the colliery owner is a consumer of his own capital. Perhaps coal reserves were believed to be inexhaustible but this was unproven. As the surface measures were depleted the cost of extraction increased so that in one sense the colliery was the worst possible base for a permanent civilisation. When coal seams became exhausted the colliery closed, leaving behind debris and deserted property so that a disorderly environment resulted.

The challenge of quick capital gain from the vast coalfields gave impetus to mankind's desire for exploitation. Coal and iron were paramount to the success of an industrial society. Activities of the 19th century were heavily committed to the progress in iron and chemicals and mining affected the whole economic and social structure of the nation. In general terms growth of industry depended on output from collieries which in turn determined the direction of many inventions and improvements. (1)

The presence of the colliery was important initially for the steam engine and ultimately for the steam locomotive and by extrapolation the steam ship. The colliery was also important for the escalator and elevator which were first utilized in the cotton industry and the subway for urban transport. The railway is another derived benefit from the colliery. It may be said that

the 19th century town was in effect and in appearance an extension of the colliery. The cost of coal transport increases with distance so heavy industries tended to concentrate in the coalfields. (2)

Technical history from 1800 - 1900 was directly or indirectly bound up with the history of the steam engine. More efficient mining techniques and the need to reach deeper seams prompted efforts to devise a more powerful pump than human power or horse power could operate. They demanded a pump more regular and more accessible than the wind or water mills could produce so that galleries could be drained.

Newcomen, in 1712 erected an improved type of pumping engine but it was still clumsy and quite inefficient since it lost tremendous quantities of heat during the condensing cycle. Nevertheless it had more power than any other earlier prime mover and because of the application of steam power at the original source of energy - the colliery, it was possible to sink deeper shafts and keep them free from water. The main lines of a steam pump were known before Watt came on the scene so that Watt is credited not with the invention itself, but with considerably raising the efficiency by utilizing a separate condensing chamber and by utilizing the expansive pressure of steam.

Watt's improvement in turn required improvements in the metallurgical arts. Machine work was extremely inaccurate and the demand for better engines led to Wilkinson's boring machine and Maudslay's numerous inventions and simplifications a hundred years later. In particular Maudslay's perfection of the French slide rest for the lathe provided stimulus to machine crafts.

In many spheres the 1780s witnessed great advances; for example Murdoch's steam carriage and his contribution to gas



lighting, (3) Cort's reverberatory furnace, Wilkinson's iron boat, Cartwright's power loom, and Jouffroy's and Fitch's steam boats, the latter with a screw propeller, date back to this decade.

The whole technique of wood had now to be perfected in the more difficult refractory material, iron, and the need for coal developed with the larger demands for fuel that wide spread adoption of the machine carried with it. The fact that Watt's steam engine required about eight and a half pounds of coal per horse power in comparison with Smeaton's atmospheric engine which used nearly sixteen pounds, simply increased demand for Watt's engine and widened the area of exploitation.

The steam engine tended towards monopoly and concentration. Wind and <sup>water</sup> power were free but coal was expensive; so too was the steam engine and the machines that it turned. The mine and the blast furnace were characterised by twenty four hour operation and other industries which had hitherto respected the limitations of day and night fell into line. They were moved by a desire to earn as much as possible from capital investment - for example the textile manufacturers (4) lengthened their working day. Factories and mills were lit by gas and powered by steam so they could work almost continuously - why not the worker? The steam engine had taken over as pace maker.

The steam engine required constant attention by the stoker and the engineer so that steam power was more efficient in large units. The result was that instead of a host of small engines working when required one large engine was maintained in continuous operation. Steam power brought with it the tendency towards large plants and great size became a symbol of efficiency. (5) The result was that industrialists not only accepted concentration and magnitude as a



fact of operation, they came to believe in it as a mark of progress. Efficiency was supposed to exist in direct ratio to size so the large steam engine, factory and blast furnace fostered the impression that bigger meant better.

The steam engine tended towards bigness in another way. The railway increased travel distance and the amount of locomotives and transport but it worked within relatively narrow limits. Locomotives gave poor performance on gradients over two per cent so new lines followed water courses and valleys. This tended to bring the population away from the back country which had been served by roads and canals. With integration of the railway system and the growth of internal markets the population tended to increase in the great terminal cities, in junctions and in port towns. Main line express services tended to further the concentration and feeder lines and cross country routes ran down, died or were deliberately closed. As a result travel across country became arduous and it was often necessary to go twice the distance through a central town and back again, hairpin wise.

Iron and coal overshadowed everything else. No matter what the original colour of the surroundings it was soon reduced by soot and acidic gases to characteristic tones of grey, black and brown. The centre of the new industrialisation in Britain was appropriately called the Black Country. (6) The nineteenth century was characterised by pollution of the atmosphere. Manufacturers disregarded Benjamin Franklin's suggestion that coal smoke should be utilized a second time in a furnace because it was unburnt carbon. Instead they built factory chimneys without any attempt to improve the efficiency of combustion. In a similar manner they did not attempt to utilize the by-products from early coke ovens or utilize gases produced in the blast furnace. For all the boasts

of improvement the steam engine was only ten per cent efficient and waste was tremendous. Just as the noisy clank of Watt's original engine was maintained against his own desire to do away with it, as a pleasing indication of power and efficiency, so the smoking factory chimney became the boasted symbol of prosperity. Concentration of industry <sup>3</sup>aggravated the problems. Pollution and dirt from a small ironworks located in the country could be absorbed or carried away without difficulty. When twenty or more large ironworks were grouped together their combined atmospheric pollution and other waste products caused wholesale deterioration of the environment.

In the new chemical industries which sprang up during the nineteenth century no serious effort was made to control either atmospheric pollution or effluent pollution, nor was any effort made to separate such industries from the dwelling quarters of the town. (7) Even when chemical factories were not conspicuously present, the railway distributed smoke and dirt so that the reek of burning coal became the symbol of the new industrialism. A clear sky in an industrial district became the sign of a strike, a lockout, or an industrial depression.

If atmospheric pollution was the first mark of developing industry river pollution was a close second. (8) The discharge of industrial and chemical waste into streams was <sup>an undesirable side effect</sup> ~~a stimulus derived~~ <sup>of technological progress which had far reaching consequences</sup> ~~from cultivating numerous different modes of thought, living standards~~ <sup>disappeared.</sup> The result was insecure industry, unbalanced social life, an impoverishment of intellectual resources and often a physically depleted environment. Intensive regional specialisation at first brought huge profits to the owners of industry but the price it extracted was too high. Even in terms of mechanical efficiency the process was doubtful because it was a barrier against



that borrowing from foreign processes which is one of the principal means of effecting new inventions and creating industries.

Considering the environment as an element in human ecology shows the sacrifice of its varied potentialities to mechanical industries alone was very much against human welfare. Usurpation of park sites and bathing sites by new steel works and coke ovens, reckless placement of railway yards with no respect to any fact except cheapness and convenience for the railway itself, destruction of forests, and the building up of solid masses of brick and paving stones without regard for the special qualities of site and soil were all forms of environmental destruction and waste. The cost of such indifference towards the environment as a human resource is immeasurable but it is beyond doubt that it offsets a large part of the otherwise real gains in producing cheap textiles and transporting surplus foods.

By 1850 many of the fundamental scientific discoveries had been made, for example the electric cell, storage cell, dynamo, motor, electric arc lamp, spectroscope as well as the theoretical principles underlying electrical engineering. Between 1875 and 1900 detailed application of these inventions to industrial processes was carried out in the form of electric power stations, the telephone and the radio telegraph. Finally a series of complementary inventions, including the phonograph, moving picture, gasoline engine, steam turbine, were all progressing, if not perfected by 1900. These in turn brought about a powerful transformation of the power plant and the factory. They had further effects in suggesting new principles for the design of cities and for the utilisation of the environment as a whole. Outlines of the process were obscured by World War I and by the sordid disorders, reversions and compensations that followed it

but they were there.

### The importance of science.

A detailed history of the steam engine, railway, textile mill and the iron ship could be written without more than passing reference to scientific work of the period. These devices were made possible largely by empiricism and by trial and selection. The coking industry falls easily into the general pattern. Labour was cheap and lives were lost by the explosion of steam boilers before the safety valve was invented. All these inventions would have been better for science, they came into existence mostly without it making a direct contribution. It was the practical men in the mines, factories and machine shops who made major contributions towards the advancement of technology and engineering. Perhaps the only scientific work that affected technological design was the analysis of the components of mechanical motion itself. (9)

Two facts of critical importance became plain. First, the scientific method, whose chief advances had been in mathematics and the physical sciences, took possession of other domains of experience, the living organism and human society also became objects of systematic investigation though the work was handicapped by the temptation to take over categories of thought, modes of investigation, and special apparatus developed for the isolated physical world. The extension of science here was to have a particularly important effect upon technology. (10)

### Displacement of wage earners.

Typical productive units of the nineteenth and early twentieth centuries were obsessed with size so they increased in scale and



number without attempting to relate size and efficiency. To some extent this was due to a defective system of communication which preceded the telephone and this confined efficient administration to a single plant and made it difficult to disperse several units, whether or not they were needed on a single site. Help was also provided by the difficulties of economic power production with small steam engines so engineers tended to crowd as many production units as possible on the same shaft, or within the range of steam pressure through pipes limited enough to avoid excessive condensation loss. Driving of individual machines in the plant from a common shaft made it necessary to place the machines without close adjustment to the location of the work itself. (11) There were friction losses in the belts and the numerous belts offered special dangers to workers. Furthermore the use of shafts and belts limited the use of overhead transport by crane.

Introduction of the electric motor transformed many plants for it created flexibility in factory design so that not only could individual units be placed where they were wanted, the use of direct drive increased efficiency. The installation of electric motors made belt drives rare and opened the way for rearrangement of machines in functional units without regard for shafts and aisles in the old fashioned factory. Each unit could work at its own speed and start and stop without power loss through the operation of the plant as a whole. All these developments came about during the first half of the twentieth century and it goes without saying that in general only the more advanced plants incorporated all the refinements and economies. The coking industry is exceptional because many components do not lend themselves to continuous improvement. Plants are rebuilt at 25 - 30 year intervals (12) for technical considerations so that many advances are incorporated then. For

this reason chapter V shows that some plants had modern electric pumps installed early on while others, which had rebuilt at a less appropriate time continued with the old system. Chapter V describing Glasshoughton coking plant highlights exceptional disregard for replacing steam power by electric power as late as the 1960s.

Because of special features of the coking industry, the case for replacing steam prime movers with electric motors is much less clear out than in very many other industries. Retention of small steam engines was not wholly regressive, at least until the 1950s, although a sharp increase in the price of fuel later on made small steam engines uneconomic. Coke ovens require steam for two purposes; for power, and for heating and as a carrier in the distillation process. For reasons of economy most plants discharged pass-out steam from engines into a ring main for re-use as a heating medium or as live steam for distillation. Both high pressure and low pressure systems were balanced for maximum efficiency so that any financial gain from installing electric power had to be offset by the expensive device of bleeding high pressure steam into the low pressure steam.

Other industries which were exceptional include special operations such as iron production. In the production of steel from scrap iron the electric furnace is more economical for operations on a much smaller scale than the blast furnace permits. Even without the use of electric power the small workshop survived in defiance of confident expectations of early Victorian economists who marvelled over the mechanical efficiency of the monster textile mills. With electricity the advantage of size is generally questionable. Moreover the weakest part mechanically of automatic production lies in the expense and labour involved in preparation

for shipment, so that a local market and direct service dispensed with these operations and removed a costly and entirely uneducative type of work. Bigger no longer automatically meant better; flexibility to the power unit, closer adaptation of means of ends, and better timing of operation became new marks of industrial efficiency. Concentration became a phenomenon of market rather than technology because financiers saw large organisation as an easier mechanism for manipulation of credit, for inflation of capital values, and for monopolistic control. The electric power plant was not only the driving force in new technology, it was perhaps one of the most characteristic end products. From the movement of coal from a wagon or barge by means of a travelling crane, operated by one man to the stoking of coal in the furnace by mechanical feeder, power replaced human energy. The worker, instead of being a source of work, became an observer and regulator of the performance of machines - he was a supervisor of production rather than an active agent.

Qualities of the new worker became alertness, responsiveness, and an intelligent understanding of the operative components. In effect he had to be an all-round mechanic rather than a specialised hand. The following section shows how well the highly specialised coking industry fitted into the general pattern and later chapters describe in detail its influences on other industries and in turn their effect of the coking industry.

#### Early use of coke and industrial progress.

Abraham Darby (1678 - 1717) solved the problem of using coke for smelting iron. He was a Quaker ironmaster who was born near Dudley, learnt the trade of ironfounder in Bristol and in 1708



acquired the lease on a small charcoal blast furnace at Coalbrookdale, (13) see figure 1. His objective was to have control over his own supplies of iron used for casting pots and other small utensils.

Darby in effect took over a small furnace which was not particularly important but he was quick to see the potential of the site - the capability of expansion, timber, ironstone, clay, sand, limestone and, most important, coal were all available within a short distance from the furnace. A small stream ran down the valley and through the works before joining the river Severn. It was suitable for driving the furnace bellows and the Severn enabled Darby to transport the final products. Clearly Abraham Darby was much more than an ironfounder - he was an entrepreneur. Figure 2 gives an impression of how Coalbrookdale might have looked ninety years after Darby built his furnace.

Records show that the year after Darby came to Coalbrookdale 1709 he was using coke for iron smelting purposes. (14) It has long been recognised that Darby was the first person to use mineral fuel successfully and various dates for his achievement are given in the published literature. Detailed researches in the last twenty years or so have established the year 1709 as being the date of his success beyond doubt.

Why was Darby successful when others had failed? There are several reasons, some of which are fortuitous while others illustrate his keen business mind. He did not invent the coking process; coke was already in limited use for smelting because the smoke and sulphur fumes from coal were unacceptable. The fact that Darby was apprenticed to a malt-mill maker provided every reason for him to know of the use of coke in the smelting process. (16) Darby was well aware of the harmful impurities in coal in the context of



FIGURE 1

THE OLD FURNACE, COALBROOKDALE





FIGURE 2

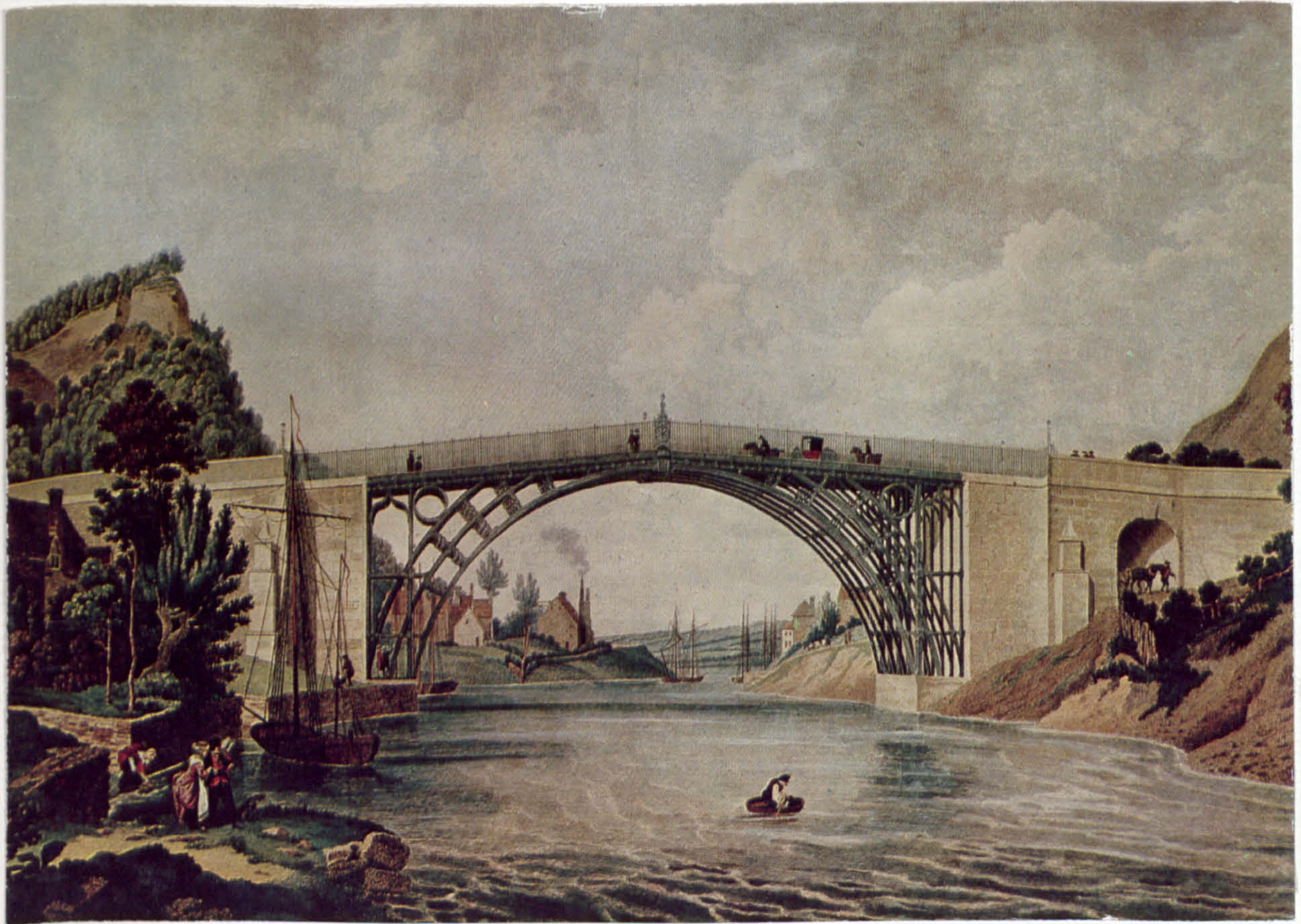
COALBROOKDALE AT NIGHT c 1800 (15)





FIGURE 3

THE IRON BRIDGE, SHROPSHIRE 1779 (15a)





brewing and he accepted that removal of them would improve the quality of the resultant iron. The local Shropshire coal had a low sulphur content which Darby was able to reduce still further by the process of carbonisation. Because coke does not burn as easily as charcoal Darby would need to provide a stronger blast and a larger volume of air for his furnace. In all probability he would need to modify the bellows and make alterations to the furnace because the internal shape is critical in detail; different fuels require small but significant changes. Also, he would find that coke had a better carrying capacity than charcoal because it is harder. The benefit of this phenomenon was long-term, furnaces eventually began to increase in size as a direct result of the use of coke. Other considerations were of more immediate interest.

Although Darby did not leave any notes of his technical problems it is known that he had to experiment before he was successful. It is recorded that he spent much time at the furnace even spending whole days there so that another important personal characteristic is revealed - tenacity.

Darby's success in using coke made from local coal as an alternative to charcoal is one of the great landmarks in the history of the iron industry. It freed the ironmakers from the restrictions of the charcoal famine and put them a step forward in the great expansion of the iron trade which was to follow. However, consistent with other discoveries, there was no sudden or dramatic change. Coke smelting was slow to spread so that more than a century later there were still some charcoal furnaces in use. The first printed reference to the smelting of iron, with coal at Coalbrookdale was in 1747. (17)



What were the factors which controlled the rate of expansion of coke smelting? Abraham Darby was an ironfounder who required iron for his casting business, he did not have any interest in wrought iron which was still the main product of the iron industry. The successors at Coalbrookdale did manufacture wrought iron but Darby remained a foundryman. He did not patent his process, neither did he publicize it. In view of the importance of the process and the possibility of other workers discovering it this may have been an oversight on Darby's part. An alternative view is that patents were rare and difficult, requiring an Act of Parliament with the result that simply trying to keep it quiet was common place - it might have been hard to enforce a patent, as Boulton and Watt found much later. The remoteness of Coalbrookdale meant that news travelled slowly and gives credence to Darby wishing to keep his success quiet. Since Darby was not producing wrought iron it is unlikely that other iron masters even if they heard of his method of smelting, paid much attention to it. Furthermore some areas where coke smelting would have been of interest were prevented from using it because of a lack of water power. One such area was the Black Country south of Staffordshire, not far from Coalbrookdale.

Eventually coke smelting increased in popularity and spread to other parts of the country so that by 1788 the number of charcoal furnaces in England and Wales had fallen to twenty-four, while the number of coke furnaces had increased to fifty-three, of which twenty one were in Shropshire. There were in addition a few furnaces in Scotland. Production had also increased so that the average annual output from the charcoal furnaces in 1788 was 545 tons and that from the coke furnaces was 909 tons.

In broad terms a coke-fired blast furnace was similar to an older charcoal furnace and Darby had proved that coke could be used in a charcoal furnace. Other furnaces were converted but the furnaces built specially for coke were larger.

Coke furnaces were able to operate continuously without having to blow out from time to time until supplies of fuel accumulated. An old problem of the iron industry - a fuel shortage - had been solved in part but charcoal was still required for the forges. This latter problem was overcome before the end of the eighteenth century.

Darby's successful use of coke highlighted another problem - a lack of power. Water power was limited in this country because suitable streams were not always where they were needed and in any case they were liable to freeze in winter and dry up in summer. The situation was less serious when charcoal furnaces were the sole means of producing iron and the pace of 'industry' was slower because a water shortage could be used to accumulate fuel. A coke furnace in contrast, needed plenty of continuous power. It was fortunate that while Darby was experimenting with coke the initial steps to develop steam power were taken.

Savery's engine of 1698 was used for mine drainage but it was no use to the iron industry (18) and Newcomen's engine of 1712 was directly used only for mining. (19) This engine, however, did have a link with the iron industry because the Coalbrookdale works supplied several cast iron cylinders for Newcomen engines and therefore marked the start of a link between the iron and engineering trades which grew in importance in years to come. Newcomen's engine had a cylinder, piston and rocking beam, and paved the way to the inventions of James Watt which were of major importance to the iron industry.



The Watt engine was at first only capable of reciprocating motion and, like Newcomen's, its interest was then confined mainly to the mining industry. However, though the first engine made by Boulton and Watt at their Soho works in 1775 was delivered to a colliery for pumping the second engine was delivered to an ironworks. John Wilkinson (1728-1808) designed the second engine to operate a blowing cylinder at his blast furnace at Broseley, not far from the Coalbrookdale works. Wilkinson was probably the most famous ironmaster of the eighteenth century. It was Wilkinson who realised that although the Watt engine could not power rotating machinery at this stage, the fact that it could operate a reciprocating pump for water meant that it could work a similar pump for air for blowing a furnace. Watt designed this particular engine which incorporated his patented separate condenser and Wilkinson built it. As a result Wilkinson supplied cast iron cylinders and pistons for Watt engines for many years, casting and machining them to the orders of Boulton and Watt and sending them direct to the place of installation where they were erected with other components under the supervision of Watt or a Soho engineer.

Wilkinson was a large-scale iron master who, at the time of the Boulton and Watt partnership, was the only person who could bore cylinders sufficiently accurately for the Watt engine. (20) The accuracy of machining was much greater than that required for the Newcomen engine and it was achieved by Wilkinson in 1774 with a machine invented for boring cannon.

The <sup>6</sup>business association of Wilkinson and the Boulton and Watt partnership emphasises the increasing interdependence of ironmasters and engineers. Wilkinson was an innovator with blast furnaces and ironworkers in Shropshire, Staffordshire and North Wales,

and he pioneered uses of iron. He built the first iron boat in 1787 and launched it on the river Severn, he also built a chapel for his workpeople at Bilston in Staffordshire and used iron for the door and window frames and the pulpit. (21) He was also one of the promoters of the famous iron bridge, see figure 3, which gave its name to the Severnside town of Ironbridge although it was primarily the work of Abraham Darby III (1750-89), the grandson of Abraham Darby I who was then in control of the Coalbrookdale works.

By 1750 ironmaking had undergone great changes and was almost completely ready to start the great expansion which followed after about 1800. Darby's coke smelting process had avoided the problems associated with a charcoal shortage. Watt's engine had provided a new and adaptable source of power so that they were in demand in other industries, consequently new markets for iron castings and forgings became abundant. As a result the manufacture of cast iron and the working of wrought iron by power tools became out of phase with the making of wrought iron itself. Wrought iron output rate was small and it still required charcoal as a fuel. There was therefore a need for making wrought iron from blast furnace pig iron.

Henry Cort (1740-1800) succeeded in making wrought iron by a new method but Thomas and George Cranage and Peter Onions came near to success before Cort made wrought iron using coal as fuel. The Cranage brothers patented their process in 1766 and Peter Onions took out a patent in 1783. Both patents were quite feasible but for reasons unknown neither was ever brought into commercial use.



Cort, who had a small forge at Fontley in Hampshire, used a reverberatory furnace to melt the pig iron and decarburize it to make wrought iron. The reverberatory furnace had been used for some metallurgical processes before Cort's time but he was the first person to use it for making wrought iron and patented the process in 1783 and 1784. In this process raw coal could be used because the fuel and the iron being decarburized were separated by a firebridge inside the furnace.

Cort's puddling process spread fairly rapidly even though it had some limitations, one of which was the fact that it was only capable of dealing with pig iron low in carbon and silicon. In order to make the process economical it was necessary to treat the blast furnace iron in a refinery before charging it to the puddling furnace. The refinery was similar to the earlier finery but used coke instead of charcoal. Puddling was the only remaining process needed to fill the technological gap in the second half of the eighteenth century and it retained its position as the standard method of producing wrought iron for about half a century.

Another important development by Cort was the use of grooved rolls for producing rolled shapes other than flat products. The process was covered by his patent of 1783. John Handbury had used plain rolls since 1720 for making iron sheet but Cort's idea enabled iron bar to be produced by having a groove equal to half the diameter of the bar cut in each roll. Cort did not originate the idea of grooved rolls but he made a success of them.

So much progress was made since Darby used coke in the blast furnace that it is appropriate to examine in more detail the ironworks and machinery as they existed towards the end of the eighteenth century. Blast furnaces had increased in size though

the shape and general appearance changed very little.

The growth of the blast furnace was due to two factors; the use of coke as a fuel, and mechanisation.

Steam power was used for blowing many, though not all furnaces and it was also used to reduce the cost of charging them. From 1781 onwards steam engines were increasingly used to haul barrows filled with coke, ore and limestone up an incline to the top of the furnace. This led to the engine hauled platform which could carry three or four barrows and in turn gave rise to the use of two platforms simultaneously. By the end of the century engine worked inclines were standard methods of charging blast furnaces except where natural geographical circumstances made it easy to assemble the furnace materials at furnace top height and wheel them across a short bridge. Such an arrangement can be visualised from the remains of a furnace of 1777 preserved at Coalbrookdale, see figure 1, page 39.

Blowing the furnace was provided by double water driven bellows or a double-acting steam powered blowing cylinder. Lower down the furnace an archway in the side of the brickwork provided access to the tuyeres whose wear and tear called for frequent replacement. At hearth level a low wall built from heat resisting stone and supported on the outside by an iron plate retained the molten iron until it was ready to be drawn off some twelve hours later. At the top of the dam was a slag notch and the iron was tapped through a hole normally closed by a plug of clay. The frequency of slag removal depended on the purity of the iron and the rate of production from the furnace.

Blast furnaces having the above characteristics were common at the end of the eighteenth century though a few of the older



furnaces still remained. Sussex had lost importance from a leading position to a producer of no real significance but a few charcoal furnaces continued working. (22) The last furnace there, at Ashburnham, continued working until 1809-10 and the last forge at the same place closed in 1820. Charcoal furnaces continued to be used on a small scale in other areas too; the last one closed in 1917, but by then the charcoal furnaces had *become obsolete*.

The picture at the forges was similar to that at the blast furnaces. Old fineries and chaferies still existed by 1800 but the numbers were decreasing rapidly and they were being replaced by a new works using the puddling process and generally employing steam power. Consequently a typical ironworks might have one or more blast furnaces, refineries, puddling furnaces power hammers and rolling mills. No longer was it necessary to be located near to water power and be spread out to make the best use of it.

The start of integrated works had been made with production units close together and conveniently situated for supplies of raw materials. (23) However, not every works was integrated so some ironmasters made pig iron and sold it to ironfounders and to foregemasters who did not own blast furnaces - a pattern which has continued to the present day. The facilities existed for those who wished to run integrated plants and Coalbrookdale with its blast furnaces and foundries was but one which still made cast iron hollow vessels. However this company developed several works in the Coalbrookdale area, including engineering works and wrought iron works. It also mined the raw materials and had an extensive narrow-gauge tramway linking the various works, pits and wharves. There were other works like it elsewhere in the country though

many smaller works existed as well. The growth of industrial society could not have progressed in the way it did without parallel growth of the carbonisation industry. This is described in subsequent chapters.

### Summary

The Industrial Revolution, which began in Britain during the eighteenth century, and which is still transforming the world, was also a social revolution. It changed not only the life of the country but also the size, structure and context of the institutions in which it was evolved. For good or for bad the revolution altered the quality of life; it changed the size and shape of the building in which work was carried out. It influenced the community, the houses in which people lived and their relationship with each other.

The geography of the country changed so that tremendous growth of town populations took place. *Cottage* industry was replaced by mills and workshops and the labour force worked for wages instead of being self employed.

There was a change from rule of thumb working in industry to a science base mainly because of the development of electricity and coal tar chemicals. Birth of the coal and steam era brought many side effects in its wake, not the least of which was dirty factories and chimneys, polluted atmosphere, foul rivers, giant spoil heaps and houses close to the place of work. The Industrial Revolution had to come but the question remains - should the coal based revolution have brought so much hardship when it was intended to allow society to progress and develop? The following sections attempt to answer this and other related questions.



## REFERENCES AND NOTES.

1. It also provided impetus to find a market for small size cooking coal not required by industry.
2. Chapter VI demonstrates the concentrated growth of coal mining and heavy industry in South Yorkshire and North Derbyshire in the 19th century.
3. This is described in more detail in chapter III.
4. For an account of how growth of the textile industry and the iron and steel industry influenced the chemical industry see S.F. Mason, A History of the Sciences, Cambridge, 1953 p.416-418.
5. In general terms increased size brought with it a reduction in unit cost which should not automatically assume an increase in efficiency. Heat transfer and thermodynamics were in their infancy.
6. By 1850 there was similar blackness around the Pittsburgh district of America and soon afterwards there were others in the Ruhr and around Lille.
7. Chapter VI, figure 18 is a good visual example.
8. These features remained unabated until well after the first half of the twentieth century.
9. The relationship between science and technology and between theory and empiricism in the making of investigations in the nineteenth century are discussed in J. Jewkes, D. Sawers and R. Stillerman, The Source of Invention, London, 1958, chapter III. These writers do not suggest that the relations were much different in the late 19th century from what they were in the late 18th century and early 19th century.
10. The development of organic chemistry is given by J.R. Partington, A Short History of Chemistry, London 1937, reprinted 1965, p. 300-322.

An account of many of the developments in the industrial application of chemical knowledge is given by F. Sherwood Taylor, A History of Industrial Chemistry, London 1957 chapter XIV et seq.

The History of the chemical industry developing against a background of geography, engineering, economics and sociology as well as against personal triumphs and disappointments of a number of great men is described by W.A. Campbell, The Chemical Industry, London, 1971.
11. Chapter VI figure 16 illustrates the principle.
12. Chapter IV refers in more detail.
13. This furnace has been preserved and forms part of the museum at Coalbrookdale.

14. T.S. Ashton, Iron and Steel in the Industrial Revolution, Manchester 1924, p.29-30
15. Reproduced from a painting by P.J. de Louthembourg in the Science Museum, London.
- 15a. *Reproduced from an engraving by Michael Angelo Cooke 1782.*
16. A Raistrick, Dynasty of Iron Founders, Newton Abbot, 1970, p.25.
17. C. Mason, Phil Trans 1747, Vol.XLIV, p.371.
18. This was by no means the first patent for the utilization of steam power but was the first which worked. For a description of some earlier ones, see H.W. Dickinson, A Short History of the Steam Engine, London, 1939, p.1-2
19. A Newcomen engine built in 1787 at Elsecar near Barnsley for draining a mine has been preserved on the original site, now owned by the N.C.B.
20. Patent No. 1063, for a Mill in which the casting, cylinder or cannon, rotates around a fixed boring bar along which the cutting tool can be traversed.
21. Cf the extensive financial contribution made by John Brown and Co.Ltd. towards the cost of building the new church at Brinsworth early in the 20th century - chapter VI refers.
22. Rhys Jenkins, Ironfounding in England 1490-1603, Part I Trans. Newcomen Soc., vol XIX 1938-9, p.35-49.
23. The fact that integrated works were becoming popular may have been a matter for common sense rather than financial acumen but the hypothesis is unproven.



## C H A P T E R   I I I

### THE   GAS   INDUSTRY

#### Introduction

Coke is the name given to the solid residue left by the destructive distillation of coal and other carbonaceous substances. It contains mostly carbon together with mineral matter or ash and smaller quantities of sulphur, phosphorus and arsenic.

Traditionally the aim of carbonisation has been to obtain as much as possible of the energy stored in the coal in a condition most appropriate to its ultimate uses. Because these vary widely, practical experience led to the destructive distillation of coal being carried out mostly under two distinct sets of conditions - one aiming to maximise the yield of gas and the other at obtaining the best possible coke.

Between 1912 - 1917 or thereabouts attempts were made to bring into line the two major industries of gas making and blast furnace coke production because both dealt with the destructive distillation of similar types of coal. There was an awareness that the properties of coals varied widely and different coals had different uses. However, in most cases there was a lack of appreciation of the principles underlying the mechanism of carbonisation and this proved to be an obstacle - each industry viewed the problem from its own standpoint and failed to grasp the differences between substances made as the result of a process designed for their special production and the same substances produced as a by-product.

Towards the 1920s and as a result of gradual evolution carbonisation of coal in bulk was carried out in practically identical plant; continental chambers were used to produce gas and the by-product oven was used for coke. Nevertheless two totally different practices developed. For instance, it was realised that coke must have special properties for metallurgical use which could not be produced during the process of manufacturing illuminating gas. On the other hand illuminating gas had to meet parliamentary requirements laid down for most large towns and also the same volume of gas could not be expected from coke ovens. Gas works did not have the economy of scale like coke ovens but they were compelled to carbonise relatively small charges in order to obtain the quality and quantity of gas. At this time gas retorts and coke ovens used similar temperatures but the rate of carbonisation in a coke oven and the mass favoured good quality blast furnace coke. The relationship between the gas industry and the coking industry is described in detail in the section describing the Woodall Duckham Company in chapter VIII.

Coke was produced at gas works simply because gas could not be produced by carbonising coal without it. The coke remained as a residue and very little attention was given to its quality. It was always understood that coke made in a gas retort could never be used in metallurgical processes. It was understood too that coke had certain distinctive physical and chemical properties which were dependent upon the nature of the coal carbonised, the temperature of the process, and the rate of heating. As a result the impracticability of combining two great carbonisation industries was accepted though



much of the ancillary equipment supplied by contractors was common to both gas works and coking plants.

### Social and Scientific Background.

The Gas Industry came into being during momentous years in Britain's history. In 1792, while Murdock was making his famous experiments in gas lighting at Redruth in Cornwall, France was proclaiming herself a Republic and preparing for the wars which were to prove critical and arduous to this country, and were not finally concluded until Wellington's victory at Waterloo - three years after the incorporation of the first gas company. It could not have been anticipated that, one hundred years later, the gas industry would play such an important part in providing munitions and other war needs without which 'it would have been perfectly impossible for this country to have waged the campaign.' (1) The function of the gas industry had changed from the supply of light to the supply of heat and by the striking results of the application of chemical technology to gasworks practice. The magnitude of the industry changed dramatically.

Coal gas was at first an object of suspicion and ridicule, mainly because of the dangers associated with it and few people were able to realise its potential. Even Sir Humphry Davy jocularly enquired if it was contemplated to use the dome of St. Paul's cathedral as a gas holder. (2) There were several facetious commendations but they were balanced by more restrained appreciations, one of which came from Colin Mackenzie in 1821 who stated that the streets were dismal prior to 1810 because

illumination was confined to oil lamps. He went on to state that the use of gas for street lighting divested the streets of many terrors. (3)

In order to understand the importance of such contemporary comments it is necessary to examine the social and scientific background of the times because the discovery of practical uses for gas, in common with those for steam, electricity, the internal combustion engine, and wireless transmission, had a far reaching impact on every day life. It is necessary to consider the achievements of the early pioneers of the gas industry in the circumstances pertaining at the time. Scientific knowledge was established only in areas appropriate to the period in hand and theories were advanced for specific purposes at the time, and this must be taken into account when considering the inventions which came from the workshop rather than the laboratory to comprise the Industrial Revolution. (4)

Many current theories were relatively crude and twenty five years after the first gas works had been used to supply gas to Westminster it may be doubted whether there were more than a *few* dozen people in Britain receiving systematic instruction in practical chemistry and in all probability that supply was equal to the demand. (5)

Considering that the gas industry was basically a chemical industry, the above statement is very significant and notions still current in 1827 are revealed by a historian of gas, William Mathews, who attempted to explain 'a few of the scientific terms and to elucidate some of the chemical principles, which are connected with the operation of gas-lighting, intended for the use of those who may not previously have any knowledge of chemistry.' (6)



The low value placed upon scientific research and education is shown by the fact that in 1800 John Dalton had just resigned his post as tutor at the Manchester Academy when he was thirty four years of age and was seeking pupils in chemistry for a fee of two shillings a lesson. As a professor of Natural Philosophy and Chemistry at the same Academy he was paid £80 a year. Almost 50 years later there was no laboratory in the country for practical instruction in physics and it was not until 1846 that William Thompson, who later became Lord Kelvin, used an old wine cellar in a former Professor's house in the University of Glasgow as a first physics laboratory. (7)

How was scientific knowledge shown in the manners and customs of the days when gas lighting was about to take the place of candles and oil lamps? The magic lantern, with an oil lamp as a source of light, was looked upon as a remarkable invention which provided amusement for all age groups. (8)

The hobby horse, which became the forerunner of the bone-shaker bicycle, was gaining popularity with men while the Plentum, or hand propelled tricycle was widely used by ladies.

The stage coach was the only transport available for long journeys and the absence of a properly organised police force made highway robbery easy.

Travel and work were almost impossible at night time and the well-to-do had to drive or walk with link boys carrying torches. The trials and difficulties were clearly, although excuseably, exaggerated in the annual 'Lamp Lighters' Poem' which was issued each Christmas and delivered in the form of an illustrated broadsheet to each door. The objective of issuing the broadsheet, which originated early in the 18th century, was to extract Christmas presents from the public.

## Discovery and Initiation

There is doubt about the name of the first person to use coal gas on a practical basis for illumination purposes. This is to some extent a debatable question and several strong claims have been put forward and later rescinded. The first authentic record of the fact that the distillation of coal would produce an illuminating gas that could be collected and stored for future use is given in a letter to the Royal Society dated 1688, from the Rev. John Clayton, D.D, Rector of Crofton near Wakefield. (9)

At this time Chemical and Physical Science was starting to emerge from the Alchemy period. The nature of gases was not understood although Boyle had published work on 'elastic fluids'. Many years later all gases were thought to be varieties of air and common gases such as methane (fire-damp) which came from mines and marshes were regarded as 'inflammable air', similarly carbon dioxide (chokedamp) from mines and breweries was known as 'fixed air'. In this period experiments on distillation were conducted by gentlemen of leisure and the results handed on to one or other of the learned societies being formed. Observations which fall into this category were made by Shirley in 1659 on the evolution of natural gas, by Sir William Lowther in 1733 (10) on gases found in coal mines and by Dr. Hales in 1727 (11) who measured the volume and weight of 'air' from Newcastle coals.

Joseph Black took a major step forward when he isolated carbon dioxide and showed that it remained unchanged through many stages of combustion. Black regarded it as 'fixed air'.



Joseph Priestley gave impetus to the chemistry of gases by discovering nitrous oxide, nitric oxide, ammonia, sulphur dioxide and oxygen. The phlogiston theory of combustion predominated in chemistry during the 18th century and so Priestley called oxygen 'dephlogisticated air' in 1774. (12) The phlogiston theory was no longer adequate and it was over-thrown by Lavoisier in 1774 - 1790 who provided a new rational basis for chemistry in terms of the oxygen theory of combustion. Lavoisier explained Cavendish's discovery of the formation of water from 'dephlogisticated air' and inflammable air (1786) as the combination of oxygen and hydrogen, the new names which had been given to these gases.

By the start of the 19th century, theoretical chemistry was sufficiently able to explain most of the chemical phenomena upon which the production and use of coal gas depended. George Dixon took a practical step forward in 1779 when he established the first works for extracting tar from coal at Cockfield, in Durham. (13) Dixon had been experimenting with coal distillation from 1760 when he used a kettle containing coal on his own fireplace. From this he developed a facility for lighting rooms in his own house and he envisaged lighting his collieries. A larger plant having a capacity of one ton of coal was built but this was wrecked in an explosion.

About the same time (1764 - 1766) two Frenchmen, Sacs and Chassier suggested collecting mine gases for lighting purposes and in 1765 Carlisle Spedding, an agent of the Whitehaven Collieries, succeeded in collecting mine gases for lighting his office and proposed that the scheme should be extended for

lighting the town. It is worthy of note that in 1952, 188 years later and in the same place this came to pass as a result of methane drainage by the National Coal Board. It is known that Lord Dundonald used coal gas from early coke ovens to illuminate Culross Abbey though the precise date is in doubt. (14)

Up to now, none of the experiments had any commercial value and they did not attract much publicity. During this period mechanical inventions were coming to the fore with Watt improving the steam engine, Smeaton assisting the iron industry, Hargreaves, Arkwright and Crompton inventing textile machinery and so leading to the commencement of the factory period and the Industrial Revolution.

The problem of assigning to any particular person the credit for making gas from coal and using it for light must to some extent be undecided but the genesis of the Gas Industry is credited to William Murdock, Phillipe Le Bon, Frederick Albert Winsor and Samuel Clegg. Murdock is credited with the largest part in the development. (15) He joined the well-known firm of Boulton and Watt as an engineer in 1777 after having been trained by his father, a millwright. He became the firm's Resident Engineer in Cornwall from 1779 - 1798 and was in charge of the erection and maintenance of their pumping plants in the area. He returned to the headquarters of the firm in 1798 and became concerned with steam engine manufacture until he retired in 1830 at the age of 76.

In 1808 Murdock was awarded the Rumford Gold Medal of the Royal Society for his work in connection with gas which culminated



in a paper entitled 'An Account of the application of the Gas from Coal to Economical Purposes'. (16). He was also a brilliant mechanical engineer and his inventions include the oscillating engine, the sun and planet motion, the eccentric, a working model of a steam-driven road carriage, the driving of machine tools in a workshop by individual vacuum engines powered from a central source as well as a number of specialised machine tools.

Phillipe Le Bon was the son of a Court official of Louis IV. He became a student of the École des Ponts et Chaussées in Paris in 1787 and by 1792 he had achieved considerable reputation as a scientific engineer who was responsible for inventing the fire tube steam boiler and the superheater. He also experimented with the elimination of smoke from furnaces by water washing. He was appointed engineer of the École des Ponts et Chaussées and devoted much time from 1792 until he was murdered in 1804 to the development of gas lighting. He submitted a paper to the Institut Nationale on this subject in 1799 after patenting his proposals in considerable detail.

Frederic Albrecht Winzer, born in Brunswick, was a man of extraordinary character, he was an amateur scientist, a speculator and a company promoter who had a lively imagination and fanatical zeal. Winzer studied Le Bon's work in Paris and conceived the idea of distributing gas through streets to individual houses by underground mains from gas works, (17) a situation which had already been achieved with water. Winzer's idea failed to receive support on the continent so he came to England in 1803 and changed his name to Winsor. He was instrumental in forming the first gas undertaking of which he was a director for a few years. He died in Paris in 1830.

Samuel Clegg had a good education and studied science with Dr. Dalton. As an apprentice at Boulton and Watt he was engaged in helping to develop Murdock's ideas on gas manufacture at Soho. Clegg left the firm in 1804, became a self-employed gas engineer, and designed and installed a number of gas works for individual factories. He is credited with numerous inventions, a number of which were important to the gas industry until the middle of the 20th century. By 1813 he was competent to produce the large gasworks needed for public supply and was appointed chief engineer of the first Gas Company. In 1808 Clegg was awarded the Silver Medal of the Society of Arts for his contribution to the Art of Gas production. In 1817 he left the Chartered Company and built a private works of advanced design for the Royal Mint, after which he left London and started gas undertakings at Bristol, Birmingham and Chester. From this time onwards Clegg gradually left the scene as far as the gas industry is concerned. (18) At least one writer believes he made a serious mistake after leaving the Chartered Company by joining an engineering firm in Liverpool in which he lost all his possessions and took up an engineering appointment with the Portuguese Government. He returned to England and finished his career as a Government surveying officer and was engaged in conducting enquiries in connection with the applications for new gas companies.

Perhaps Murdock is most well known for his investigations into gas manufacture, especially when he lit his house in Redruth in 1792. He was impressed by the amount of gas evolved from coal as well as with the brilliance of the light and the ease of



gas production. All this led him to institute several experiments to determine the relative cost of producing equal quantities of light by this means compared with oil and tallow. Clegg later claimed to be the first to propose coal gas as an economical alternative to oils and tallow as an illuminant.

Murdock requested James Watt's assistance in patenting his ideas in 1795 but at that time the firm were unwilling. In 1801, Gregory Watt, the son of James Watt, visited Paris and became acquainted with the work of Le Bon. When he returned to England, Murdock, who was established at Soho, was encouraged to resume his investigations. During this period Murdock was assisted by Samuel Clegg and by 1804 progress with the design of gas plants had reached a stage where Boulton and Watt were satisfied with the sale of gas plants and the first was installed through them by Murdock in 1805 at the large cotton factory of Messrs. Phillips and Lee at Manchester. By the time the plant was completed in 1807 it was using some 150 tons of coal per year. Murdock and Rumford received a Gold Medal for providing a detailed description of the plant. In 1808, Murdock installed gas plants at factories for Burleigh of Manchester, Gott of Leeds, Kennedy of Manchester and a factory in Glasgow.

The firm was very much against the starting of public companies because they thought they would restrict the progress of their business. However they continued to install some private plants for a few years but by 1815 they had ceased to make this type of equipment.

Murdock and Le Bon were unaware of each others' work and in 1792 Le Bon started experiments with wood gas, filed a patent in 1799 and added to it in 1801. The patent included the carbonisation of coal but it is certain that Le Bon used only wood for his experiments and demonstrations.

#### Social consequences of gas lighting.

The general gas lighting of London started in 1814 and by 1842 the last place to receive gas, Grosvenor Square, had been converted. The use of gas for lighting rapidly spread to other cities so that in the 1840s it was sufficiently widespread to make an impact on society. Was the impact on society in keeping with the simple change-over from oil lamps to gas lighting and what sections of the community received greatest benefit? In order to answer these questions it is necessary to look at the manner in which gas lighting became adopted.

The spread of gas lighting had a big effect on theatres, factories and other public places. It was responsible for increasing the length of the working day and improving the quality of social life. The advent of street lighting was responsible for creating a new class of worker, the lamplighter, who in common with many others at that time had an unenviable job, especially in inclement weather. Other unpleasant conditions existed in the retort houses by virtue of the heat, dirt, and the long hours expected of the workers. (19)

Many private houses had gas lights early on though the quality of the illumination they enjoyed varied widely. (20) Some writers claim that after an initial rapid expansion, domestic lighting did not become really widespread until the 1840s.



Based on research into the districts of Brinsworth and Canklow, and at the risk of generalising from the particular, the author is convinced that gas lighting was not widespread at this time. Special gas burners were designed for use in schools. There was an awareness that improved burner design might avoid the need for quite so many gas lights in school buildings. The advent of gas lighting had a two-fold impact on education, it helped with the efficient running of day schools but, quite traumatically, it made possible the establishment of evening classes which became a very important part of working class life in the later part of the 19th century.

As early as 1823 a Government Commission on 'Gas Lights' advocated them 'as a means of Police' for London. There was a strong belief that gas lighting of the streets would be an important crime deterrent and it is worthy of note that when gas lighting began in Manchester in the 1830s it was administered by the police force itself. One London gas company appears to have owed its existence to the desire to eliminate highwaymen from Whitechapel Road.

The manufacture of coal gas was essentially involved with the production of coke which was unsuitable for use in the metallurgical industries. (21) Winsor's suggestion that the coke should be used for domestic heating was taken up so that the sale of coke from gasworks became an important source of revenue.

Not all the social consequences of gas lighting were beneficial and in the 19th century there were many unnecessary deaths both from explosions and from coal-gas poisoning.

Without doubt many tragedies occurred at the source of production and at the point of utilization because of a lack of detailed knowledge of combustion. Perhaps there was indifference to the fact that consumers ought to have a fuel which was reasonably safe provided it wasn't misused. The reality was that science and technology were relatively unknown by most people who were in any way connected with the gas industry. As a result the industry eventually became safer because of entrepreneurs rather than because of academics who adapted their knowledge to the level of practical people. This viewpoint is possible but unproven.

Gas lighting was the predominant form of illumination in the 19th century. Its importance cannot be overestimated but towards the end of the century the advantages of electricity as a means of providing illumination started to gain impetus. The gas industry accepted the challenge from electricity but the long term advantages lay with the latter. The gas industry was able to prolong its life for several more decades as a result of a very important invention - the incandescent gas mantle. The gas mantle was originally a direct reaction to the challenge of the electricity industry but it had a side effect in that it opened up new areas of chemical discovery in the study of rare earths whose compounds were used in the production of gas mantles.

#### Methods of Gas Manufacture

Early methods of coal carbonisation, either for gas manufacture or coke production were unpleasant to say the least and technicalities made the former particularly objectionable. Although people in authority were well aware of the unacceptable part of gas



manufacture, they did nothing to make the process attractive. Did they fail to produce a remedy or were they shrewd business men who continued to put financial objects above all else? The answer is open to conjecture.

Progress in the manufacture of illuminating gas lay chiefly in the direction of securing a better yield of gas per ton of coal carbonised and an improvement in the yield of ammonia and liquid by-products. (22) Gas works coke was unsuitable for use in blast furnaces so there was a natural desire to improve the coke quality while maintaining the yield and calorific value of the gas. Coke ovens had the blast furnace coke market to themselves and for gasworks to enter this market would have necessarily meant they would have had to become more like coke ovens. Alterations in gas manufacture were made in two main directions:-

- (a) The development of vertical retorts, and
- (b) Attempts to secure greater efficiency in horizontal or inclined retorts.

The chief progress in vertical retorts was due to attention to details rather than to any new principle, chapter IV shows this comment could be applied equally well to the coking industry. One major improvement was that new batteries of vertical retorts avoided men having to deal with red hot coke. Coke discharged from the retort was comparatively cool and readily transported. This development was important in view of anticipated difficulties with labour in the immediate and long term future.

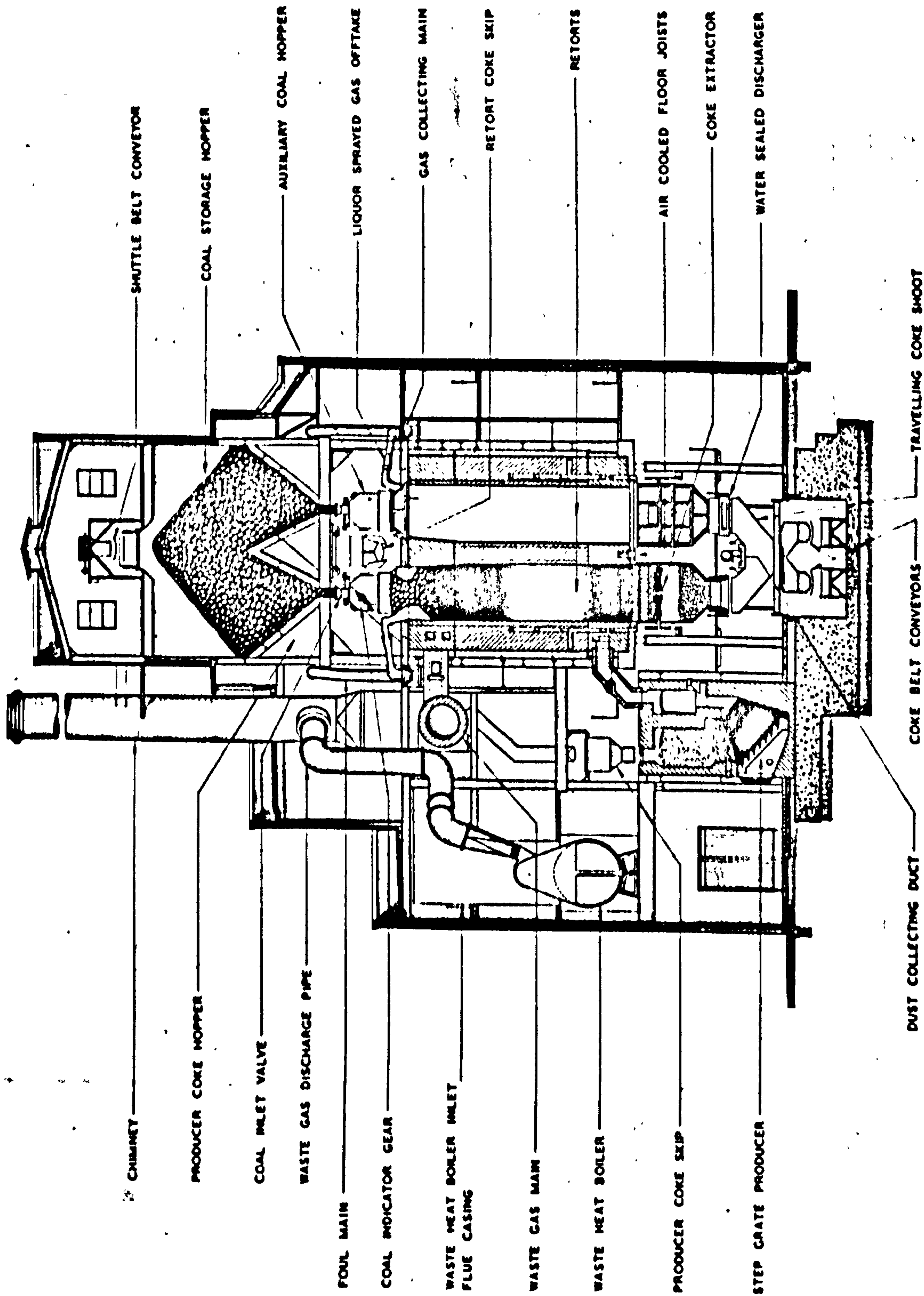
Another advance was the passing of hot gas through the retort so that the coal was almost in a fluidised bed and carbonised by radiant heat. (23) However, McLaren (24) observed that there was a serious reduction in calorific value of the gas but it enhanced the value of by-products even though the resultant oils had quite different properties so that their market value was uncertain. Better results were obtained by forming producer gas in the retort using a jet of steam. The fears that steam would have a serious effect on the brickwork were unfounded provided reasonable precautions were taken, (25) and the practice became a common feature of the Glover-West retorts.

Research into the gasification of coal was carried out with vigour and determination. Hollings and Cobb found, on a laboratory scale, that passing a current of crude coal gas through coke at  $800^{\circ}\text{C}$  yielded a large increase in the amount of gas. (26) W.B. Davidson (27) suggested that the gas should be passed through a chamber with walls at a temperature of  $760 - 815^{\circ}\text{C}$  in order to overcome the deficiency in unsaturated hydrocarbons which was characteristic of the gas from vertical retorts because of the heavy hydrocarbon vapours escaping. On a much larger scale, F.M. Perkin found that by passing coal gas through a vertical retort, the amount of tar produced per ton of coal carbonised increased.

Vertical retorts could be operated in three different ways, (i) intermittently, (ii) semi-continuously, (iii) continuously. The continuous retort produced coke which was not so large and hard but the intermittent and semi-continuous retorts incorporated a long rest period which was so essential for the production of hard coke, though they had undesirable fluctuations in the quality



*Fig. 1. W-D Continuous Vertical Retort*



of the gas. *See fig. 1.*

Vertical retorts offered better facilities for dealing with low grade fuels and many attempts to use them for carbonising high ash or high shale coals were made but they never proved commercially viable. This was partly due to the large amount of inert material which had to be passed through the retort and which had no value afterwards, but another contributory factor was the introduction of other devices which had desirable and undesirable features. For instance T.F. Winmill (28) used a vertical retort with an internal stirrer which carbonised 8 cwt coal in  $3\frac{1}{2}$  hours at a temperature of  $500^{\circ}\text{C}$  but the process was unprofitable because the constant stirring prevented the formation of coke and deprived the plant of a valuable product.

Vertical retorts had certain advantages where suitable fuels were available but they had obvious limitations, such as:

- (a) The difficulty of withdrawing the various products as they were formed.
- (b) The degradation of higher hydrocarbons when this was not required.
- (c) The impossibility of exercising little more than a general control over the temperature in various parts of the retort.

The general view was that vertical retorts were in a state of adolescence though their future was distinctly promising.

Inclined retorts had not met with the success expected and were regarded as an interesting stage in the evolution of



vertical retorts. Horizontal retorts remained by far the most popular. (29) The main progress made in respect of horizontal and inclined retorts comprised:-

- (a) More complete filling of the retorts in order to reduce the over-heating of the gas by the incandescent walls of the retort and to increase the yield of gas without decreasing the quality.
- (b) Better utilisation of the heating system by improving the arrangements in the setting of the retorts. Traditionally horizontal and inclined retorts were heated by producers built into the setting in order to avoid loss of heat by radiation and to reduce the capital cost of the installation. These producers required much attention and unless the firemen were skilled and conscientious, the fluctuations in the temperature of the retorts were detrimental to efficient gas production. Externally fired producers gave greater latitude in the type of fuel used, ammonium sulphate and tar were recovered more completely, and the cost of working was reduced. (30)
- (c) More efficient use was made of the waste heat by means of regenerators and recuperators in the setting.
- (d) The rate of heat penetration through the retort and into the charge was increased in the following ways:-
  - (i) By reducing the thickness of the walls of the retort.
  - (ii) By using retorts made of material having a higher thermal conductivity. (31)

(iii) By passing hot gas through the charge as well as using it for external heating. The gas could be inert or it could have a sufficiently high calorific value (e.g. water-gas) to make it a desirable constituent of the sales gas. Another alternative was to use gas which was decomposed in passing through the retort. This had several advantages when used in conjunction with live steam.

It was generally understood that ordinary horizontal retorts did not produce an acceptable blast furnace coke, the reason being that owing to the absence of compression, the coke was friable, soft and contained too much volatile matter and coke dust. There were some optimists who thought these difficulties were more apparent than real because ordinary coke ovens had essentially the same general characteristics as very large horizontal retorts. This vastly oversimplified the situation.

Much of the progress made in the gas industry was made possible by the rescinding of the old standard of illuminating power. The Gas (Standard of Calorific Power) Act of 1916 provided that, subject to the permission of the Board of Trade, the previous standard of illuminating power could be abandoned and a standard of calorific value substituted. The change to a calorific value basis obviated the need for gases rich in hydrocarbons so that the extraction of benzole and naphthalene became common. The rapid development of incandescent gas-mantles had made use of luminous gas unnecessary and substitution of a



minimum calorific power for a minimum illuminating power was long overdue. The removal of this restriction enabled gas manufacturers to take full advantage of the idea of passing water gas through the retorts to produce a high gas yield together with an improved quality and yield of by-products. The reasons for selecting a standard gross calorific value of 500 B.Th.U are unknown to the author, but it is worthy of note that early in the century it was felt that this value could not be achieved from coal alone in gasworks and that some admixture of water-gas appeared to be essential. This is indeed a strong indication of the shortcomings of materials of construction used in gas retorts and also the inability to build retorts that were airtight. It is reasonable to believe that the calorific value which became accepted was in fact a reasonable maximum. However, the fact that admixture with water-gas was considered necessary to reach the desired calorific value suggests there was a considerable lack of understanding of related science. Both points of view have merit but their relative influence is unproven.

Undoubtedly this Act conferred several advantages but the general question of the calorific value of towns gas was in a bewildering and chaotic position. There were only about 120 companies or corporations out of some 800 undertakings which had power under the new standard. This was an anomalous situation and the time had come for the standard to be enforced by law. Adoption of the standard would enable the gas yield per ton of coal carbonised to be increased and it would also enable manufacturers to test and standardise cooking and heating appliances before they were sold. Gas undertakings using horizontal and inclined retorts could benefit from the

latter and those having vertical retorts could increase the yield of gas, tar and ammonia,

The mixing of coke oven gas with town's gas for illuminating and heating purposes was long regarded as a desirable means of using the former. In Middlesbrough, Leeds and Sheffield this was already being done with considerable success even though only the rich gas evolved in the earlier stages of coking was used for the purpose. The gas evolved during the later part of the carbonising cycle was used for heating the ovens and supplying power. (32)

Benzole was first extracted from town gas in the 1914-18 war when its toluene content was desired for high explosive manufacture. After the passage of the Gas Regulation Act of 1920 and the consequent sale of gas by its heating value it became customary to remove benzole when it was profitable to do so, in particular from the richer gases of the various systems of carbonisation. Prior to this Act gas was sold on its illuminating value. The duty obtainable from a gas was rated in terms of candle power per cubic foot when gas was burned in burners of a certain type. The luminosity of a flame burning under these conditions depends largely upon the aromatic hydrocarbon content of the gas and, since benzole recovery removes some of the aromatics, the duty also falls. The size of installation was as important as type in respect of economic recovery of crude benzole. The recovery of benzole, amounting up to 3.5 gallons from each ton of coal, was largely used in the Dyestuffs and Plastics Industries, and as motor spirit. The gas industry was able to take advantage of its own developments in chemical engineering plant design, as well



as those in the oil and chemical industries. (33)

### Traditional Gas Industry

Prior to World War II the gas industry comprised hundreds of mostly small undertakings operating under statutory control and serving a small geographical area. A large majority of the gas works were below the economic optimum size and only Nationalisation of the industry could change the structure to improve efficiency. These generalisations can be applied equally to the coking industry, see chapter VII. The Gas Act of 1948 set up twelve Area Boards with power to manufacture, buy and distribute gas in their areas. The Gas Council became the co-ordinator and supervisor of the Area Board's activities and held the responsibility for raising capital, dealing with industrial relations and providing research. The industry was highly decentralized from the outset insofar as the Boards had full responsibility for production, investment, pricing and marketing policies. There was no national gas grid and the transfer of gas between Boards was virtually non-existent. Up to 1960 the absence of a national gas grid was unimportant because the production of gas at large plants supplying the needs of a number of Boards was considered to be technically and economically impossible.

Three processes were used to make gas:-

- (1) Carbonisation - This involved heating selected coal in closed vessels. This process produced gas and also by-products, the most important of which was coke. The viability of the process relied on the sale of by-products. The North Thames Gas Board had a large coking plant as part of its gas manufacturing equipment.

(ii) Water Gas - Steam and air were blown through red hot coke to produce low calorific value gas which had to be blended with rich gas to raise the calorific value up to the statutory requirement.

(iii) Oil Gas - Several processes were used to 'crack' the oil by the action of heat to produce gas.

The demand for towns gas from 1920 to the late 1950s has fluctuated year by year but the general trend has been upwards. This is shown pictorially in figure 1.

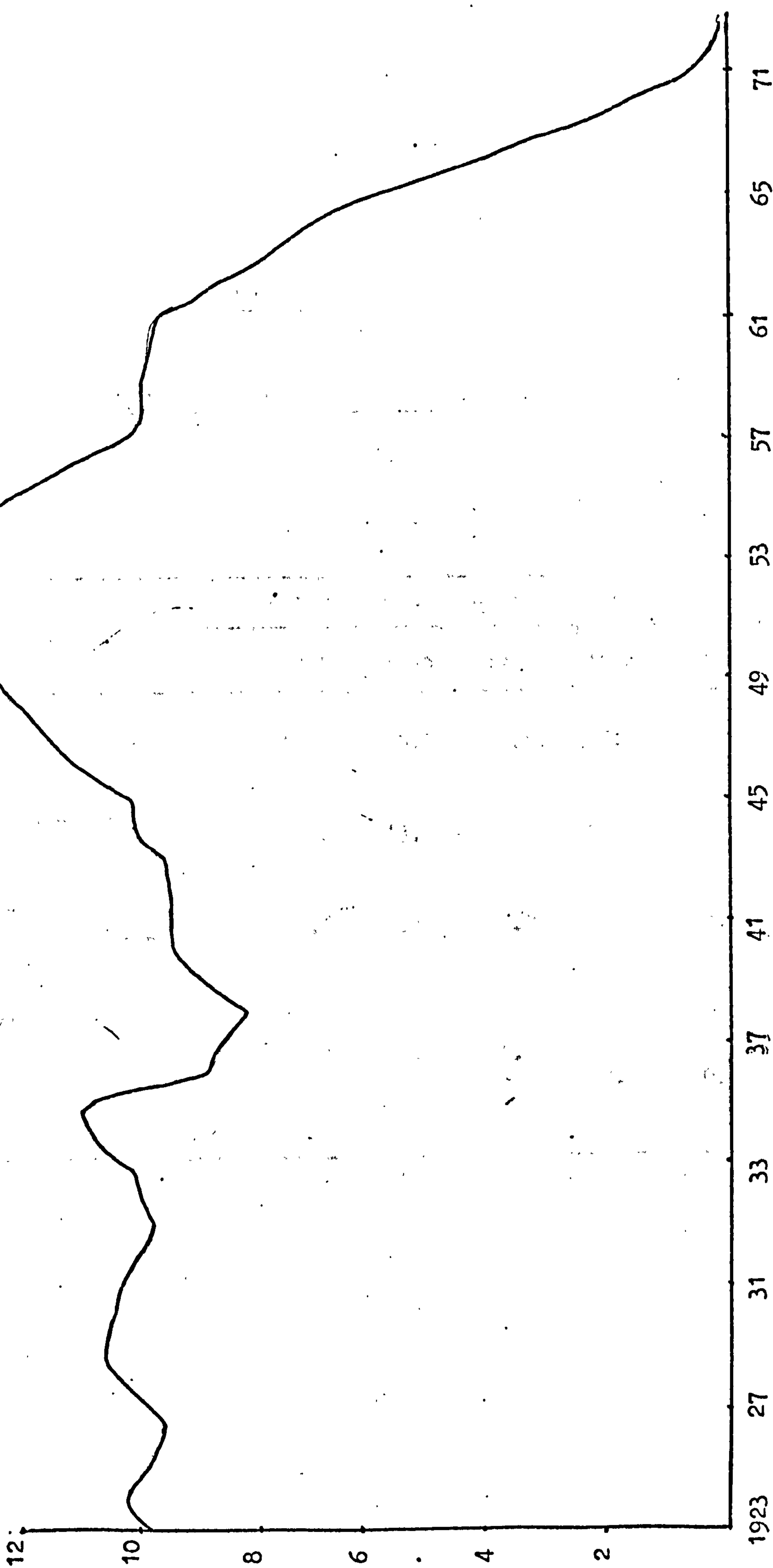
Although data for the numbers of various types of gas retorts are not available, the amount of coal carbonised in the different retorts given in figure 2 which indicates the increasing number of vertical retorts, especially continuous vertical retorts that were in operation. Horizontal retorts and continuous vertical retorts dealt with about 30 per cent and 55 per cent respectively of the total coal carbonised at gasworks.

In contrast coke ovens at gasworks accounted for about 5 per cent and intermittent vertical retorts accounted for most of the remaining 10 per cent. The increase in the coal carbonised by miscellaneous types of plant shown in figure 2 is probably entirely due to the use of coke ovens for gas production by the North Thames and South Eastern Gas Boards, as indicated by the data for 1954 and 1955. The growth and decay of the conventional carbonisation plant for gas production is illustrated in figure 1a.

All the Area Boards bought additional supplies of gas from N.C.B., B.S.C. or independent coking plants. The purchase of coke oven gas was especially important to the Boards in Wales,



FIGURE 10.  
COKE PRODUCED AT GAS WORKS (34)



# FIGURE 2

## COAL CARBONISED AT GASWORKS (35)

	Coal Carbonised in million tons					
	1946	1948	1950	1952	1954	1955
Horizontal retorts	9.6	10.1	10.3	9.5	8.2	7.8
Continuous vertical retorts	10.9	12.0	13.0	14.4	14.9	15.7
Intermittent vertical retorts	1.4	1.6	1.8	2.2	2.5	2.7
Coke Ovens	0.5	0.7	0.8	1.4	1.3	1.4
Others					0.3	0.2



the East Midlands and the Northern region. Some methane was purchased from collieries and a very small amount of natural gas was used by two Boards.

For the first decade after 1950 the sale of gas increased by only 5 per cent overall. Increases in industrial and commercial sales were offset by a decrease in domestic sales which accounted for about half the total sales in 1960.

During the same period electricity sales increased by 125 per cent and oil sales rose by 145 per cent so that the proportion of gas to the total energy requirement decreased from 17.5 per cent to 14 per cent. Why was the increase in gas sales so

slow? During the 1950s gas prices rose rapidly in relation to alternative fuels. Gas increased by 64 per cent while

electricity and oil increased by 24 per cent and 40 per cent respectively. The rapid increase in gas prices reflects the

trend of costs in the industry. In 1960 61 per cent of gas making capacity was based on coal and this contributed to the

escalating costs - see figures 3 and 4. High grade coal was in relatively short supply because it was more difficult to

mine. It also required substantial preparation at the washery

and as a result this coal was more expensive than the low-grade coal used for electricity generation. Because of the relative

scarcity, coal for the gas industry increased in price by

70 per cent between 1951 and 1960 while coal for power stations rose by only 45 per cent. At the time coal for gas making

was expected to become progressively more expensive. Another

factor in the relative increase in gas prices was that the

conventional carbonisation process had high capital and high running costs and it could only operate economically with a

high load factor and continuous production. Therefore carbonisation

FIGURE 3

GAS SUPPLIED AS A PER CENT OF THE

TOTAL AVAILABLE (36)

Date	Gas Made					Gas Bought		
	Coal	Water	Oil	Other	Total	Coke Ovens	Other	Total
1950/57	71	15	—	1.9	87.9	12	0.3	12.3
1958/60	61	14	2.2	0.9	78.2	17	4.5	21.5



FIGURE 4

COST OF PRODUCTION OF GAS 1959-60 (37)

Made gas	Price per therm
Coal gas	5p - 6.25p assuming high load factor
Water gas	4p - 6.25p according to technique and load factor
Oil gas	3.42p - 4.17p with favourable load factor 5.33p when used for peak load
Bought Gas	Price per therm
Coke Ovens	2.71p unpurified
Refinery gas	3.32p - 3.71p
Mine Methane	2.9p unpurified
Domestic natural gas	3p - 3.46p

plants were inappropriate for seasonal or daily peak demands. The industry was able to store gas in sufficient quantity to meet daily peak demands but it was unable to even out variations in production between summer and winter seasons to allow the carbonisation plants to operate continuously at a high rate. Figure 4 shows that even with a high load factor carbonisation plants were expensive.

Bought gas was attractive to the Gas Boards but to a large extent the quantity was out of their control and only 21.5 per cent of the total gas demand was bought in 1959 - 60. Water gas and oil gas were relatively cheap sources of producing small quantities of gas to meet peak demands but the carbonisation process was the only one which could provide the base load requirements.

In 1959 - 60 the demand for gas was stagnant but prices were rising relative to other fuels, and the major source of gas needed expensive production methods based on coal, whose price was rising rapidly. In this period the Gas Council was anxious to find a process for producing gas at a cost of 3.3p - 3.5p per therm.

#### The Gas Industry 1960 - 1970

Three potential sources of cheaper gas were available in the 1960s.

##### (i) The Lurgi process.

This totally gasified cheaper low grade coal completely without producing coke as a by-product. The process was examined in detail in the 1950s and two plants each having a capacity of 30 mcf/d and 40 mcf/d came on stream in the early 1960s. The cost of producing this gas was 4.02p



and 4.69p per therm because the N.C.B. supplied the coal at an artificially low price. Both these two plants were well below the optimum size and an intensive study by the Gas Council and the N.C.B. estimated that in 1964 a 100 million cubic feet per day Lurgi process would produce gas at 3.44p - 3.54p per therm provided the load factor was favourable. Though collaboration between these two nationalised industries resulted in a process which met the Gas Council requirements in respect to cost almost completely, there was obviously some collusion on the part of the N.C.B. to supply coal at a price which would enable gas to be produced at a pre-determined cost. The N.C.B. were anxious to retain the Gas Board market for coal but they had their own financial problems. The unanswered question is - how long would one nationalised industry be prepared to subsidise another at a time when both industries were coming under close scrutiny both internally and externally?

(ii) Importation of methane.

Liquified methane was first imported from Algeria on a commercial scale in 1964. The methane was stored in refrigerated tanks at a specially constructed terminal at Canvey Island and distributed through a new high pressure grid to seven English Area Gas Boards. The methane was reformed or used to enrich lean gas such as that produced by the Lurgi process. The cost was estimated at 3.54p - 3.65p per therm and the supply potential was considered to be large. The prospect of the Gas Council developing

this source of supply was probably instrumental in encouraging the N.C.B. to help the financial viability of the Lurgi process.

(iii) Oil-gasification.

In 1962 Imperial Chemical Industries Ltd. were looking at methods of obtaining ammonia for fertilizer manufacture more cheaply. A method of using high pressure steam to reform light distillate (naphtha) was developed for this purpose and it also proved to be a cheap source of lean gas. The Gas Council devised a method of enriching the gas to meet their own requirements. These new techniques constitute by far the most important development in gas production technology.

Advantages of oil-gasification over the traditional method of gas production were remarkable. The capital cost was less than one-third that of an equivalent Lurgi plant, small oil-gasification plants could be produced without appreciably altering the economics and they were sufficiently flexible to be used on peak loads. They required less land and labour than the Lurgi plants without the attendant effluent problems. The net result was that production costs were 2.92p - 3.33p per therm - well below the Lurgi estimate. The oil-gasification process yielded gas at high pressure so that transmission costs were reduced and the high pressure grid linking areas became a reality.



Understandably the Gas Council terminated development work on the Lurgi process and Area Boards started to invest heavily in oil-gasification plants. The change to oil-gasification plants was massive so that in 1967 - 68 nearly 75 per cent of the total gas-making capacity was produced by this method, whereas in 1960 - 61 it was only 6.7 per cent. Much of the traditional carbonisation plant had been dismantled and the number of gas works almost halved. The changed production methods brought about a corresponding change in the feedstock for the industry. The requirement for coal decreased from 22 million tons in 1960 - 61 to about 13 million tons in 1967 - 68 while the demand for light oil increased from 0.4 million tons to 4.3 million tons over the same period. Figure 5 shows the maximum daily plant capacity increased by over 100 per cent as a result of the massive growth in demand for gas in the 1960s. Figure 6 gives details of the gas sales in the same period.

It has already been stated that between 1950 and 1960 gas sales increased by only 5 per cent. In contrast the period 1960 - 68 saw gas sales increase by 61 per cent attributable almost entirely to the increasing demand in the domestic market caused by the promotion of space heaters and central heating systems. In effect the gas industry created demand. Sales of gas space heaters increased from 265,258 in 1960 - 61 to 878,998 in 1967 - 68 and warm air boilers and central heating units increased even more rapidly. What circumstances brought about such a change? One factor was the drastic change in the design and style of gas fires and heaters,

# FIGURE 5

## MAXIMUM DAILY PLANT CAPACITY 1961 and 1968 (38)

Type of Plant	Gas Volume mill.cu.ft./day		Per cent change	Per cent of total plant
	1961	1968	1961-8	1968
Carbonisation	1341.2	646.6	- 52	11.2
Lurgi	15.0	96.0	540	1.7
Oil gasification	167.3	4202.3	2412	73.1
Water gas etc.	975.8	806.8	- 17	14.0
Total plant	2499.3	5751.7	130	100.0
No. of gasworks	378	192	- 49	-



FIGURE 6

GAS SALES 1960-1 AND 1967-8 (39)

Outlet	Million therms		Per cent change	Per cent of total
	1960-1	1967-8	1960-1 to 1967-8	gas sold 1967-8
Domestic	1291.2	2652.1	105	63.1
Industrial	851.8	914.5	7	21.8
Commercial	405.9	569.9	40	13.6
Other	63.4	62.6	- 1	1.5
Total sales	2612.3	4199.1	61	100.0

Another factor was the successful 'High Speed Gas' advertising campaign which started in 1962 - 63 to improve the image of gas as a domestic fuel.

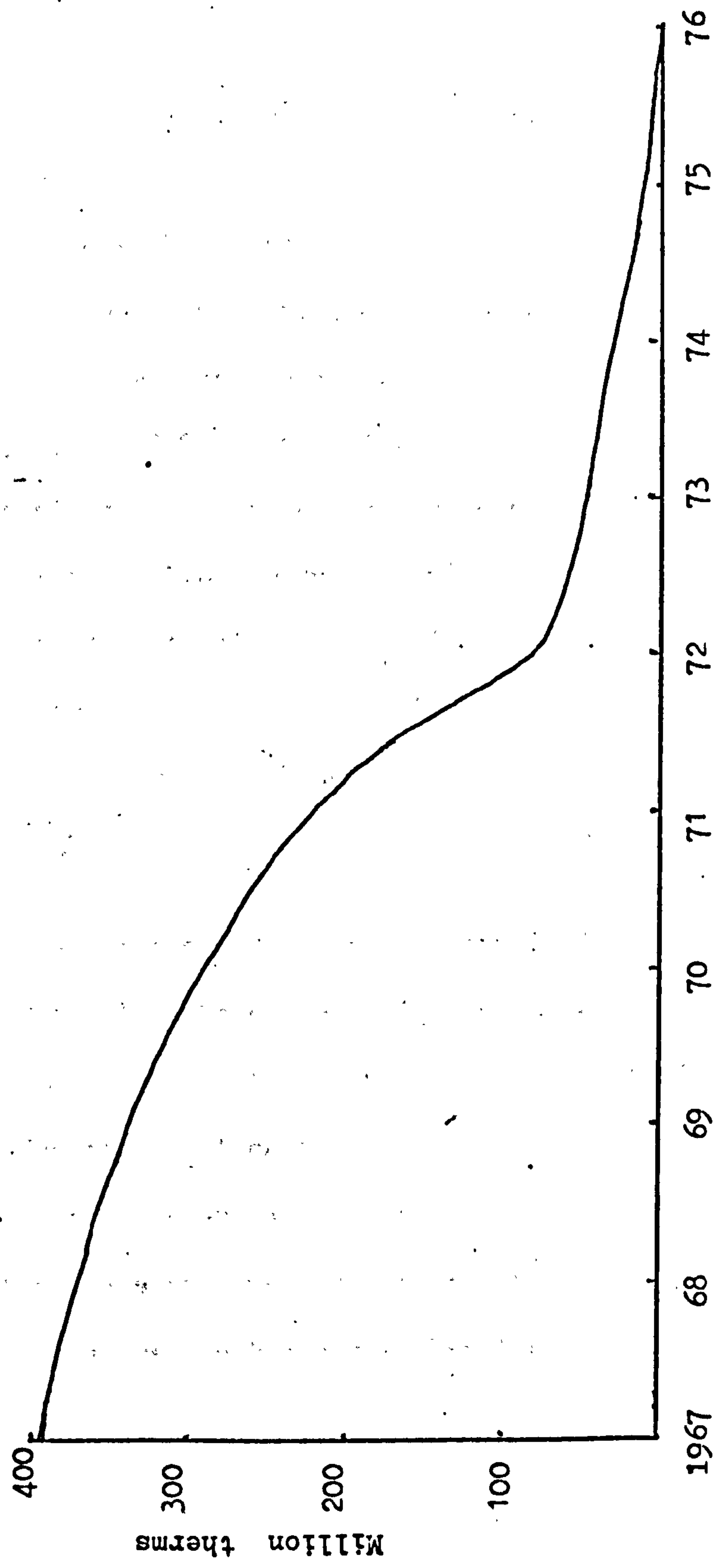
Increased domestic sales gave rise to peak demands which increased faster than the total demand so the proportion of gas supplied in the six winter months (October to March) increased from 57 per cent in 1960 - 61 to 63 per cent in 1966 - 67.

The industry was much better able to meet these peak periods than it had been in the 1950s because of the advent of oil-gasification. The oil gasification plants had stabilized the net cost of gas production and were economic at low output so they could meet peak demands more efficiently than the conventional carbonisation plants. The carbonisation plants which had survived were more expensive than an equivalent oil-gasification plant. They were most economic at high output. Consequently they were used intensively to supply the base demand, see figure 7. In 1967 - 68 carbonisation plants provided 34 per cent of the total gas requirement though they represented only 11 per cent of the gas making capacity. By this time the N.C.B. had carried out a ruthless programme of closures to bring the production of coke more in line with demand and allow the massive coke stocks to be reduced. The demand for gas and for coke were divergent in this period and in order to meet contract conditions for the supply of gas an attempt was made in the North Eastern Division of the N.C.B. to operate coke ovens on variable throughput according to the anticipated demand for gas requested by the East Midlands Gas Board. The scheme did not work well and it probably



FIGURE 7

COKE OVEN GAS SOLD TO AREA GAS BOARDS (40)



caused considerable damage to oven chambers, specially at Manvers. It violated the cardinal rule that coke ovens must be operated on a consistent schedule. The coke stock position is depicted in figure 24 *chapter VII*

The conventional carbonising plant which the gas industry had developed and relied upon for so long was given a last chance to compete with modern methods of gas production for a short while. A few years later, the gas industry changed its role and became simply a distributor of natural gas, see figures 2, 3, 8 and 9. The net result was that the traditional methods of gas production and the modern processes terminated their existence almost simultaneously. The history of conventional gas production and distribution had gone full circle. The unanswered question is - will the traditional gas industry be reborn and rise to become one of Britain's major industries again?

The following chapter shows how the coking industry developed in its own right although several aspects were developed in co-operation with the gas industry to the benefit of both of them. The next section is given as a finale to the present chapter and a prelude to chapter IV. Links between the two industries were at their strongest during the first quarter of the twentieth century when the industries were most complementary.



FIGURE 8

TOWN GAS DEMAND (41)

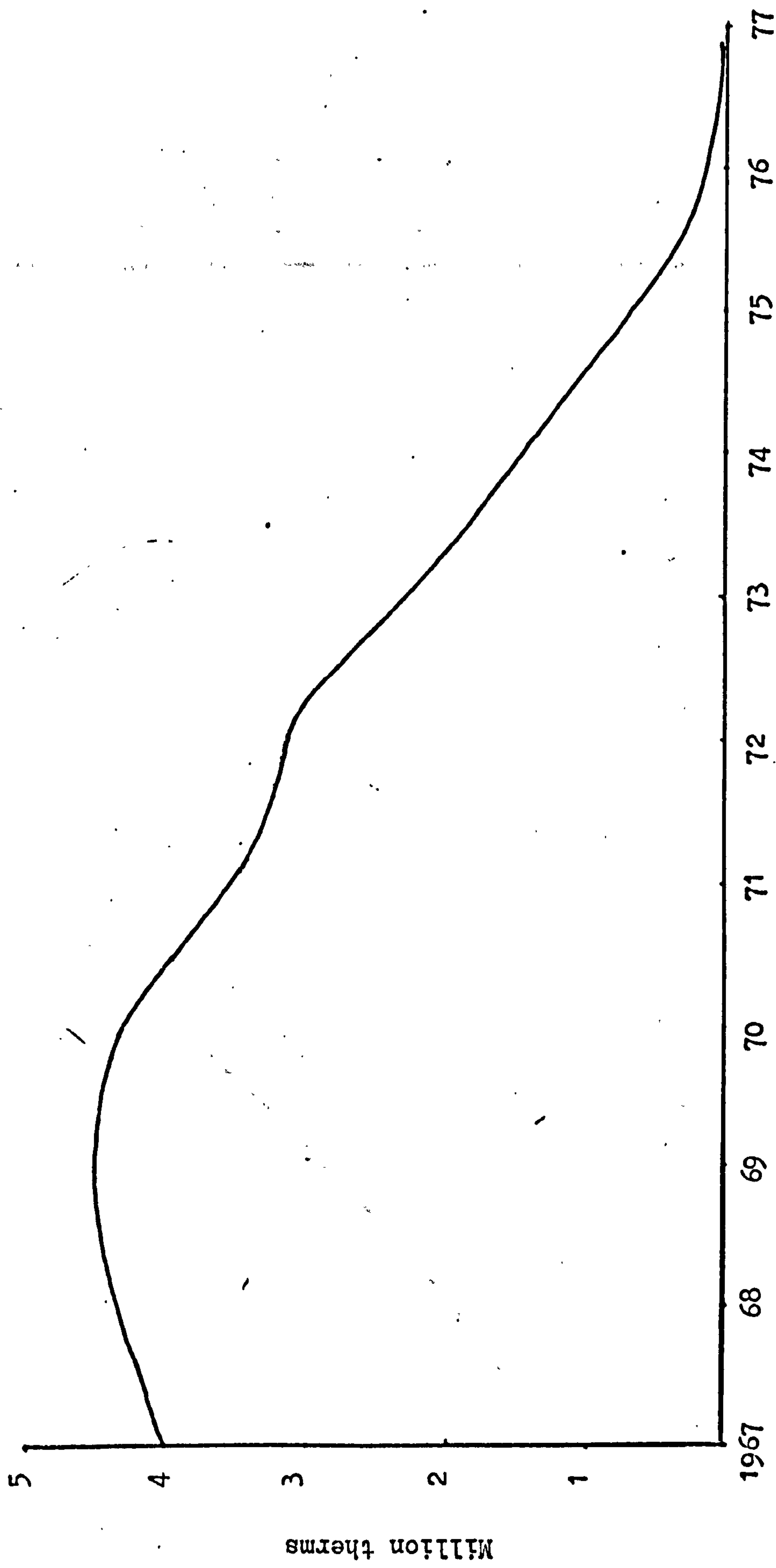
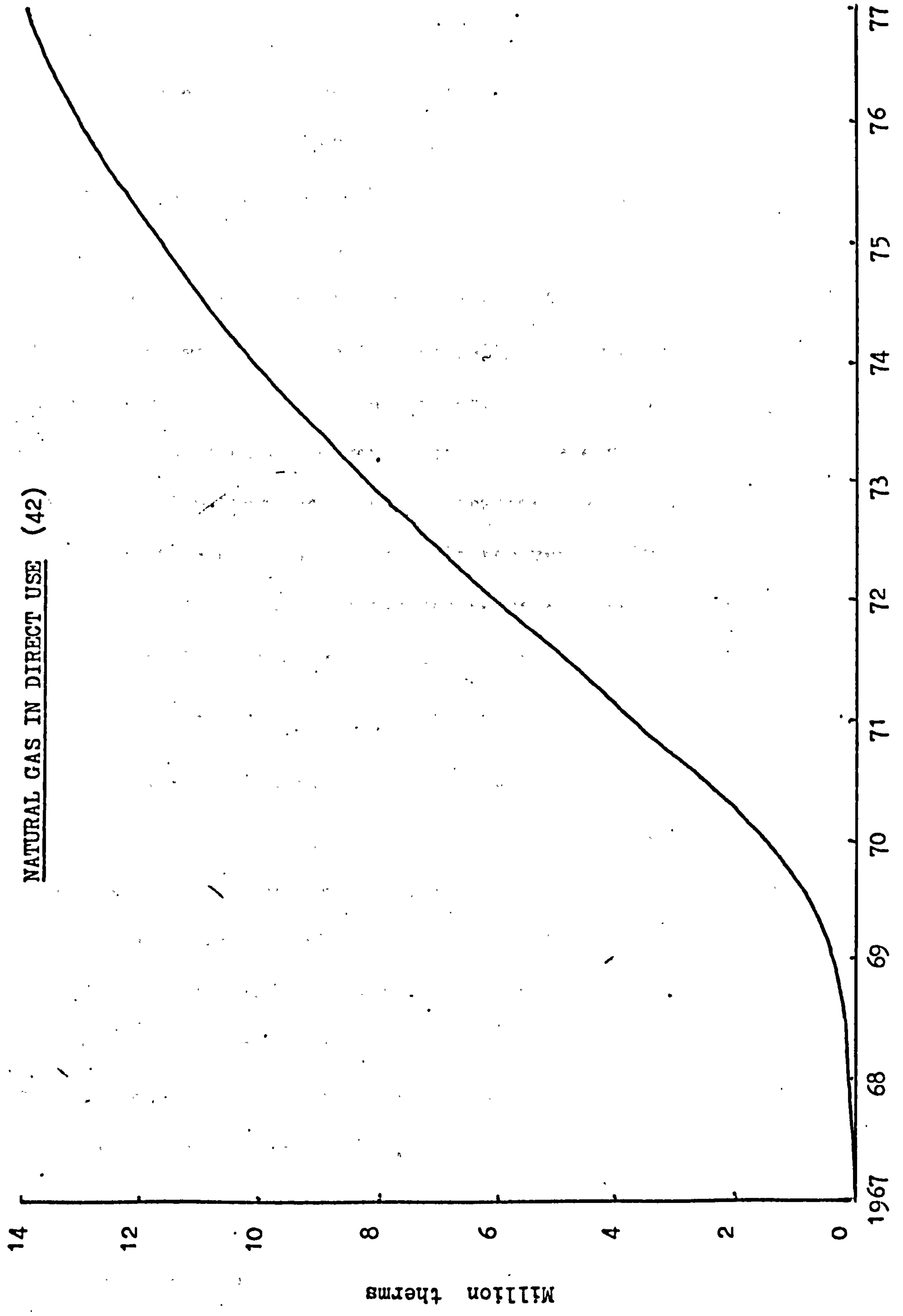


FIGURE 9





## Relationship between gas production and coke production.

Carbonisation of coal for town gas and for the production of metallurgical coke have some similarities and any advance with the former had an influence on the latter and vice versa. This is illustrated in detail in chapters III, IV and VIII. It was inevitable in the early days of by-product coking, when recovery was confined to tar and ammonia, that methods and plant adopted were modelled almost universally on gasworks practice. Later, many of the improvements effected by coke oven constructors, especially in ammonia recovery processes, were utilized in modern gasworks, while from early in 1914 onwards the principles enunciated and the experience gained in benzole recovery on by-product coke ovens was very important to gas engineers working towards solving the problem of increasing the supply of benzole and toluene for national needs.

Murdoch's simple iron cylinder for treating a small charge of 15 lb coal gave way to small firebrick ovens capable of dealing with a charge of 4 cwt to 5 cwt, until these, in turn, were replaced by oval shaped and circular fireclay retorts. Economy and rapidity of charging and discharging demanded the introduction of machinery for these processes and the through retort resulted. Retorts were built in horizontal tiers until about 1855 when the inclined system was introduced, thus utilising gravity for charging and discharging.

The invention of the incandescent mantle, and the possible consequent lowering of the standard of candle-power, induced gas engineers to search for new methods of carbonising, leading finally to the introduction of a vertical retort, capable of dealing with larger charges than was the case in the horizontal and inclined systems.

Vertical retorts were in use before 1902 because the system had been adopted by Young for the distillation of oil shale, but the present type of vertical retorts date from that year, when the first Settle-Padfield retorts were erected at Exeter, and those of Bueb were introduced in Germany. In 1903, Woodall and Duckham, following up the work of Settle, evolved a successful method of continuous working and applied to their retort the principle of a continuous discharge of coke governing an automatic coal feed.

In 1905 the Glover-West system was patented differing from that of Woodall and Duckham insofar as discharge of the coke was independent of the coal-feed and that a 'cracking' space was left above the coal in the retort. West improved the Glover system in many ways in 1909, utilizing the heat of the discharging coke for preheating the air supply of the gaseous fuel by which the retort was heated and at the same time doing away with the usual quenching by water. He abandoned the idea of a 'cracking' space, and, as in the case of the Woodall Duckham retort, the coal supply was governed by the coke withdrawal.

In the 1920s, three principle types of continuously charged vertical retorts were working successfully, viz., the Woodall Duckham, the Glover-West and a continental one - the Dessau. The results obtained were such that they proved the system generally and promised well for the future.

The advantages accruing from the carbonisation of coal in the modern by-product oven were not without their influence on the development of types of carbonising plant whose primary objective was to produce gas for domestic purposes. This applied particularly to Germany where the by-product oven had been extensively adopted,



and where its improvement had progressed rapidly. In 1906 an installation built much after the style of coke oven practice was erected at Munich. It consisted of fifteen horizontal chambers, each capable of dealing with three tons of coal. Intermittent charging was adopted, and as the plant worked successfully, others of a similar type were erected in various parts of the continent. Some uncertainty prevailed as to which kind of chamber, horizontal, vertical, or inclined, yielded the best results and some constructors erected all three types. Koppers built an inclined battery at Bochum in 1908 and later built another large battery at Vienna. Towards the 1920s they reverted to the horizontal form and an installation of this type was built at the Birmingham gasworks.

These plants had the primary objective of producing good quality gas and the ovens were heated with producer gas generated from small coke or coke dust, sometimes mixed with low grade coal, in a Mond producer. (43) The Koppers and Otto coke oven construction companies developed the idea further and designed special combination coke ovens so that a leaner gas such as blast furnace gas and producer gas or the richer gas produced in coke ovens could be used as required. (44) It was anticipated that this type of oven would commend itself to steel producers and others who needed coke oven gas for processes which could not use lean gas.

It has been shown that while there was a tendency for the gas engineer, especially on the Continent, to follow up the lead of the coke oven constructor, another line of development evolved as a commercial success to give the vertical retort. The latter system was believed to be ideal because it handled raw materials and the final product efficiently, it was clean, and it gave

increased yield of by-products in striking contrast to the older intermittent retorts. Did the vertical continuous gasifying process influence future design of coke ovens?

In order to answer this question it is necessary to examine the requirements for an ideal coke oven in the 1920s:-

- (1) Ovens should be such that while possessing maximum solidarity~~they~~ should be simple to construct and require few repairs.
- (2) They should gasify coal economically in large quantities with minimum loss of products during charging and discharging.
- (3) The resultant coke should be sufficiently hard for metallurgical use and have a low moisture content.
- (4) Maximum use of all residual products, whether gaseous or otherwise was necessary and yields should be close to theoretical.

Inspection of the above conditions shows that coke ovens built in the 1920s were capable of improvement. Where else, it can be argued, was coal treated so ruthlessly as in the coking process where wet coal was subjected to high temperature in fireclay ovens. Also, there was the undoubted disintegration brought about by high moisture content and the bugbear of salt corrosion; these two factors combined to produce the principal cause of heavy repair costs. A more resistant material of construction for the oven chambers was urgently required.

The conditions laid down in (2) and (3) were problems of design and engineering. In general there had been a tendency for the



size of coke ovens to increase, especially during the burst of activity in the industry during the 1920s. Modern charging and discharging had reached a high level of perfection but it was never assumed that perfection or finality had been reached.

The clay luted door was regarded as old-fashioned and by no means gas tight. (45) The charging operation usually resulted in a loss of gas and in an urban area this was a nuisance. It was accepted that in a rural locality there were poisonous effects on vegetation which often led to exaggerated claims for damage. During the quenching process large volumes of water are necessary and the considerable amount of energy in the incandescent coke is lost and if too much water is used a further loss is incurred by the actual user of the coke.

Thoughts gradually turned towards making the coking process continuous or semi-continuous like the vertical gas retort so that the forementioned problems might be resolved. In most branches of industry it had come to be regarded as almost axiomatic that the rendering of a process continuous, even if it required high capital cost, led eventually to a better quality product produced at less cost. The coking industry had already seen the introduction of continuous ammonium sulphate production and continuous crude benzole plants had superseded the older intermittent process.

Vertical intermittent ovens were the subject of many patents by A. Owen Jones but they came to nothing. Although the coke produced in vertical gas retorts was more uniform in quality and larger than that produced by coking in thin layers in the older retorts it was thought highly probable that the absence of a 'rest period' would militate against the adoption of a continuously operated oven because the resultant product would probably be

condemned by many users as being too small. (46) Yet it was known that coals which could not be coked in the 1880s were being coked in the 1920s, mainly because of the introduction of stamp charging. Perhaps Arthur Duckham had in view the above mentioned objection when he patented a continuous vertical coke oven in which the charge was kept compressed by a ram. This subject was interesting and it was hoped that the experience gained in vertical retort operation would at some future date assist in solving the problem of the ideal coke oven.

Research in the early 1920s had shown that by reducing the width of the oven chamber it was possible to produce metallurgical coke from coals which had hitherto been unsuitable for producing blast furnace coke. It was believed that successful use of 13 inch wide ovens in America could be extrapolated further. The gas industry and the coking industry comprised entrepreneurs whose main handicap was a lack of detailed knowledge of science and technology. Had this not been so, many of the pious hopes for a common process to meet the widely differing needs of two great industries would have been dismissed earlier.

Progress on the scientific side of the carbonisation industry cannot be regarded as rapid. Comparatively little had been done in research work, except by those who for competitive reasons kept the information to themselves, chapter VIII provides supporting evidence. Notable steps towards remedying this were taken by the formation of the Institution of Gas Engineers, by the University of Leeds which instituted a department devoted solely to the study of fuel problems, particularly those in connection with the carbonising industries, and by the formation of the Coke Oven Managers' Association. The latter is described in detail in chapter VIII.



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20. There weren't any standards of quality control such as the Wobbe Index. 
$$\left\{ \text{W.I.} = \frac{\text{Calorific value of gas}}{\sqrt{\text{specific gravity}}} \right\}$$
21. It was too small and insufficiently hard.
22. This is similar to the early 20th century coking industry.
23. Several patents were granted, notably, U.S.A. Pat.No.1085096 (1914) to A. Bergloff who passed stripped gas through a recuperator and then through the coal to be carbonised, and No.1097513 (1914) to H.W. Benner who used water gas.
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29. See chapter VIII describing the Woodall Duckham Company. p.557 regarding number of installations circa 1910 and double number within next 8 years.
30. Methods of recovery were identical to those used in the coking industry.
31. The advent of silica for use in coke ovens and described in Chapter IV did not benefit the gas industry.
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44. Chapter VIII contains further details on this subject.
45. Other sections show this type of door had merit, see chapter VII describing Nationalisation. The section referring to Smithywood coking plant shows clay luted doors are still in use.
46. This supports the view expressed elsewhere that the coking process was not fully understood by those in the industry and the customers hadn't any real understanding of coke either as an industrial or a domestic product.

## C H A P T E R    I V

### DEVELOPMENT OF THE 20TH CENTURY COKING INDUSTRY

#### Introduction

The carbonisation of coal has been practiced in this country for over three hundred years and for the past two hundred years coke ovens in one form or another have been used for the purpose. During this period there have been developments in the art of coke production and considerable progress in the design of coke ovens so there is little resemblance between the early coke ovens and the modern coking industry. Nevertheless it is true to say that except for improvements in detail there haven't been any major changes in coke oven design for the past 50 years.

It is equally true to say that considerable changes have taken place in industries which use coke or by-products. Eventually these changes had a profound effect on coke oven builders and coke oven operators. This chapter attempts to review the coking industry in the light of these circumstances.

#### Origin of the Coking Industry

Coal is more difficult to burn than wood or charcoal and the latter remained popular as a fuel while ever it was readily available. During the reigns of Elizabeth and James I a shortage of timber was created by the increasing demands made upon it as a domestic and an industrial fuel and for the construction of ships, dwellings and carts. The type of wood used for the construction of ships etc. differed from that used for the production of charcoal and the respective



industries were not competing for the same raw material. This modern view is in sharp contrast to the traditional interpretation which does not classify timber according to use.

The shortage of wood was due to the fact that the sheer scale of industry was growing, and it was used in increasing quantities as a fuel for glass and iron making. The demand for iron was increasing and large areas of woodland were consumed to provide the means of smelting a relatively small amount of iron, consequently there was an incentive to use coal instead of wood which was becoming increasingly expensive because it had to be transported greater distances to the point of usage. Unfortunately experience with coal showed it made the iron more brittle than would be the case if it had been smelted with charcoal. Ductility of iron was an important property in its popularity at this time.

#### Coke Lore

The scepticism and misapprehension shown by many engineers at the suggestion that coke should be used as fuel for large boilers tends to prove how little known its use for this purpose was until 1915 or thereabouts, and how its inherent advantages had been thoroughly forgotten though they had been recognised and recorded in the previous century.

Early in the present century it was not uncommon to be confronted with the statement that 'coke will shorten the life of the boilers' and several boiler firemen have been known to

object to handling coke because of its supposed detrimental effect upon the respiratory organs.

Prejudice and scepticism displayed by potential domestic users of coke were no less emphatic and deep rooted. It is known that during a coal shortage which prevailed in many districts as a result of a coal dispute in 1921 one person attempted to sell coke to residents who hadn't any coal in a northern town, but this was unsuccessful. (1)

It was rumoured that coke was the cause of pneumonia.

Another widely held myth was the belief that combustion of coke was improved by the addition of water and complaints were traceable to this practice as late as 1923. There was the generally held view that coke was full of sulphur and people with some technical knowledge claimed that its calorific value was low as a result of taking too much out of it. This view is frequently held by lay people in modern times. One coal owner who was well known as a coal and coke merchant at many railway depots circularised his customers with a view to advocating coal, claiming that coke was 'half-burnt coal'. These are some of the problems which the coking industry had to overcome.

#### Early Coking Industry

The history of the coking industry is closely related to that of the iron and steel industry. Charcoal had been the only means of reducing iron ores for many years, but as timber became scarce coke was an attractive alternative first used by Darby at Coalbrookdale in 1709. The modern view is that only certain types of wood were in short supply, principally



those used to build and maintain the merchant fleet and the Royal Navy.

What factors enabled Darby to achieve success? It was fortuitous that he used coal which yielded a reactive coke (2) and that the silicon present in the ash increased the fluidity of the iron for casting. (3) The presence of silicon in the ash was a serious disadvantage to the manufacturers of wrought iron so that it was not until Cort's 'puddling' process in 1784 and the Cowper stove for preheating the air blast in 1828 that coke completely replaced charcoal as a blast furnace reagent. By this time the use of coke in blast furnaces had spread to the continent and specialists from Britain were required to advise on their operation.

A shortage of timber had been circumvented by Darby's discovery and coal was widely used for domestic heating, brick burning, glass making and steam raising. Also, Darby's works were located near to the river Severn and his iron was shipped to Bristol. He was therefore able to use his method of producing iron though it did not satisfy the lingering demand for wrought iron produced using charcoal.

Early blast furnace coke was produced by carbonising coal in heaps. After about 1820 a crude form of stamp charging was introduced whereby the coal was compressed inside wooden shutters which were removed before the coal was carbonised. The Beehive oven is the first true coke oven and the earliest known example was built in Durham about 1750. The resulting coke was unsuitable for blast furnace use.

In general, most English coals were suitable for carbonisation in Beehive ovens but many continental coals were not. In 1840 Heuser attempted to produce coke from a poor coking coal near Obernkirchen by building the first Schaumberg stalls which comprised pairs of walls with openings along the bottom to permit the ingress of air. Heuser used flues in the bottom and sides of his oven and he successfully produced a strong coke.

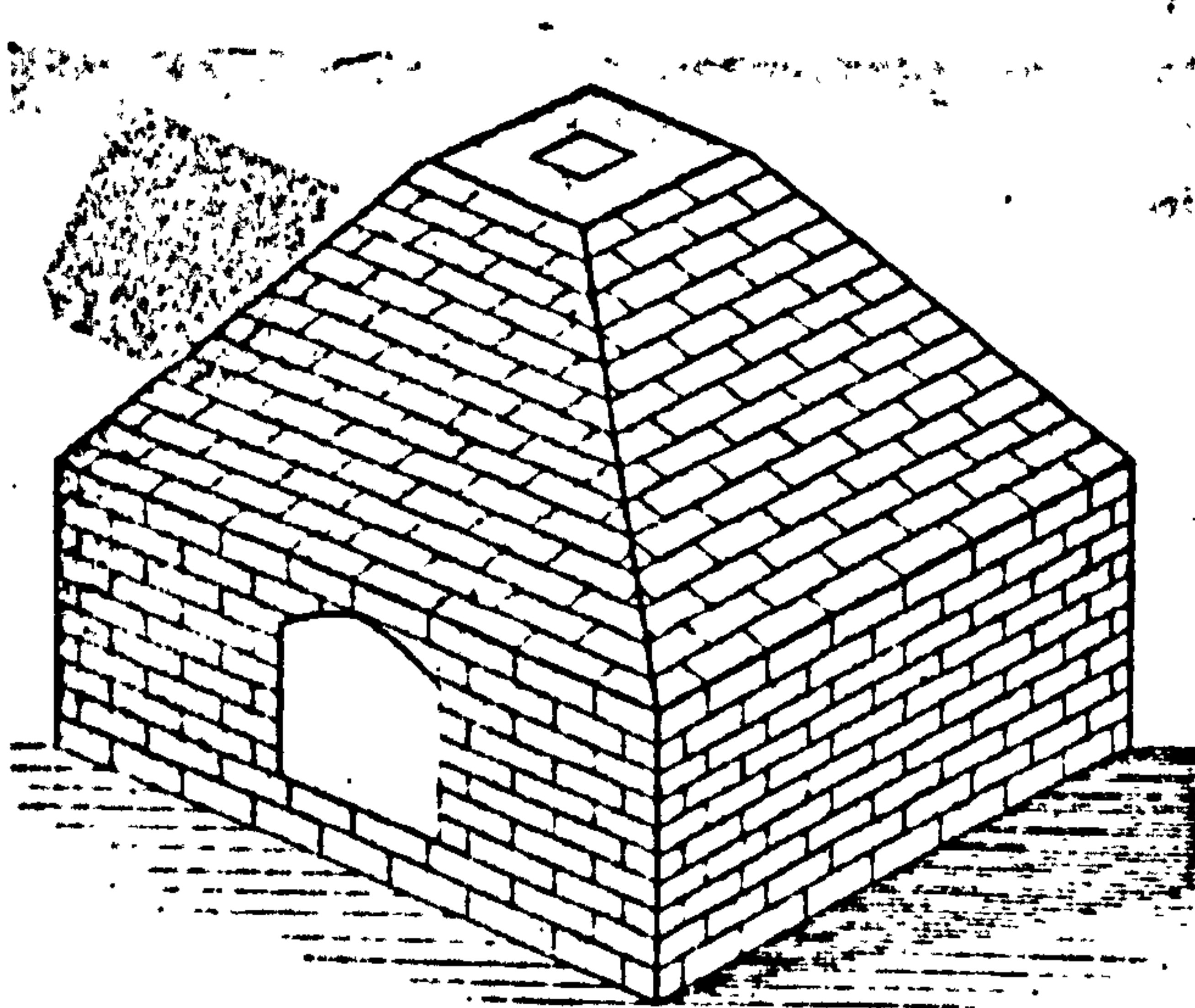
The London and Birmingham Act, 1833 compelled the use of smokeless fuel in railway locomotives and the use spread to Continental countries so that many new ovens were built to meet the increased demand for coke. The first public railway to use steam power was the Stockton and Darlington railway, opened in 1825. In the Liverpool and Manchester Railway Act of 1826 there was a clause which forbade the use of a locomotive in the townships of Burtonwood and Winwick, which would be considered by Lord Lilford or the Rector of Winwick (one of the richest livings in England), to be a nuisance or annoyance to them from smoke. (4) ~~It~~ It was soon realised that the poor coking coals available on the Continent required a long oven to give a satisfactory coke whereas in Britain Beehive ovens were used almost exclusively.

The design of the Beehive oven passed through several stages in development as experience with its use was gained and as the industrial needs changed. The early ovens had single tall chimneys but they were gradually lowered and the oven roof became hemispherical. Later the ovens were grouped together but they retained their own chimneys. The next

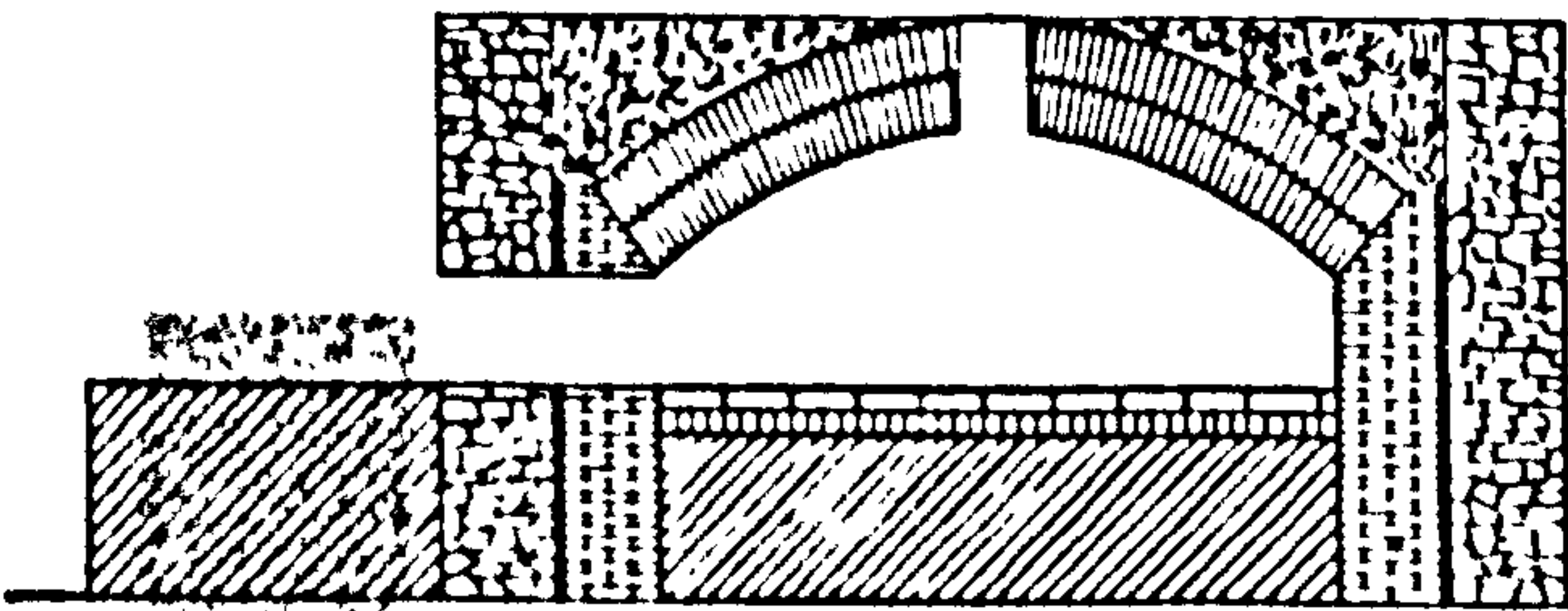


Fig 1

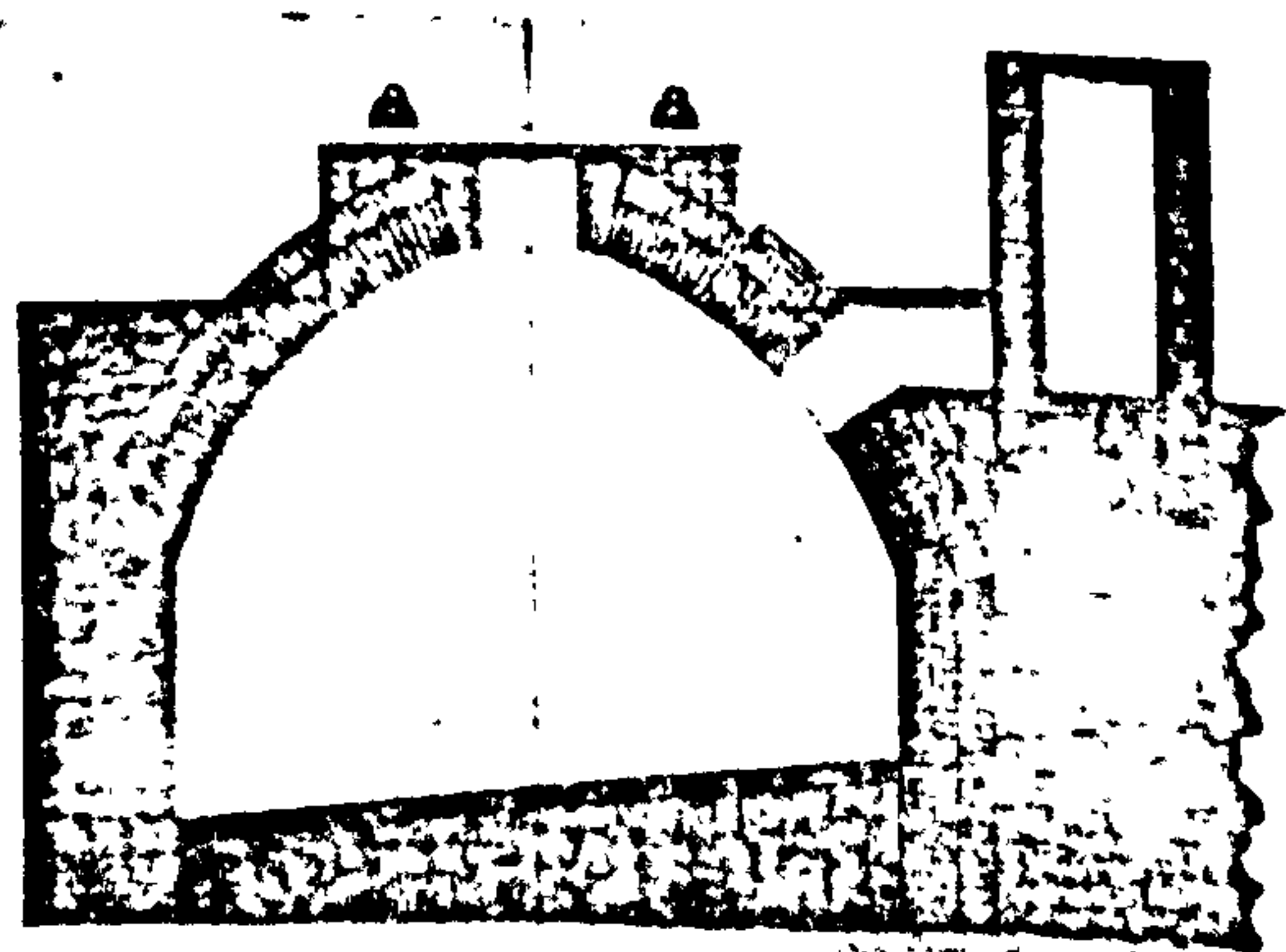
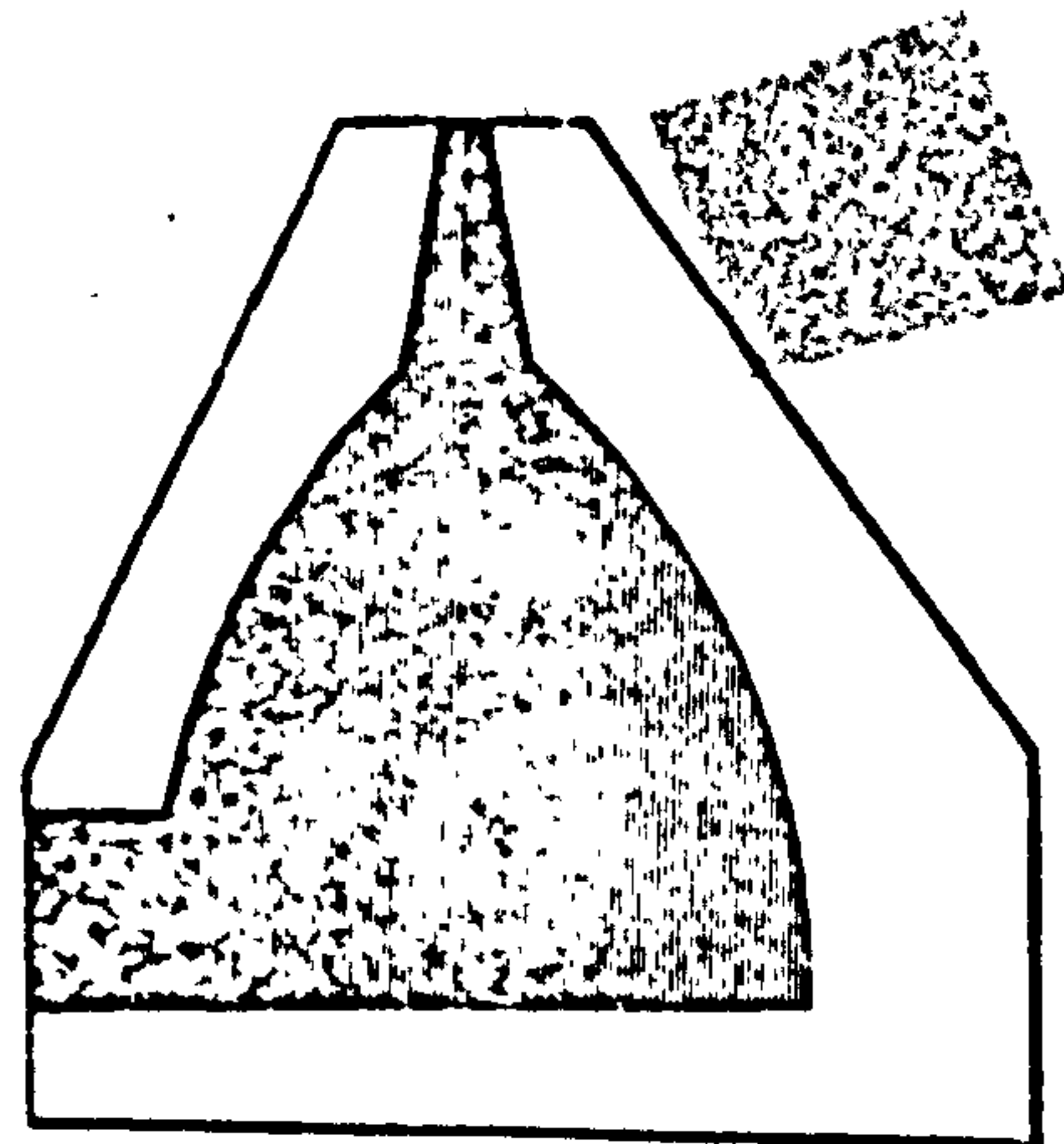
Development of Beehive Ovens



Beehive oven for coking small coal,  
Newcastle-on-Tyne, 1765.



Beehive oven, Sheffield, 1802.



Common round beehive oven, Co. Durham, 1860.

development was the use of air for combustion which was preheated by drawing it through flues under the oven sole. In plan the ovens were semi-rectangular or oval with doors at opposite ends. The rectangular oven with an arched roof followed. *See fig. 1*

Early Beehive ovens were hand charged but when they were built in rows they were charged from the top by means of tubs running on rails. The charge was levelled by hand through the doors. In the early stages of development the coke was partly quenched inside the oven and raked out by hand. (5) The rectangular oven, which had a door at each end, could be discharged first by a hand operated machine and later by a steam driven ram. The hot coke was quenched outside the oven.

Experience on the Continent soon demonstrated that increasing the rate of carbonisation improved the quality of the coke derived from poor coking coals. As a result attempts to increase the carbonising rate in this country were made by heating the Beehive ovens on the sides and the sole by taking the waste gases from the chamber through ducts in the oven side and also in the sole before taking them to the chimney. The first oven of this type was the Francois which was developed in the Saar; The Smet oven soon followed in Belgium. (6) These ovens were 6 - 7m long and about 1.5m high. The Francois ovens were 1.2 metres wide instead of the 0.56m for the Smet oven and had a carbonising time of 24 to 36 hours. Both these designs contributed to the so called modern oven because they had horizontal heating flues. It was not until 1850 that the first vertical flued oven was built in Belgium but this type rapidly became predominant.



## Development of the Modern Oven

### Waste heat recovery

Waste heat recovery was undertaken before the slot oven developed. The first waste heat boiler was constructed at a coking plant in Saxony in 1820 (7) but the first patent was taken out in this country in 1824. The boiler was placed above the Beehive type oven.

The idea of waste heat recovery grew rapidly in Belgium where it was adapted by Cockerill at Seraing. Again the boilers were placed on top of the ovens which were 6.8m long, 2.2m wide and 0.9m high. The charging was carried out mechanically through the oven doors and about twenty minutes were required to charge 6 tons of coal. The carbonising time was 36 - 48 hours.

The next development was to build waste heat boilers away from the ovens so that flues carried the waste gases from the battery to the boilers; this allowed the ovens to be top charged. Most of the steam required for a steelworks could be obtained from waste heat boilers.

The Coppée design of vertical flue ovens became the standard design built by several firms, including Dr. C. Otto of Bochum. Early designs enabled the products of combustion, formed by admitting air, to be conducted down side flues and under the oven sole to the main flue. It was soon realised that the battery could not be heated evenly because at any given time each oven was at a different stage in the carbonisation cycle and consequently evolved a different amount

of heat. In 1885 T. von Bauser constructed a battery of Otto-Coppée type ovens using a bus flue to collect the gas from all the ovens and distribute it uniformly in the heating flues. This was a major step forward and the idea was quickly adopted by several coke oven builders.

#### By-product recovery

Up to now the carbonisation process proceeded by admitting air into the oven chamber so the products of carbonisation were burnt, but Knab took out patents in 1858 and 1860 for an oven which was heated externally. The products of combustion were collected and the tar and ammonia removed before they were returned for combustion in the battery heating flues. The resultant coke was not suitable for blast furnace use but in principle was adopted by M. Carvès and improved. M. Carvès built 25 ovens at Bessèges in 1867 and by 1879 119 of his ovens were in operation. Mr. H. Simon of Manchester saw these ovens and then entered into negotiation with Mr. Carvès. The outcome was that the partnership built a battery of 24 ovens at Crook in Durham. These were the first by-product ovens to be built in this country and were put to work in 1882. (8)

By-product recovery rapidly gained favour in Europe and it was soon being used by the main coke oven constructors, notably Semet-Solvay in Belgium, and Otto and Huissener in Germany. The controversy between British Ironmasters about the suitability of the coke for blast furnace use made the adoption of by-product recovery ovens in this country much slower so that by 1902 only 23 batteries were working.



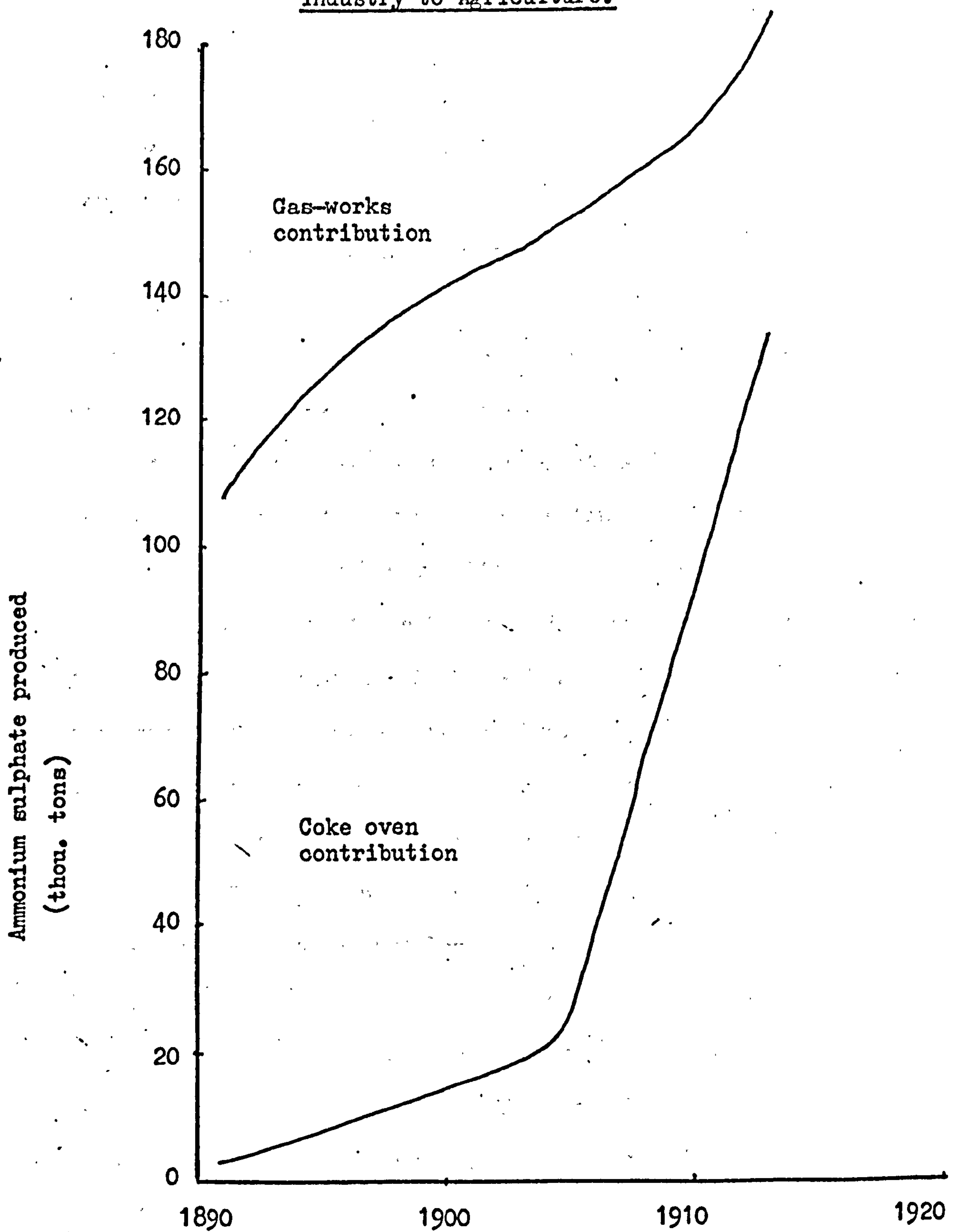
Eleven of these ovens were of the Simon-Carves design, ten Semet-Solvay and one Huissener and one was converted from a non-recovery battery. After the controversy ended in 1904 the by-product oven rapidly gained popularity.

It was only to be expected that there would be opposition to the introduction of by-product ovens. As already mentioned there was from the first a strong prejudice against by-product coke on the part of blast furnace people, who said it must be inferior. It was declared, in fact, that by-product coke could not be used for furnace work. No allowance was made for the initial difficulties of the new industry, and contemporary reports do not speak at all well of the appearance of the early by-product coke. It was termed by the ironmasters 'dirty looking cinders', and no doubt the contrast with the silvery beehive coke to which they had been accustomed was very great. The coke was quenched in the open, which as we now know tends to produce a black looking product. Other objections used against by-product coke were its smallness compared with beehive coke, that it was softer and less dense, and that the pores of the beehive coke were much larger. At the same time it was very difficult to get any scientific expression of opinion as to the real merits of the new product, and it was not until the late Sir C. Lawthian Bell made exhaustive experiments on a large scale that it was fully realised what could be done with by-product coke under proper conditions.

Figure 14 demonstrates the rapid rise in popularity of by-product recovery from coke ovens so that by 1906 they overtook gas works as suppliers of ammonium sulphate. In 1913 by-product recovery ovens were supplying nearly twice

FIGURE 1a

The Contribution of the Early Carbonising  
Industry to Agriculture.



Compiled from Alkali Reports.



as much ammonium sulphate as gas works and the gap grew wider still as time went by. The question of by-product recovery is discussed in detail later in the chapter.

### Regenerative ovens

The introduction of externally heated ovens led to the development of by-product recovery so that the next natural progression was in the use of preheated air for combustion. H. Simon introduced the idea of preheating combustion air in 1883 (9) and in the same year Dr. Otto built a battery of ovens employing a Siemens regenerator at Pluto Colliery. The battery worked well although preheating the air did nothing to improve the evenness of heating - this was an entirely different problem. Otto favoured the Coppée vertical flued oven to the horizontal flued Carves ovens so that in 1895 he produced the Otto-Hilgenstock design which paid much attention to gas resulation. In 1896 Koppers, who were already engaged in development work with the Otto Company suggested the use of the Bunsen burner type of underjet. This was successful and caused all oven designers to look closely at the problems associated with even heating. The same problems, in principle at least, have to be examined today but the solutions are well known. The design put forward by Dr. Otto used half-wall reversal but other designs favoured quarter wall reversal. A further refinement came in 1905 when Collin built a battery with hairpin flues. The Otto Company bought a patent for this system in 1903 though they did not use it until they built a coke oven battery for the Skinningrove Iron Company Ltd. at Saltburn in 1912.

In the meanwhile Koppers, who had left Dr. Otto & Co. in 1899 to found his own firm, patented the individual regenerative oven in 1904.(10) This advance used for the first time the half divided oven with each half-wall having its own regenerator. In order for this system to work rich gas was fed to the heating flues through gas ducts built into the brickwork below sole level and linking the heating flues through special nozzle blocks. This design gained immediate popularity and other companies attempted to improve it and thereby regain some of the ground they had lost. Simon-Carves introduced a new design of heating system in which the air supply to individual groups of flues was regulated from the oven front. The flow of rich fuel gas was controlled by adjustable nozzles and the air supply was regulated from the oven front.

This arrangement was used in both waste heat and regenerative batteries, some of which were in use until 1959. Further progress came with the introduction of the underjet principle which was known in Germany before 1900. Other designs which have withstood the test of time and are in use today in principle at least include Carl Still's oven in which combustion air is admitted in stages to the heating flues in order to produce a longer flame and provide more even heating in a vertical direction. Another design which has continued in principle is the Collin oven in which the gases burn upward and downward alternately.



### Lean Underfiring Gas.

Koppers firmly believed that it ought to be possible to underfire ovens with low grade gas; the idea was first tried at Mathias Stinnes in 1901. (11) The experiment failed because the gas was supplied in a hot and dirty condition so that the flues became blocked. Other attempts to use low grade fuel gas failed until Lecocq demonstrated that it was necessary to preheat the fuel gas if this method of underfiring was to be successful. Koppers saw the merits of the idea and in 1909 they built the first successful coke oven battery heated by low grade fuel gas at Vienna Gas Works. Further information on this topic is contained in the chapter describing the Woodall Duckham Company Ltd. In 1910 Koppers designed the first compound oven and built the first compound battery at Deutscher Kaiser Colliery in 1911. Details of the first merchant coking plant in Britain to be underfired with producer gas are given in chapter V describing Blackwell Coking Plant.

By 1914 the compound oven was fairly well established on the Continent, especially at the integrated German steelworks but it made very little progress in the country.

### Silica Refractories

World War I increased the pace of science and technology and amongst many other things hastened the search for improved coking plants and methods. It is generally accepted that the 'modern oven' dates from the introduction of silica refractories in oven construction at the end of the war.

Until then, and particularly in Europe, ovens were built using fireclay shapes, with walls containing 80% silica. This proportion of silica is usually described as semi-silica.

Silica was first used as a refractory material for the crowns of Beehive ovens in America in 1890. By 1894 the refractory brick makers suggested to the Otto Coke and Chemical Company that they incorporate a few silica walls in a battery of coke ovens being repaired at Johnstown. (12) The Otto Company had serious doubts about the use of such material in coke ovens because of the effect of wet coal on the walls. Consequently, when the battery was started up the ovens were tested with very wet coal. It was found that the oven walls built with silica bricks withstood the conditions better than those built with <sup>semi</sup>silica. The silica used in the experiment had a high co-efficient of expansion and this discouraged the Otto Company from using it on anything but small scale plants. Chapter V describing Glasshoughton Coking Plant shows that similar doubts were expressed when silica was first used in Britain. Knowledge of the technology of refractory materials was insufficient and hampered the practical uses.

The United Steel Company Limited ordered 280 Koppers ovens to be built in four batteries at Joliet and specified that one of the batteries should be built with silica bricks. Koppers in turn laid down a strict specification for the silica brick manufacturers and then designed their ovens with expansion joints. The silica battery was successful and



it enabled more throughput to be obtained. Fortuity played an important part because silica is a complex substance which was not fully understood. The use of silica soon became widespread in America but it was not nearly so popular in Europe where several small scale trials were called for before silica was accepted on commercial plants.

G.A. Phillipson, Manager at Cortonwood Coking Plant near Barnsley first noticed the resistance of silica to salty coals in 1912. Salt from the local coal had already attacked the semi-silica oven brickwork so severely at this plant that several different qualities of brick were inserted into the oven patches to see which gave the greatest service. Silica bricks were found to give most resistance to attack by salt and the walls of three ovens were constructed in this material. (13) There was no sign of deterioration after 15 months service even though the local coal was notoriously salty. However, the silica was not fully converted and excessive expansion caused the walls to buckle. This confirms the statement already made to the effect that silica was not understood. The use of silica was temporarily abandoned.

By 1918 silica was the universal material of construction for American coke oven batteries and by 1914 Dr. Otto and Company had built some 4000 silica ovens in Germany. (14) In Britain silica was first used commercially in the gas industry thus demonstrating the close liaison between the

coking industry and the gas industry from early in the present century. The first two coke oven batteries to be built with silica bricks were the Wilputte ovens at Fell for the Consett Iron Company, and a battery of Piette ovens built for the Shelton Iron and Coal Company. The silica brickwork, supplied by the Meltham Silica Firebrick Co.Ltd., was confined to the oven walls in the Shelton battery. (15) The Consett battery was built with silica brickwork supplied by the same company down to the mid regenerator wall level. Both plants were started up in 1924. The next battery to be constructed with silica comprised 10 ovens built by Simon-Carves at Whitehaven in 1924 and commissioned the following year. Afterwards silica gradually became a fully acceptable material for constructing coke ovens in this country.

As late as 1927 the idea that silica bricks would not resist the action of wet coal still prevailed, as did the belief that ovens constructed with silica could be closed down and restarted without damage. The behaviour of silica at temperatures up to  $1000^{\circ}\text{C}$  was not understood because of a lack of knowledge of the relevant science. It was claimed that a battery of Piette ovens built at Shelton Ironworks was started in January 1924 and worked continuously until May 1926 when they were boxed up at the start of the General Strike. When the ovens were cold the coke was discharged and the oven chambers were found to be in good condition. After the strike the ovens were heated up and operated in the normal way. Such a claim could not have been true; one of the cardinal rules of the industry is



that ovens are not allowed to cool below the temperature of inversion of silica. It is concluded that the correspondent, a director of the Meltham Silica Fire Brick Co. Ltd. was biased.(16) Even though such a claim was an exaggeration it may have encouraged the industry to move faster in the right direction. Likewise figure 3 in the chapter is biased in favour of high temperature carbonisation.

Early specifications for silica material are difficult to trace but it is known that Dr. Middleton, in his paper to the Ceramic Society in 1922 mentioned the necessity for the proper burning of silica bricks and pointed to the work of Dr. Mellor which showed specific gravity might be used to indicate degree of conversion. Middleton's work is considered to be accurate because the figure he quoted for specific gravity is still reliable. The Institution of Gas Engineers drew up early specifications for silica materials for use in Gas Works retorts.(see figure 2)

The practice in the coking industry was for local agreements to be made between the coke oven contractor and the refractory brick maker regarding silica specification. Coke oven managers were probably fully aware of the Institute of Gas Engineers' specification and it is assumed the quality of bricks used in coke ovens was similar to the official recommendation.

What were the restrictions imposed by the use of low grade silica early in the present century? When 80% silica is heated under a load of 50 lb/sq.in. it starts to squat in the temperature range 1360-1400°C. It was therefore

# FIGURE 2.

## SPECIFICATIONS FOR SILICA BRICKS

Institution of Gas Engineers					D. I. N. Germany
	1925	1934	1946	1955	1956
Composition %	92	92	92	94	93 Tolerance -1
Permanent { °C	1410	1450	1450	1450	1450
linear { h	2	2	2	2	2
Change { %	0.5	0.5	0.5	0.5	1.0
True specific gravity	not stated	not stated	not stated	Av. 2.345	95% = 2.38 none = 2.40
Refractoriness °C	1690	1670	1670	1690	1580 under load
Cold crushing strength	not stated	not stated	not stated	2500 psi (175Kg/cm <sup>2</sup> )	Wall bricks 200 Kg/cm <sup>2</sup> Tolerance -20

Compiled from Journals of the Institution  
of Gas Engineers.



unwise to operate a battery built with semi-silica brickwork with flue temperatures much above  $1150^{\circ}\text{C}$  and this in turn limited the chamber height to 10ft. In contrast high grade silica will withstand the same load up to  $1630^{\circ}\text{C}$  when it fails suddenly in shear. Modern flue temperatures of  $1400-1450^{\circ}\text{C}$  are normal and oven heights of 15-20ft are common.

Silica had other important advantages such as high thermal conductivity and resistance to attack by salty coals so the use of this material enabled ovens with greater capacity and higher coking rates to be built.

Chapter V describing several coking plants provides evidence that a typical British coke oven battery in the 1920s had a length of about 30ft, a chamber height of 10ft and a mean width of 18 in. A charge of 8 tons was carbonised in 24 hours using flue temperatures of  $1180^{\circ}\text{C}$ . The maximum safe rate of working was therefore 8 tons per oven per day. In contrast sections of chapter V describing Manvers and Avenue Coking Plants show that in the 1950s a chamber length of 45ft, height of 14ft 6in.-15ft and a mean width were typical of the new generation of coke ovens. Each oven held a charge of 18 tons which was carbonised in 16 hours with a flue temperature of  $1430^{\circ}\text{C}$  so that the rate of working was 27 tons per oven per day. The increase in throughput while retaining a factor of very nearly 3.5 is directly attributable to the use of high grade silica refractories. This was not the only benefit because the silica batteries were normally designed for firing with blast furnace gas or

producer gas whereas the semi-silica battery was limited to rich gas firing. As a result the heating system of the batteries built in the 1950s were designed to carry a greater volume of combustion gases needed to carbonise an increased coal charge and also deal with the increased volume of flue gases resulting from the use of lean fuel gas. In simple terms silica ovens had to handle about five times the volume of combustion gases per unit time handled by semi-silica ovens. Another complication was the necessity to preheat the lean gas as well as the air for combustion and the problems of inter-regenerator leakage and the effects of dust precipitation. All these factors, but particularly the effect of increased volume of flue gases on the heating systems presented new design problems which have not been matched with a perfect solution even today.

#### Problems of Silica Oven Design.

In order to understand the reasons behind the general trend in oven design development between the World Wars a brief review of the semi-silica oven design will be undertaken. Rich fuel gas was delivered to vertical flued half-divided ovens by gas gun or underjet, so that in any given cycle one half of the flues in an oven wall were on gas and their products of combustion were collected in a common bus flue at the top of the heating wall prior to being redistributed in the remaining flues on the downstream side. There was a regenerator underneath each heating wall divided into an



upstream and downstream section by a thick centre wall.

The efficiency of the heating system depended heavily on sound construction to prevent leakage of flue gas and air.

A sole flue below each regenerator filling served to distribute the combustion air or evacuate the waste gases. The system was simple and robust, and provided the throughput was low it worked satisfactorily.

Unfortunately this heating system cannot be used without modification to high capacity ovens because it causes unnecessary variations on the temperature of the oven walls,(17) because of large static pressure variations in the regenerations.

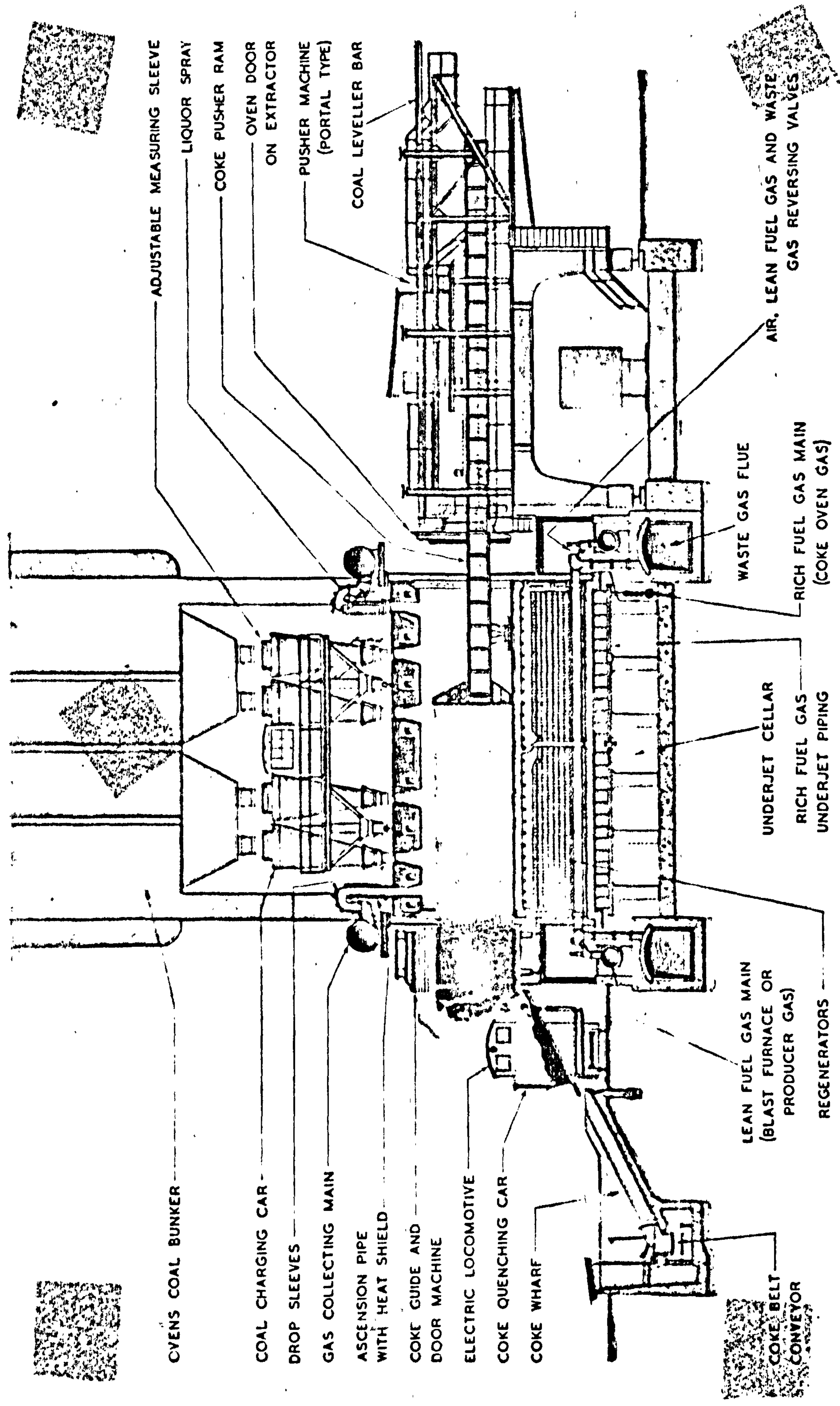
It is sufficient to say that the half-divided system so common early in the century could only be applied to low capacity ovens where static pressure differences were small.

A new heating system had to be designed to meet the stringent demands of increased throughput.

#### Early modern ovens

Different coke oven contractors placed different amounts of emphasis on design considerations. It has never been possible to meet all the criteria simultaneously because some of them are structurally conflicting. In practice all the solutions to oven design include compromise but they were all good and therefore lasted almost forty years without any major alteration. It is possible to consider various types of design to indicate the attitude of the contracting company at a given time:-

Fig 2a. W-D. Beck's Combination Underjet Ovens.





(1) Methods of heating.

Since the static pressure variations in the top horizontal flue vary approximately proportionately as the square of the gas velocity, sub-division of the horizontal flue into two or more sections was an obvious method of reducing the variations.

Simon-Carves, Wilputte and the Koppers Company were all well aware of this and they introduced the TX,

Wilputte and the Becker oven respectively. *See fig. 2a.*

The Simon-Carves oven was in effect two short ovens placed back to back. Six TX type batteries were built between 1927 and 1930 and a measure of their success can be obtained from the fact that Rotherham Main and Dalton coking plants had long lives.

Rotherham Main was particularly successful in terms of length of service and throughput; the plant is described in detail in chapter VI. The design was abandoned because it was not suitable for adaption to lean gas firing which was popular at this time.

The Wilputte oven had much longer popularity because it was modernised and adapted to lean gas firing. Although it was probably irrelevant in the early days it later proved an advantage that the divisions between the upstream and downstream regenerators were short thick cross walls.

Also, this company recognised the fact that the upstream and downstream flow on the regenerators required different treatment to obtain correct distribution and used venturi ports under the regenerator fillings.

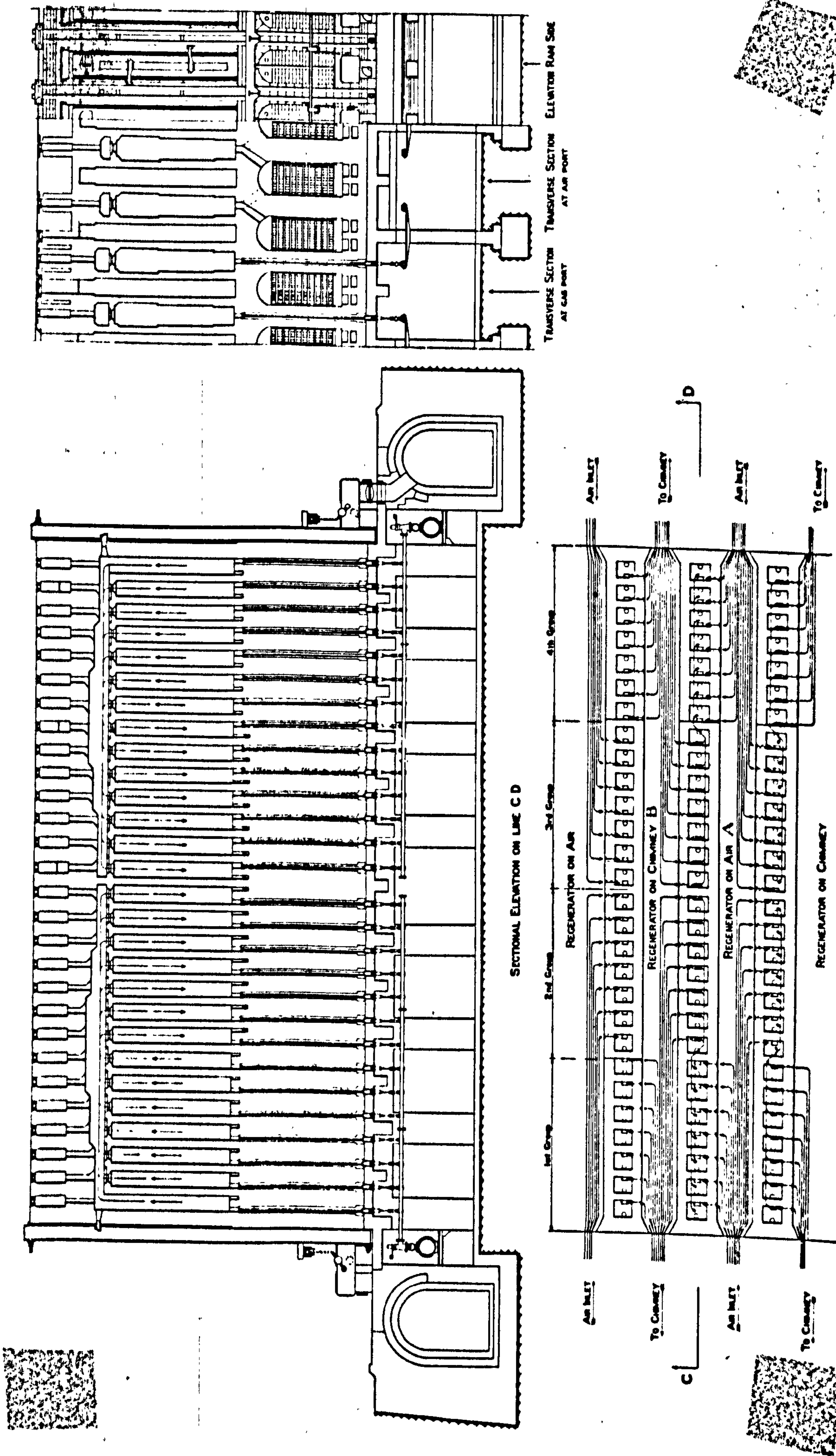
The Becker oven relied on wall to wall reversal so that groups of heating flues were connected to a number of small horizontal flues, and each was connected to a similar group of flues in the adjacent oven by a crossover flue. The resulting gas velocities in the horizontal flues were low and pressure variations were insignificant. An advantage of the system was that all the gas ports between the regenerators were short, symmetrical and steep. A more important advantage was that with lean gas firing no upstream lean gas regenerator was adjacent to a downstream waste gas flue so that if any inter-leakage took place it could only be from air to waste gas. The division walls between the upstream and downstream regenerators were necessarily large in area and subjected to temperature stresses from top to bottom. An interesting characteristic which was of little consequence was the fact that batteries could only have an odd number of ovens.

#### (ii) Flue construction

The 1920s witnessed the application of the twin flue heating system to increased capacity ovens and eliminated the top horizontal flue which not only gave rise to pressure variations but also provided a strong wall since alternate headers were carried through into the oven top brickwork in situ. Several coke oven designers adopted this system including Simon-Carves, Coppée, Koppers and Otto and each had only minor differences.



Fig 2 b. Simon Cases Underjet Ovens.



COMPOSITE PLAN SHOWING COURSE OF CASES

Simon-Cases of Industries, Inc.

On the otherhand the regenerators varied considerably. For instance both the Otto Company and Simon-Carves had upstream and downstream regenerators separated by pillar walls having a large area parallel to each oven chamber. Each regenerator was divided into three sections so that the centre compartment preheated lean gas while the compartment on each side of it preheated air. The idea behind the arrangement was that both upstream air and lean gas were maintaining identical pressure conditions and therefore leakage between any two walls was impossible. Basically the idea was a good one but in practice it was not perfect and some leakage was inevitable. Nevertheless the pressure gradients ensured that leakage was minimal and even if it did occur, it would only be air to waste gas. *See fig. 2 b.*

The Koppers cross flue design depended on the idea that the divided wall between the upstream and the downstream regenerators should be thick but of small area on the centre line of the battery, exactly as in the old half divided oven. This idea was strikingly original and it was an admirable attempt to combine the advantages of the twin flue with a simple, accessible and strong regenerator arrangement using sole flues to feed half the oven wall.

The success of this design is demonstrated by the fact that it is still built in a modern form, thereby proving that any of the early theoretical objections to sole flues were not significant in practice.

It must however be said that the problem of combining



the twin flue heating wall with a regenerator system to which there are neither theoretical nor practical objections is unlikely ever to be solved.

The foregoing is by no means exhaustive but rather an attempt to show how problems arising from increased oven capacities were dealt with.

#### Early Practical Problems

The other problems were mainly structural and engineering and were gradually resolved as experience in building and operating coke oven batteries increased.

Some examples are:-

- (i) Rich gas burned with a short flame so that it was difficult to heat the so called tall ovens.

Carl Still successfully overcame the problem by introducing air for combustion in stages up the heating flues. Koppers, in contrast built an opening between the upstream and the downstream limbs of the twin flues so that dilution gas could be introduced into the combustion zone. The Otto company used yet another method and introduced high and low burners.

The early batteries soon showed failure of oven ends because of mechanical shock, thermal shock, neglect or a combination of each. In simple terms the silica ends and the ends with false fireclay quoins either interlocked with the silica wall or with a straight joint and the successes or failures were quite unaccountable. Evidently the successes were a close

tie-up between practical experience and the state of knowledge of refractories which was probably coincidental. At that time a perfect practical solution was still being sought though a knowledge of this particular refractory material was well understood.

- (ii) By custom and practice the run of mine coal was washed and then sent to the adjacent coking plant. As a result the coking plant usually received freshly washed coal with an excessive free water content. If the wet coal was charged to the ovens spalling of the chamber walls was bound to result. Two local examples of this are Cortonwood and Nunnery Handsworth where considerable damage to the ovens resulted from carbonising wet coal. Other damage was caused by over-filling ovens with highly swelling coals so that the chambers were damaged by pressure from the coal during the carbonising cycle, this type of damage was more serious because burst ovens were not normally repairable. Both experiences concentrated attention on coal preparation and coal blending.

- (iii) The problem of leakage from self sealing doors has never been completely resolved though the oven doors at ~~Rotherham~~ Rotherham Main were quite satisfactory throughout the long life of the plant and the oven doors at Avenue are still giving satisfactory service.



The success or otherwise of these doors depends largely on correct use and maintenance. The first self sealing doors were installed in Britain in 1928 and the idea spread rapidly and they were soon used at most coking plants. The original Wolff patent was sound and worked well but it was considered to be expensive and several lighter designs followed and gave trouble within a few years, particularly in tall ovens when a high carbonising rate was used. Chapter V describing Glasshoughton Coking Plant shows a classic failure of self sealing doors. These experiences led to reversion to clay luted doors at some plants. Smithywood Coking Plant, also referred to in detail in Chapter V is a good example of a plant which has continually used clay luted doors throughout its life of some sixty years to date.

- (iv) Traditional American practice has been to use silica brickwork down to the foundation pad but European practice is still to build the regenerator wall in fireclay up to the point where the temperature is above the alpha-beta quartz conversion. The American construction was important because of greater expansion of silica opened out cracks in the fireclay underneath and thereby encouraged leakage. The contrary view point held in Europe was that somewhere down the silica pillar wall the inversion temperature of silica must be reached so that eventually the wall would spall. Silica regenerator soles are frequently lined with fireclay to avoid this. The important point is that

the passage of time has shown that even though several thousand coke ovens have been built, very little trouble has been experienced with either design. As a result what was a major point of technical interest some 30 - 40 years ago is now disregarded.

#### Advantages arising from an increased use of Coke Oven Gas

One important social benefit of using coke oven gas for towns supply was a cheaper source of heat, light and power than would be the case if only the gas produced at gas works was available. It was assumed that gas undertakings in this country could not hope to reduce to any great extent the price of gas and that, if coke oven gas was used in this manner on the scale intended, its price to the distributor would be sufficiently low to enable a substantial reduction in the price charged to consumers. If this was so, demand for gas would increase and more coal would be required for carbonisation. The collieries would not suffer because the loss of the coal market would be offset by an increase in the demand for coking coal. This view <sup>was</sup> broadly true but it does not take into account an increased demand for coke which would also need more coking coal. There is a hint that coke oven managers were trying to justify at least part of the industry on the sale of gas alone.

From the environmental standpoint a greater use of gas instead of coal in the domestic market was expected to reduce the amount of smoke, dirt and fog in the towns and cities. Furthermore, coke ovens were always situated away from towns, whereas gasworks were usually located close to town centres.



A simple form of grid would enable gas to be available to every part of a district at a uniform price whether it was used in a big city or a small village, and the additional revenue obtained from the sale of surplus coke oven gas, which hitherto contributed little to the credit side of the balance sheet, was expected to enable the price of blast furnace, foundry and domestic coke to be reduced. The extra income was expected to enable coke ovens, which were usually associated with collieries, to pay an increased price for coking slack and thereby ease the burdens at the collieries. It is difficult to see how a market for surplus gas, sold cheaply, would enable the price of coke to be reduced and the price of coking coal to be increased.

At this time the vast majority of the benzole, toluole and naphtha, so indispensable for the manufacture of dyes, medicines and perfumes, as well as to the motor trade, was obtained by stripping from coke oven gas. Therefore any increase in the manufacture of coke oven gas would directly result in an increase in the production of benzole for dyes and motor spirit. Gas works, in contrast, did not strip the gas and so their only source of benzole was limited to the very small amount contained in the tar. There was therefore a feeling in the coking industry that the national interest was best served by maximising the supply of home produced motor spirit. There was no other way of doing this than by carbonising more coal in coke ovens and extracting the crude benzole for refining. The coking industry was determined to grow, if necessary at the expense of the many small gasworks which had to sell tar and liquor at very low rates because they did

not produce them in sufficient quantities to justify refining on site. The rail charges often swallowed up the value received and there were losses on the transactions.

Concern for the participation of the coking industry in the development of the gas industry gained momentum and on 7th June 1929 the Area Gas Supply Committee of the Board of Trade wrote to the Coke Oven Managers' Association requesting assistance in respect of evidence bearing on the availability and suitability of coke oven gas for public purposes (18) On 21st October 1929 representatives of the Coke Oven Managers' Association attended the offices of the Board of trade and presented their evidence to the Area Gas Supply Committee. Chapters V, VI and VII show how successful they were.

#### Scientific and Technical Knowledge in the 1920s.

Following World War I there was an unprecedented demand for blast furnace coke and by-products. In some of the larger manufacturing districts there was an enormous increase in the use of coal gas for furnaces and this created an abnormal demand. Furthermore there was a general labour shortage which encouraged the use of any available labour saving devices and a shortage of sulphuric acid led to an increased interest in possible substitutes, especially methods for converting the sulphur compounds in coal gas into ammonium sulphate.

One important result of World War I was the development of appliances which were just emerging from the experimental stage and the successes which has been obtained, together with the obvious need for a thorough investigation of the whole



subject of coal carbonisation. The outcome was the formation of a Board of Fuel Research under the direct auspices of a Government which consisted mainly of people who studied Classics at Oxford. <sup>The Government</sup> was forced into accepting the value of research experts and set up the D.S.I.R. about 1916. It is an unproven possibility that better knowledge of coal carbonisation would have enabled the industry to progress more rapidly and it may be claimed that insufficient attention was paid to research. The Second Report published in the autumn of 1917, stated that the Board of Fuel Research had obtained the lease of land adjoining the South Metropolitan Gas Company's works at East Greenwich and had a research station and plant for investigating the following:-

1. A general study of the carbonisation of coal at 500 - 600°C. (19)
2. An enquiry to find whether raw coal could be replaced by some form of coke or semi-coke which was free from tarry matter and oil so that it could be sold at a profit.
3. An enquiry as to whether in the preparation of such a manufactured fuel, adequate supplies of fuel oil for the Navy could be obtained at the same time.
4. An enquiry as to whether towns gas could be obtained more economically than by the methods pertaining at that time.

5. An enquiry into the utilisation of gas and fuel oil.

In addition, the Department of Scientific and Industrial Research, of which the above Board formed part, was financing research on the carbonisation of coal in various parts of the country, and other research projects were organised and financed by businessmen and associations in various parts of the world. Increasing economic and technical specialisation in the 19th and early 20th centuries had created the need for accountants, insurance specialists and advertising agents on an increasing scale.

Early in 1918 a paper was read to the Institution of Petroleum technologists in which it was proposed to 'establish a New British Industry' by distillation of cannel coal at a low temperature on a very large scale of 1200 tons per year and it aroused considerable interest. Although details were not given it would appear that the authors proposed to use vertical retorts and low temperature carbonisation.

Unlike the large German firms with big research departments which produced many new synthetic dyes - though *not all* became popular, research into coal carbonisation continued to be carried out in the traditional manner. Impetus was given to investigations into carbonisation of coal and considerable developments were anticipated in years to come - progress made in the period 1912 - 1917 is worth further consideration. The following groups, bearing in mind some overlapping was inevitable, were suggested:-



- |                      |                     |
|----------------------|---------------------|
| a) General progress  | b) The raw material |
| c) Illuminating gas  | d) Coke ovens       |
| e) Ammonia           | f) Tar              |
| g) Other by-products |                     |

### General Progress

It was essential that if progress was to continue satisfactorily, those engaged in coal carbonisation should have a much clearer knowledge of the nature of the material which they had to deal with and that they should endeavour to regard it with more detachment from existing methods and traditions than hitherto. It is true that much progress could be made by the logical development of existing methods of carbonisation, but greater progress could be made as more investigators, having the requisite ability and free from the limitations of those who had been trained as works managers, *brought* to the subject inventive minds and a willingness to attack it on lines based on the underlying principles of physics and chemistry rather than on the existing practice of destructive distillation.

The first requirement needed a full and detailed knowledge of the nature of the raw material - coal - and this was unfortunately still unobtainable because the knowledge of the chemical composition of coal had not been expanded for some years. Furthermore, work in which pyridine had been used as a solvent had shown that its action was by no means as simple as first hoped and that it did not effect a very satisfactory separation of the different constituents

of coal. The reason given was that it extracted too many substances and appeared to enter into combination with some of them.

Hollings and Cobb had found that the thermal curves of pyridine extracts agreed closely with those of the coal as a whole from which the extract was made.

Jones and Wheeler (20) had stated that if the portion of a coal soluble in pyridine was treated with chloroform or benzene the resinous constituents could be separated from the cellulose derivatives. The resinic derivatives consisted of alkyl, naphthene and hydro-aromatic radicals attached to highly complex groups. They doubted whether aromatic compounds were present in the coal.

F. Fischer and W. Glund found that the yield of pyridine extract was greatly increased by working at  $288^{\circ}\text{C}$  under a pressure of 50 atmospheres. They stated that no serious decomposition of the extracted materials occurred. Other solvents which showed promise were phenol, benzene, chloroform, liquid sulphur dioxide and ozone.

Pictet, Ramseyet and Kaiser used boiling benzene to extract a number of complex hydrocarbons from coal which were also found in tar when the coal was distilled in vacuo. Similar hydrocarbons were assumed to be present in the coal and capable of removal from it by extraction or evaporation.

The result of a large amount of purely chemical work was to leave the constitution of coal very much in the same



position as it was twenty years earlier, shortly after Bedson published his work on the use of pyridine as a solvent.

The work of Lomax, Hickling, Stopes and Wheeler (21) and others who undertook the separation and examination of different morphological tissues or portions of tissues showed more promise and by 1918 they had separated some vegetable debris such as wood and spores and were engaged in an examination of each.

Most gasworks engineers and coke oven managers realised the complex nature of tar but in contrast, coal was regarded as a simple material charged into an oven or retort at a temperature far in excess of that needed to decompose it into primary products, so that primary and secondary reactions occurred simultaneously in a confusing manner.

In order to make further progress it was felt that attention should be directed towards controlling the primary products and this showed up an urgent need for some form of simple equipment in which control could be effected in an efficient manner. Some people felt that none of the existing retorts or ovens were suitable although vertical retorts approached the ideal because they avoided the 'brutal' treatment of coal which is inevitable when charged into a hot oven. There is evidence to suggest that writers who used the word 'brutal' in this context were sub-consciously aware of 'thermal cracking' - a more detailed explanation is given on page 137. Even vertical retorts are open to the serious

objection that they do not permit enough control of the heating of the coal in its various stages of decomposition and are not sufficiently adaptable to the widely differing characteristics of different coals. This is clearly shown by the numerous patents for retorts and ovens which differ from each other only in details. Two lines of research were indicated:-

1. To find a suitable carbonising apparatus capable of dealing with any coal.
2. To improve the existing retorts in accordance with the latest discoveries in the physics and chemistry of carbonisation.

Both lines of research are quite separate and it was felt that most progress would be made in seeking equipment which would be a sufficient departure from existing designs to avoid their errors in principle and yet retain their commercial advantages.

It was generally understood that the nature of the coal to be treated and the products needed decided whether high or low temperature carbonisation was to be used.

In general this was correct but the research workers extrapolated too far in specific instances. For example low temperature carbonisation was considered most suitable for coal containing a small amount of nitrogen and a high proportion of light oils. High temperature carbonisation was believed to be most suitable when high yields of ammonia, aromatic oils and gas were required. However, the



interpretation that low temperature carbonisation produces a soft semi-coke with a low yield of ammonia and a high yield of paraffinic oils is quite correct. It was known that high temperature carbonisation produced a hard coke although it is doubtful if comparative tests were done. It is more likely that this conclusion was reached through general observations at coking plants. Presumably full scale plant observations proved that the ammonia yield and the gas yield were higher but the fact that the oils were more aromatic or benzoid in nature would almost certainly be demonstrated in the laboratory and on the full scale coking plant. It was realised that the low-temperature by-products were of less commercial value than those obtained from high temperature carbonisation because they chiefly comprised paraffins and olefines. Furthermore, the yield of gas was low so that the coke was of less value for metallurgical purposes and the low temperature carbonisation process was relatively labour intensive and so the demands for this process were not great. (22) The traditional optimism prevailed and it was hoped that a new demand for the by-products of low temperature carbonisation might arise, such as would be possible if a decision to supply the Naval and Aircraft Services with fuel oils solely produced in this country were made. Another ray of optimism lay in the event of special legislation regarding the conservation of coal or the abolition of smoke.

The economics of the carbonisation process produced a strong tendency to increase the operating temperature while

still retaining the term 'low temperature carbonisation' from about 1912. Therefore, according to Harger (23) the modern coalite process carbonised coal at  $650^{\circ}\text{C}$  with a greater yield of ammonia and gas and a smaller yield of tar than had hitherto been the case. Shortly before his death Professor Lewes (24) advocated carbonising coal at  $1050^{\circ}\text{C}$  and diluting the gas with water gas to a calorific value of 500 B.Th.U. Dilution with producer gas was commonplace in the 1950s when there was a shortage of gas and a surplus of coke. The practice of diluting with air was also used at some coking plants which did not have gas producers, even though it was technically undesirable. He claimed this method gave a ready-burning smokeless fuel with 6% of volatile matter. Although Lewes was optimistic with regard to the ready burning smokeless fuel for practical reasons, his judgment was presumably based on theoretical considerations and as such it was *better founded*. The section describing individual plants shows that the carbonisation temperature and sales gas calorific value advocated by Lewes was taken up almost without exception by the coking industry and remained for the next 50 years or more.

Coal was carbonised over a wide range of temperatures from  $400^{\circ}\text{C}$  to  $1050^{\circ}\text{C}$  and gave rise to many conflicting statements. The term 'low temperature carbonisation', 'medium temperature carbonisation' and 'high temperature carbonisation' related to below  $500^{\circ}\text{C}$ ,  $500^{\circ}\text{C} - 900^{\circ}\text{C}$  and above  $900^{\circ}\text{C}$  respectively.



Experience indicated that high temperature carbonisation tended to get out of control because of overheating of the gas and the formation of naphthalene and other troublesome secondary products. Better control of the coal at various stages in its decomposition was advocated but not spelled out in detail. This was perhaps a grey area and a fundamental knowledge of coke oven construction, refractory materials, and exhaust control were some of the pre-requisites to reducing naphthalene precipitation.

In general terms coal carbonisation was well understood and is demonstrated by the following summary; the chief objections to low temperature carbonisation were:-

- (1) Low yield of benzole and its homologues.
- (2) Low yield of ammonia and its compounds.
- (3) Low value of the coke.
- (4) Small yield of gas.

In contrast, high temperature carbonisation resulted in a loss of light oils which was cracked to yield large volumes of gas. Figure 3 sums up the state of the art in greater detail although it is biased in favour of high temperature carbonisation. The unanswered question is - did such a biased evaluation aid the industry or was it seen in true perspective?

Often the chief objective of the advocates of low temperature carbonisation was the prevention of wastage of tar and oils which occurred when coal was burned in furnaces, boilers or open fires. In order to overcome this a smokeless fuel free from the objections of raw coal and coke when burned in an open grate was recommended.

FIGURE 3

Comparison of High and Low Temperature  
Carbonisation. (25)

Advantages of high temperature carbonisation.	Disadvantages of medium and low temperature carbonisation
Requires less ground area for buildings.	Requires two or three times the ground area.
Requires less carbonising plant.	Requires two or three times as much carbonising plant.
Requires less capital outlay.	Requires two or three times the capital outlay.
Requires less labour.	Requires two or three times as much labour per ton.
Has a high yield of gas.	Lower gas yield.
Gas has a higher calorific value after by-products are removed.	Gas has a lower calorific value after recovery of by-products.
Produces hard coke.	Coke is badly carbonised, friable and results in waste.
Tar and liquor are not reduced and are of better quality.	The coke contains a considerable quantity of by-products which are wasted.



The economics of solid smokeless fuel production was unsatisfactory because of the many issues which affect its profitability. Without doubt there was an excellent case for the production of smokeless fuel but two obstacles needed to be overcome if it was to ignite readily and require minimum attention:-

- (a) If sufficient volatile was left in the fuel so that it was comparable with South Wales coal it was difficult to maintain domestic fires without providing relatively much more attention. Moreover the amount of fuel oil extracted in the process of manufacturing smokeless fuel was only a fraction of the by-products otherwise obtainable.
- (b) If all the volatile matter was removed the resultant coke was unsuitable for use in boilers and fire places without modification.

The above are the main reasons why the production of smokeless fuel had not become profitable. The general feeling was that it would not become financially attractive until the use of smokeless fuels was made compulsory by Act of Parliament. The London and Birmingham Act of 1833 compelling the use of coke in locomotives was not effective and the Clean Air Act did not come along until 1956.

Several fuels were receiving attention in various amounts at the turn of the century but by 1918 little was heard of them. It is reasonable to assume that the war interfered with their development because many of the people

who were interested in them were men of influence.

Indeed, the Fuel Research Board (26) was clearly in favour of some form of low temperature carbonisation and much of its work consisted of finding the best means of producing:-

- (1) A good fuel oil for normal use.
- (2) A good smokeless fuel.

The Report shows that the Board attached most importance to the oil but they realised, as few individual inventors had done, the necessity for making the bulk of the profit from the sale of solid fuel.

The Board was in contact with several public departments and was especially well placed for having its proposals supported by the Government. As a result its interest in the subject gave an importance to low temperature carbonisation which was quite independent of the intrinsic merits of the process.

A study of patents showed that researchers of many smokeless fuels had overlooked two important considerations:-

- (a) Without legislation stipulating the use of smokeless fuel or coke, the fuel would not fetch as much as the coal with which it had to compete.
- (b) The oil and other by-products had to be saleable to make up the deficiency in the selling price of solid fuel and to pay for the cost of carbonisation.



Often the high value of benzole and its homologues and the relatively small value of the paraffins were overlooked and because the oversight included the actual selling price of the smokeless fuel it was easy to obtain erroneous ideas about the value of the process.

One objectionable feature was that some people reiterated attempts to preach low or high temperature carbonisation to the exclusion of the other. Neither low nor high temperature carbonisation was right for all cases though both had definite spheres of usefulness.

A less parochial attitude would have enabled the whole subject of coal carbonisation to be investigated more thoroughly and scientifically. It is sad that so much ingenuity and labour was spent on *inventing* new shapes for retorts etc. when a more thorough investigation would have shown the underlying principles which must be followed before success can be reached and the narrow limits in which high and low temperature carbonisation is profitable.

The high degree of practical inventiveness is shown by the idea of double carbonisation but a little more experience would have soon shown it to be impracticable. It was known that when carbonisation was carried out in two periods the coke at the end of the first (low temperature) period was soft, friable and of little value for metallurgical purposes. During the second (high temperature) period, the volatile products passing through the coke were thought to be partly decomposed and the material deposited on the coke hardened it and thereby increased its value. This is a good example of a misconception because of a total lack of

knowledge concerning the mechanism of carbonisation.

Researcher~~s~~ were in fact guessing and though their reasoning was wrong the final conclusion was correct. Another misconception was that too high a carbonising temperature tended to reduce the size of the coke.

The first stage in the process of double carbonisation was chiefly effected by the heat applied to the retort or oven and, in continuous plants, by the hot gases given off during distillation. The second stage was effected by external heat but was supplemented by passing the gas produced at low temperature through the retort for a second time or by using other gas or steam. The idea that the products evolved during carbonisation should be removed from the retort or oven as soon as possible was well known but this could not be done in the case of double carbonisation and the scheme was dropped in favour of low and high temperature carbonisation.

Attitudes towards carbonisation changed and it was emphasised that low and high temperature carbonisation both had merit according to the fuel available and the product required. When the chief product was towns gas low temperature carbonisation on its own was undesirable but it was realised that with higher temperature retorts many of the volatile products showed the characteristics of low temperature carbonisation.

Because coke ovens and gasworks were so numerous there was a demand that, simultaneously with research, there should be a sustained effort to improve existing equipment. The directions in which such improvements ought to move were many:-



- (a) Better control of retort or oven heating.
- (b) Better tie-up between retort or oven dimensions and the various coals. In retrospect this was probably quite a worthless exercise, but in context it was a reasonable idea.
- (c) Better materials of construction, firebricks etc.  
The chapter describing Glasshoughton Coking Plant shows the first use of silica in coke oven construction in Britain.
- (d) Better separation of the products of various reactions to improve the control of both.
- (e) Better utilisation of the by-products, especially the more efficient use of the gas evolved during carbonisation.

The above items are worthy of further consideration:

- (a) Coal was recognised as a complex mixture that was difficult to deal with and so the aim was to have control over every part of the carbonising process.  
In practice retorts and ovens were very simple structures and so the amount of control was limited and in fact it is remarkable that such good results were obtained with them.
- (b) There is no more to be said regarding the adjustment of the carbonising equipment to meet the needs of a particular coal. Even if this was necessary fulfilment would be virtually impossible.

- (c) Some progress in refractory materials had been made since about 1912. The use of silica instead of fireclay in American coke ovens enabled them to carbonise coal more rapidly and the main reason given was that silica had a higher thermal conductivity than fireclay above  $1000^{\circ}\text{C}$ .

*Another* reason ought to have been that silica is better able to withstand temperature above  $1000^{\circ}\text{C}$  and is not attacked by salty coals. We have for the first time a sense of commercialisation regarding the rate of carbonisation.

- (d) There was enthusiasm to try and separate the products of primary and secondary reactions, presumably to try and obtain better control of the carbonisation process but the idea was not feasible. Some people believed the objective could only be achieved with a radical change in the type of carbonising plant and this never happened.

- (e) Coke oven managers had recently become aware that it was more economical to supply surplus gas for gas engines than to burn it under boilers, although at many coking plants the gas was burned to waste because those plants were located <sup>in a way</sup> such <sub>^</sub> that the gas was not in demand. It was also known that using lean gas, such as that from blast furnaces, for underfiring made rich gas available for illuminating and driving engines and enormous financial savings could be made. The ability to benefit from lean gas underfiring rested very much on the location of the coking plant. The choice of site



now took into consideration criteria which had not needed to be considered earlier in the century. The fortunes of the industry at this time depended to some extent on chance - a ready outlet for surplus gas. In the absence of blast furnace gas a low grade gas could be made using inferior coal or coke in a gas producer. The first plant to use producer gas for underfiring is described in detail in chapter V. Hitherto coke ovens had always been situated on land adjacent to a colliery.

Economic and technical progress in the industry and in society as a whole opened up the whole question as to where a coking plant should be situated; the colliery location was no longer so desirable and the well known axiom in commerce that a works should be located as near to the market as possible also applied to coke ovens. These ideas exercised minds but the special circumstances of the coking industry needing large quantities of coal meant that it continued to be located at collieries. Those coking plants which had an easy outlet for gas had an advantage.

#### Progress in Coke Oven Construction

Up to 1927 the coking industry was both inefficient and uneconomical and owners were reluctant to spend the large sums of money necessary for the complete reorganisation of plants. In consequence there was little opportunity for coke oven contractors to put into practice the improvements which had been made.

One effect of the considerable improvements in oven construction made abroad was to enable both German and American practice to be incorporated in British coke ovens. This view is supported in chapter VIII describing the development of Simon Carves Limited and the Woodall Duckham Company Limited. Thought was given to oven construction after 1927 with the result that much progress was made. The result was that about half a dozen British coke oven contractors had designs which compared favourably with those produced abroad.

It was realised that improvement in the coking process could only be achieved by a drastic alteration in the design of ovens so that the carbonising time, the quantity of underfiring gas and the cost of operating them could be reduced. It had been found that a reduction in the coking time required better heat transfer between the flue gases and the charge, which in turn necessitated the use of higher temperatures and narrow ovens. The refractory material in general use could not withstand higher temperatures and so the demand for silica increased, bringing with it special problems of expansion. See chapter describing Glasshoughton Coking Plant. In order to compensate for the loss of capacity due to the narrower ovens, they were increased in height and length. Increasing the height brought new problems in the heating of the taller flues required so that details of oven construction were altered on an extensive scale. The operation of the taller ovens brought about consideration of labour saving devices on a large scale which had hitherto been unheard of. Some startling advances had been made, particularly in relation to chamber height and also chamber length. The overall result was the charge weight doubled and the output per oven per day increased by a factor of 2 . 5. The use of silica instead of firebrick in oven construction was largely



responsible for the improvements which, together with increased availability of coke oven gas for sale gave the industry fresh impetus.

Figure 4 presents some detailed information of ovens built in this country in the 1920s and makes comparison with older ovens. It should be noted that the oven dimensions at some of the plants were dictated by the need to conform to the dimensions of existing ovens on an adjacent site so that the same oven machines could be used. Some 527 ovens with a total weekly throughput of more than 70,000 tons of coal had been, or were being erected in the 1920s. Never before had the contracting industry been so active. It may be stated in passing that British ovens were generally wider than those used in America and on the continent. The widths used here were considered suitable for the size of coke required in British foundries and furnaces. Some 3 or 4 years earlier, the German owners erected large numbers of ovens having widths of 14 to 16 inches but present thinking was nearer to 17.5 inches. The advantages of narrow ovens did not materialise and the only plant in this country to be built with 14 inch ovens was Nunnery Handsworth which was specially built to produce smokeless fuel. It was also the first battery of Becker ovens to be built by the Woodall Duckham Company in this country. The plant is described in detail in chapter V.

#### Coke Ovens in between the Wars.

The coking industry developed rapidly after World War I and figure 5 shows that even though there were fluctuations, particularly in the early 1930s and to a greater extent in 1926, output increased tremendously. One of the most striking signs of progress was the rapidity with which by-product ovens were built early in the century. Figure 6 compares the number of

FIGURE 4

Comparison of Old and Modern Ovens (27)

		Old Regenerative Ovens	New Compound Regenerative Ovens
Chamber dimensions:			
Length	ft.	33	38
Height	ft.	6.5	14
Width	in.	20	18
Material of construction		Firebrick 84% silica	Silica 95-96%
Volumetric capacity	cu.ft.	357	741
Charge weight	tons	8	16.5
Carbonising time per oven	hours	30	26.4
Carbonising time per ton of coal	hours	3.75	1.6
Throughput per oven per day.	tons	6.4	15
Quantity of gas used for heating.	%	60	38.5
Quantity of gas available for sale	%	40	61.5



FIGURE 5

Coal Carbonised (34)

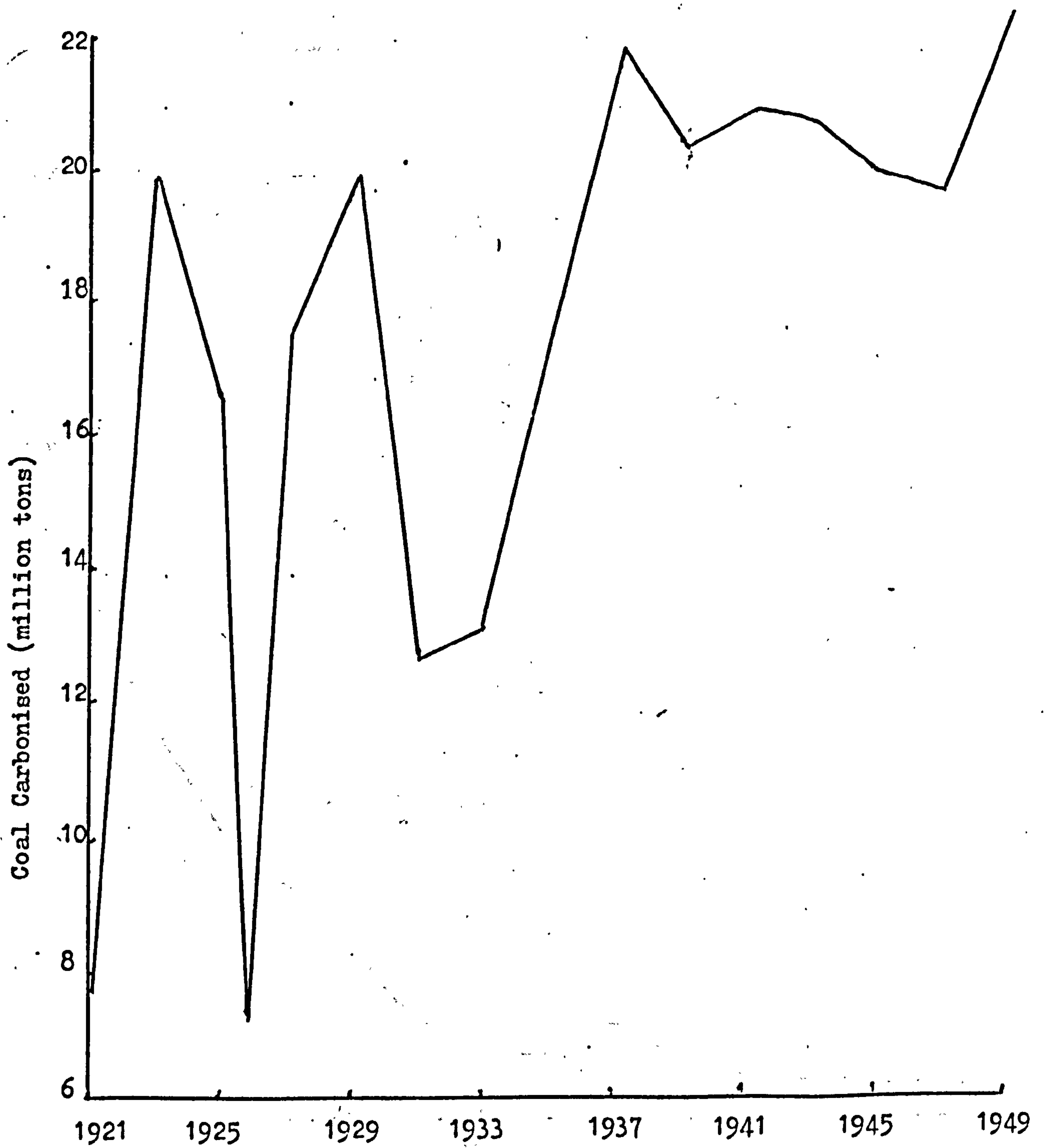
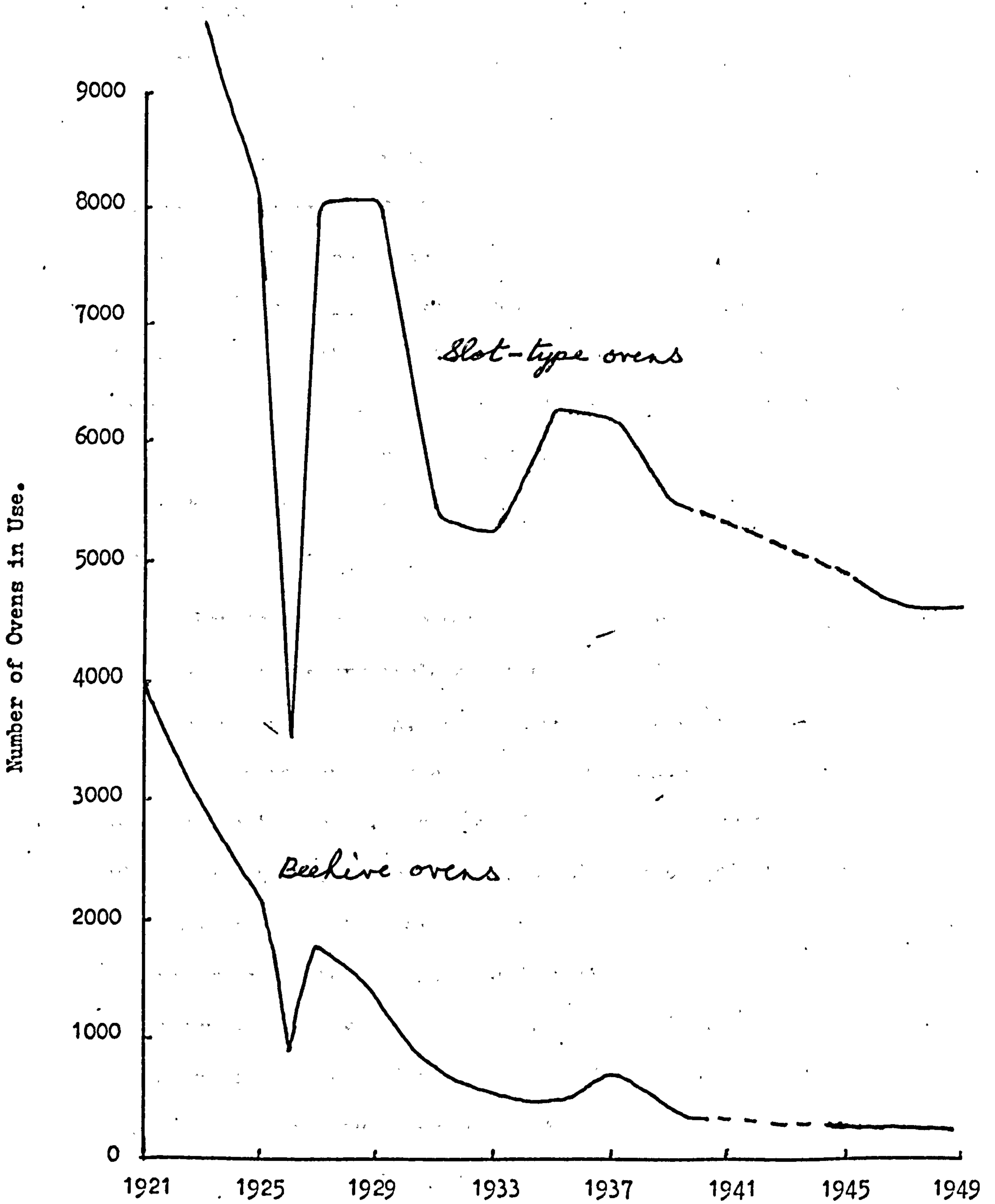


FIGURE 6

Average Number of Ovens in Operation (35)





Beehive and slot type ovens in use, the lower value in 1926 is due solely to the General Strike. The attractive grey coke traditionally made in the beehive ovens was seldom seen in some districts because it had been superseded by the darker coke produced in the by-product ovens. A considerable number of beehive ovens remained in existence but for several years almost all the new ovens erected were of the by-product type. Beehive ovens are known to have existed at Parkgate near Rotherham, Thorncliffe, near Sheffield and Hazelhead near Penistone. Evidence of the beehive ovens at Parkgate still exists. The needs of the nation as a whole had compelled the ironmasters to forgo the use of the coke they preferred and events subsequently proved that the by-product oven fully justified the confidence placed in it by its advocacy. In this period a well managed by-product oven produced 15% more coke than a beehive oven of the same capacity.

Developments in the method of carbonising coal early in the twentieth century included improvements in the details of well-known types of oven, and the use of blast-furnaces or producer gas for underfiring. However the idea that coke ovens were 'brutal' to coal, first put forward by Professor Lewes in 1912 persisted for several years, partly because of the fear that heating coal at a low temperature might destroy its coking power. The fear was based on several small scale experiments but it was exaggerated. It was felt that the resinous constituents of coal were easily oxidised and so the coal could no longer produce good coke. Therefore oxidation rather than prolonged heating at low temperature appeared to be the main reason why the coking properties of

some coals were readily destroyed. If the risk of destroying the coking power was as important as was generally supposed, the central portion of the coke in the charge would be in the form of powder because that portion is heated most slowly. The idea existed that where moderate sized coal was carbonised so that ample space occurred between the pieces heating would be fairly rapid, but in denser charges it must necessarily be slow, was also not correct. In fact the converse was true. The view that hot gases evolved from the outer portions of the coal passed up the interior of the mass was not generally held at this time, (28) but even if it were true it would not affect the argument.

Much was talked about the method of carbonisation and some of the comments would not withstand detailed investigation. The chief reason for using high flue temperatures was to convey the heat as rapidly as possible to the interior of the charge and so minimise the coking time. Although this was a simple way to achieve the objective it was by no means certain that it was the best method. Some of the people who were interested in vertical retorts were convinced that it was better to effect the bulk of the carbonisation at a relatively low temperature and then submit the resultant semi-coke to a more intense heat in order to give the final product the desired hardness, and to remove as much nitrogen as possible in the form of ammonia.



The most important improvements to existing  
ovens were:-

(1) Larger Ovens

Most British coke ovens held charges of 8 tons and ovens with a charge of 10 tons were very rare although a recent Semet Solvay plant had ovens of 16 tons capacity. As in the case of other industries the Americans made most progress and they had ovens of 15 tons capacity in common use. It was realised that it was unlikely existing types of ovens could be adapted to produce coke in wider chambers but it was understood that the height and length of the chambers could be increased although they were already near to the maximum size - experience had shown that in very wide ovens the central portion of the charge was imperfectly carbonised unless abnormally long coking times were adopted. The widest ovens in this country, at 24 inches, were at Holmwood Colliery when the traditional width was 17 - 18 inches. Each of the ovens held a charge of 12 tons but a carbonising time of 48 hours was needed. (29)

It was soon recognised that so long as the present type of coke ovens were retained the narrow oven had the following advantages:-

- (a) Less sponge in the coke.
- (b) Harder coke.
- (c) Higher yields of by-products.
- (d) Lower oven wall temperatures.

(2) Faster Carbonisation.

More rapid carbonisation was desirable for many reasons, including the improved quality of the coke. Some coals containing more than 30% volatile matter produce unsatisfactory finger-shaped pieces of coke unless they are blended with other coals and carbonised very slowly. Another advantage held early in the century was the belief that non-coking coals used for gas making would produce excellent coke if heated rapidly. In support of this Alfred B. Searle claimed that a notoriously troublesome coal, because of its non-coking properties and its close association with good coking coal, gave an excellent coal when crushed and heated to 900°C for 30 minutes. He went on to say that starch, which is ordinarily non-coking can be made to yield a hard and brilliant glossy coke if heated rapidly. Searle was perhaps too enthusiastic and too ready to generalise, he would have done well to question the importance of crushing the coal before carbonisation on a laboratory scale.

On a commercial scale, a higher rate of carbonisation had been obtained partly by the increased use of refractory materials in oven construction and partly by using silica instead of firebrick. The outstanding feature of silica was claimed to be its better thermal conductivity; the fact that it softened at a higher temperature than firebrick went unnoticed. This indicates a limited approach to the concept of increased throughput. Research in refractories was in its



infancy and there was optimism that the idea could be extended to other refractories with even greater results. Enthusiasm<sup>a</sup> was provided by the fact that in 1912 W.E. Hartmann (30) had reduced the cooking time from 24 hours to 16 hours at an American coking plant and thus obtained a superior coke.

The thermal conductivity of heated coal is so low that the charge itself is the greatest obstacle to heat transfer. In ovens heated mainly from the sides Ramsburg and Sperr (31) found the carbonising rate to be half inch per hour in an oven 18 inches<sup>wide</sup> with a wall temperature of 1000°C.

This should be compared with old beehive ovens where the heating was largely from above with some from below, both of which were claimed to be more rapid than heating from side to side. The most rapid heating of all was known to occur when a high temperature gas was passed through the charge but with that overheating spoiled the by-products. The knowledge of thermal degradation and cracking was in its infancy.

Theoretically the most effective means of carbonisation would be obtained by crushing the coal into thin layers to give a large amount of surface exposed to the heat. Sir George Beilby had already devised an arrangement of this kind but it never became popular, perhaps because it was unsuitable for coking coals (32)

### (3) Faster Removal of Gas.

Rapid removal of gas had by this time become essential because experiments had shown that a gas produced below  $450^{\circ}\text{C}$  was readily decomposed at  $700^{\circ}\text{C}$ , often with the formation of carbon and a darkening of the coke. The temperature at which decomposition occurred was well below the coke oven chamber temperature. In gasworks, where by-products were not very important the gas was sometimes overheated in order 'to crack' the higher hydrocarbons but where the maximum amount of paraffins were needed in the by-products the gases should be drawn off quickly and uniformly.

The effect of pressure on the gas in a coke oven was investigated by J.H. Capps and G.A. Hulett (33) who found that up to  $600^{\circ}\text{C}$  pressures below 20 atmospheres reduced the amount of high boiling point compounds and increased those of low boiling point. They also increased the amount of low boiling point aromatic compounds.

### (4) Utilisation of Waste Gases

This underwent much improvement from 1912 - 1918 in the operation of coke ovens to give the maximum availability of high calorific value gas, and in the utilization of more heat in the waste gases going to the coke oven chimney which had hitherto been wasted. The recovery of the waste heat was brought about by using Siemens type regenerators which had been suitably



modified. Although the use of recuperators in the coking industry was in its infancy they had been used successfully for more than 30 years in other industries. Why had they not been adopted in the coking industry much earlier? The answer lies in the fact that until a suitable market had been found for the gas, regenerators were unnecessary. Now that a vast demand for gas had been tapped regenerative ovens rapidly gained popularity. Waste heat ovens consumed about 70% of the total gas made but the regenerative ovens reduced the consumption to 50%.

Regenerators were not as efficient as they needed to be. First they required attention every half hour or thereabout in order to reverse the direction of the flow of gases and second, the reversal was a source of heat loss and damage to the brickwork. The refractories used in the recuperators had to be built with very thin walls which made serious leakages inevitable. The development of coke oven regenerators depended therefore very largely on the development of refractories.

(5) The use of lean fuel gas.

The use of blast furnace gas or producer gas for underfiring the ovens, thereby enabling the equivalent amount of rich gas to be sold, has been mentioned. The objective was to substitute a gas of low calorific value which was cheap in place of rich gas which was more valuable.

(6) Heat loss by radiation and leakage.

Heat loss in more recent times has been reduced by paying attention to detailed oven construction.

However the thinness of the oven walls caused inevitable heat loss. It was hoped the use of better refractories in the future would reduce the heat loss, especially that produced by leakage, but the heat lost through radiation and by discharging red hot coke was regarded as the most serious. There was obviously an awareness of the need to improve heat loss and several practical recommendations were made:-

- (a) The duration of the coking period should be kept to a minimum with minimum consumption of gas.
- (b) The coke should be cool when withdrawn from the oven.
- (c) The gas should be as cool as possible consistent with avoiding undue condensation.
- (d) The waste gases leaving the chimney should not be hotter than needed to produce sufficient draught.

The difference in the yield of a well or badly managed oven could exceed 25% of any production so that advantage of alert inspection and prompt action in preventing heat loss was great. Unfortunately many coke ovens were situated in areas where it was difficult to make use of the valuable heat and surplus gas so the ovens were worked at low efficiency.

The growth in demand for all coke oven products in the 1920 and 1930s brought about a revised attitude towards coke oven operations and efficiency.



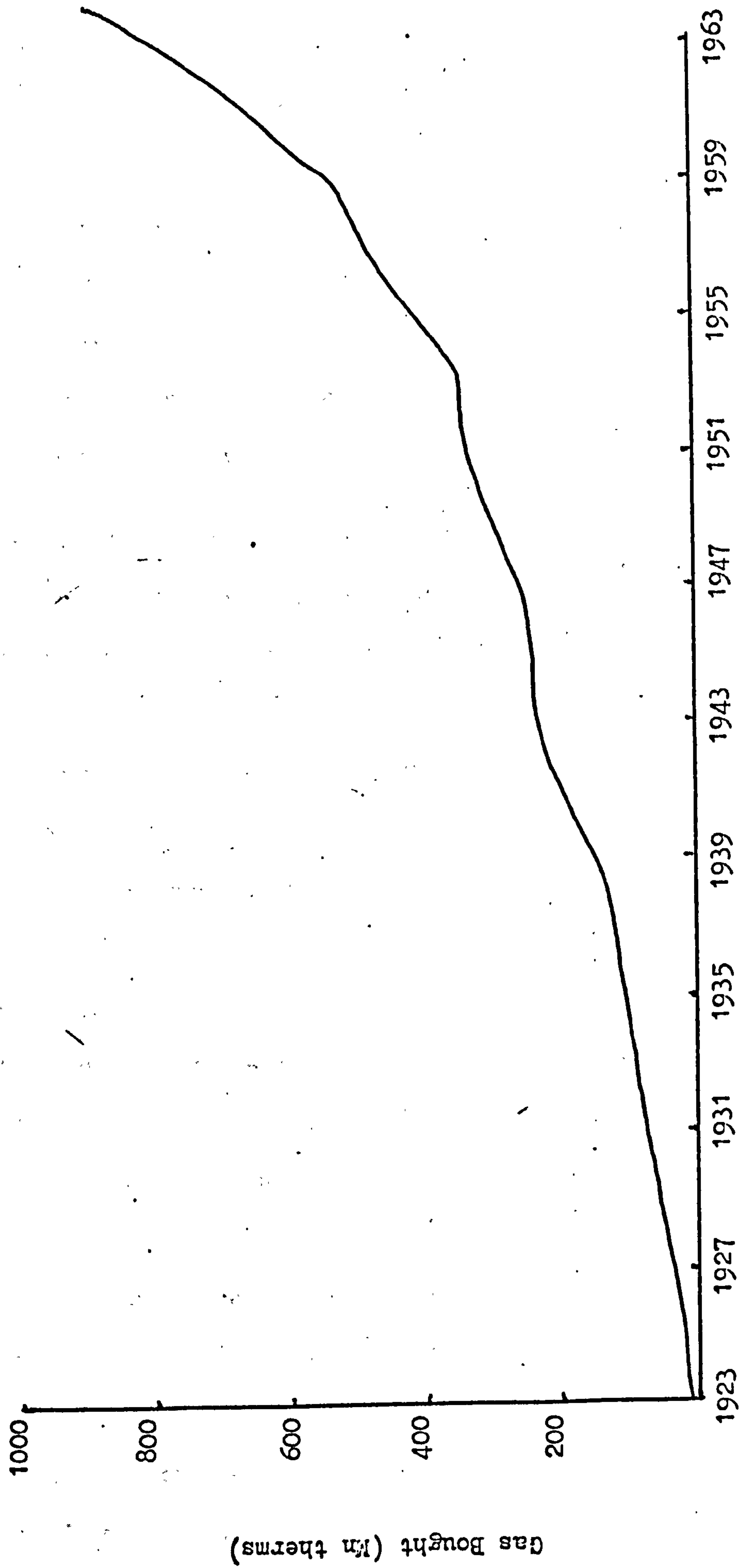
Coke oven gas for town's use.

Prior to 1927 the use of coke oven gas for town purposes cannot be said to have made any significant progress in this country, see figure 7. At places where it was being used its employment was probably due to the mutual enterprise of a few coke oven owners and gas authorities rather than to a general belief in its value or suitability. The reasons for this are worthy of further consideration. From the first inception of the recovery oven in Britain the early history has been one of struggle against prejudice. When it required much of the gas evolved during carbonisation for heating the ovens it had to fight the consumers of furnace coke who alleged its produce was inferior to beehive coke. In time the ironfounders wearied of paying extra for beehive coke and they accepted the view that by-product oven coke was every bit as good, or even better than beehive coke. Troubles then arose because by-product recovery ovens had been so improved that only half the gas produced during carbonisation was needed for heating the ovens and the more conservative members of the gas industry were obsessed with the fear that coke oven gas <sup>might</sup> ~~may~~ become a rival. They believed the gas manager's by-product market might be injuriously affected - a feeling which made it difficult for advocates of the by-product recovery oven to get an impartial judgment on their claims.

The problem was that the gas manager, whose objective was to produce maximum yield of gas, collect it and distribute it, used part of the coke produced in the process to heat the retorts. In contrast the coke oven manager was concerned with

FIGURE 7

Gas Bought from Coke Ovens and other Sources. (38)





producing the largest yield of coke and so those ovens were heated with coal gas evolved during the carbonisation process. There was a feeling that when high candle power gas and metallurgical coke were required coke ovens should be used, but when low grade gas of fourteen candle power and domestic coke were needed gas making plant was appropriate. Coke oven managers took the view that if the carbonisation process was to succeed the use of candle power as a standard of illumination would have to be abolished.

Perhaps the greatest statement of the claims of by-product recovery ovens as a means of providing illuminating gas was made by Ernest Bury at the Institution of Gas Engineers in 1907. (36) Much credit was due to the absolutely fair way in which the drawbacks as well as the advantages of carbonisation were stated. Bury had long experience in coke oven management as well as a good scientific knowledge so that he was probably the best person to speak on the subject. He freely admitted that because of the method of constructing by-product ovens, the large end doors which could be made only partially tight by luting, and the length of the carbonising period, it was more liable to serious leakage than any other system. Subsequent events disproved this point of view. See chapters V and VII. He also stated that the high temperature in the top of the oven chamber, which was always above that of a gas retort, was a factor which at first sight appeared to condemn coke ovens as sources of town gas, but in spite of these drawbacks the economics were so great that the cost of 540 B.Th.U. gas at the colliery was only 4d. or 5d. per thousand cubic feet, or less than half the cost at the big London gas works.

There was support for Bury's view that if the gas was produced at collieries and delivered through large trunk mains, appreciable economies were possible but the coke produced would cause concern. It was known that in <sup>the United States</sup> the by-product oven was successful because <sup>the Americans</sup> had long ago abolished bituminous coal as a domestic fuel so that coke had to compete with high priced anthracite instead of cheap coal for domestic use. Since metallurgical coke could be used quite satisfactorily in American closed anthracite stoves it had the entire domestic market open to it. In England, however, with open fire grates, often with hardly enough draught to burn bituminous coal, and needing an easily ignited and free burning fuel, coke had little chance of success. This led to the view that carbonisation of coal would only be successful in districts where metallurgical coke was in demand.

Perhaps another reason for the lack of progress was the low value placed upon coke oven gas by potential customers and the fact that gas authorities had little faith in continuity of supply. The first item is difficult to understand because in many instances the customers were monopolistic buyers and as such they could name the price. The second reason shows the traditional innate conservatism which had to be overcome. Another factor was the mistaken idea that the use of coke oven gas would not be in the best interest of the officials who recommended its purchase.

Coke oven owners were also largely to blame for the reluctance of gas engineers to use the gas because they would not guarantee the quality or the quantity in the terms

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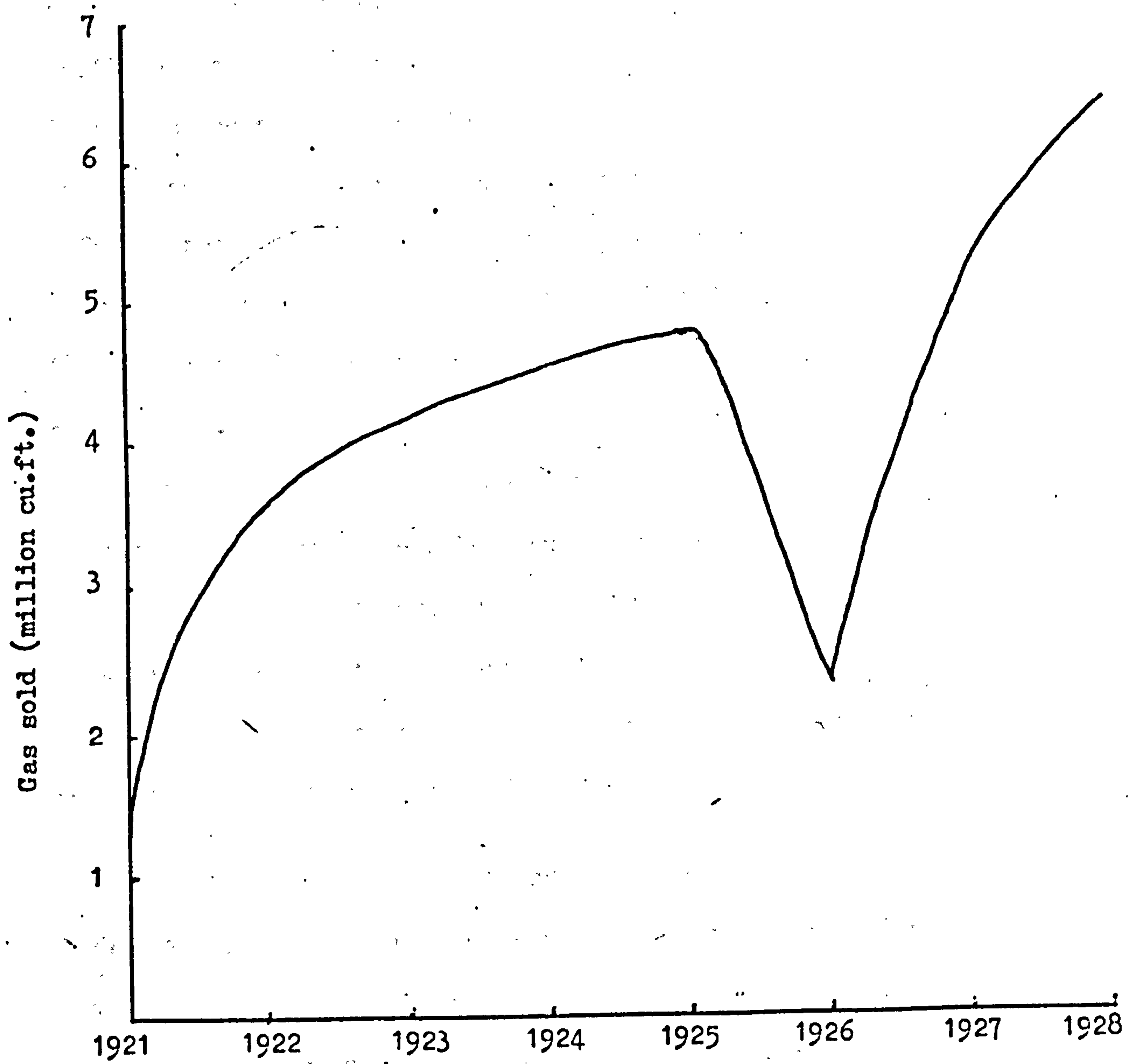


which gas authorities were compelled by their responsibilities to the public to insist upon.

During 1927 much more interest was taken in the use of coke oven gas as a potential fuel for town use. Probably the extension of the use of coke oven gas in Germany (37) and the attention devoted to the subject by the technical press coupled with the pressing need of coke oven owners to increase their revenue, compelled both sides to consider the subject more seriously. Maybe the Gas Authorities saw the wisdom of providing for their present and future needs of gas without adding to their financial burden at a time when they were already overburdened with financial charges and faced with heavy expenditure on new plant. The outcome was that 1928 witnessed a number of gasworks taking coke oven gas and an even larger number of authorities actively considering this subject. Figure 8 shows the quantity of gas consumed by the general public in the 1920s and demonstrates the reduced availability of gas during the General Strike. Other contracts which were already concluded, or would be so in 1930 would greatly increase the gas sales. Figure 9 indicates the position of the coking plants in this matter in detail and shows that most of them sold unpurified gas. Among the ovens being erected and intended for the manufacture of towns gas were those at Altham, Clay Cross, Canklow and Dagenham. Already considerable quantities of coke oven gas were being sold for towns use but the potential market was far greater. Coke ovens existed in many districts of Yorkshire and Derbyshire and the proper development of some of them was hindered by the inability to dispose of the surplus gas which was being used less

FIGURE 8

Coke Oven Gas sold for Town Purposes. (39)



efficiently for underfiring and steam raising.

There are numerous examples where steam could be raised more economically by using inferior or cheap coal which was being left underground or transported to the colliery tip.

In many places prior to 1927 coke oven gas had been offered at reasonable prices to gas authorities and almost <sup>always</sup> prematurely refused. For example, in North Staffordshire some  $2\frac{1}{2}$  million cu.ft. of coke oven gas per day was offered at a price 33% less than the price being obtained in 1928 but it was refused. In 1926 some  $4\frac{1}{2}$  million cu.ft. of coke oven gas per day were offered from another works in the same district but without success. The picture was much the same in Derbyshire when  $2\frac{1}{2}$  million cu.ft. per day were offered at a reasonable price and refused. In South Yorkshire the position was much worse, huge quantities of coke oven gas which if bought by the Gas Authorities at the price asked would <sup>have</sup> enabled them to reduce the price to the customer, were being burnt uneconomically in several ways. At one plant in the district with 4 - 5 million cu.ft. of gas per day available, frequent attempts to sell the gas over the past 12 years had been fruitless.

North Lanarkshire had started to supply the public with coke oven gas and Altham Colliery Co. (1924) Ltd. had been supplying Accrington and Great Harwood with gas in 1927. They supplied Burnley Corporation with much of its requirements the following year but still had some 2 - 3 million cu.ft. a day of surplus gas.

The Coking industry was striving hard to create demand and it anticipated that area gas supply would become a reality; in which case the coking plants in existence could provide a major part of the gas demand.



The belief that coking plant owners could produce sufficient sales of gas to supply the central distribution stations was based on the following:-

(1) There was already an abundance of good quality coking coal in the areas concerned.

(2) Coke oven gas at present being burned under colliery boilers could be immediately made available for other purposes.

(3) The waste-heat ovens, which did not produce surplus gas, could be converted to regenerative ovens which had 60% of the total gas made available for sale. In retrospect this was not a practical reality although there would be many people outside the industry who would believe it.

(4) In some cases producer gas could be used for heating the ovens and liberate an equivalent amount of rich gas for sale.

Coke oven managers were willing to quickly erect modern ovens fired with producer gas in sufficient numbers to meet the market for sales gas if necessary. This poses the question - were they so ambitious that they were prepared to meet the sales gas demand at the expense of creating a surplus of other products, especially coke? This raises the further question - was the coking industry expecting the demand for coke to increase? If it was, it was well justified in encouraging the use of rich gas for towns use but if it was not, the rigorous industrial fight for expansion was taken to extreme and could have resulted in serious over-capacity and resultant price cutting of the main product.

## Influence of Technological Advancement in the Iron and Steel Industry.

Inevitably there has always been a close relationship between the coking industry and the iron and steel industry. In order to examine the relationship in some detail the number of furnaces in blast from 1920 and shown in figure 9 needs to be examined. Why is the general trend towards fewer furnaces? The iron and steel industry, like the coal industry, fluctuated with the economy and for this reason the graph ought to rise. Figure 10 has been given to show a more impressive decrease in the number of blast furnaces in use since 1945 because it avoids other factors such as World War II. Figure 11 shows the annual output per furnace over the same period and it is broadly inversely proportional to figure 10. The reasons for the increase in output per furnace are complex and have been ongoing since iron was first produced using charcoal and Darby's use of coke. Natural evolution of applied science and technology in both industries is responsible for much of the progress.

The total annual production of hard coke during the war varied between 15.3 million tons in 1940 and 14.3 million tons in 1943 and 1944. The amounts consumed in pig iron smelting were 9.6 million tons in 1940, slightly less than 9 million tons in 1943 and 8.2 million tons in 1944 and 1945. The increased use of home ironstone for war-time pig iron production made unavoidable a higher coke consumption per ton of pig iron produced than in peacetime, and although the coking industry experienced, along with other industries,

FIGURE 2

Number of Furnaces in Blast. (40)

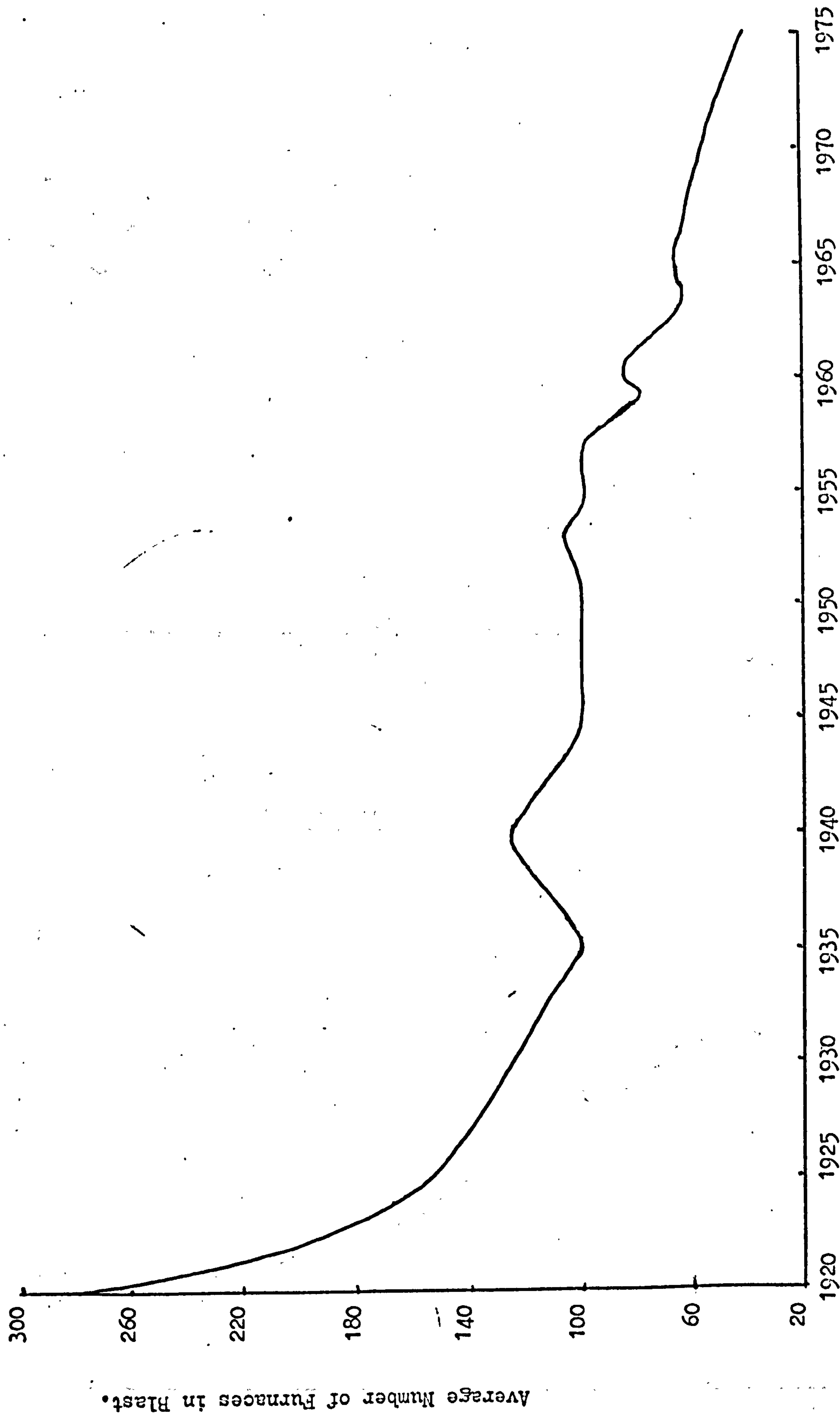




FIGURE 10.

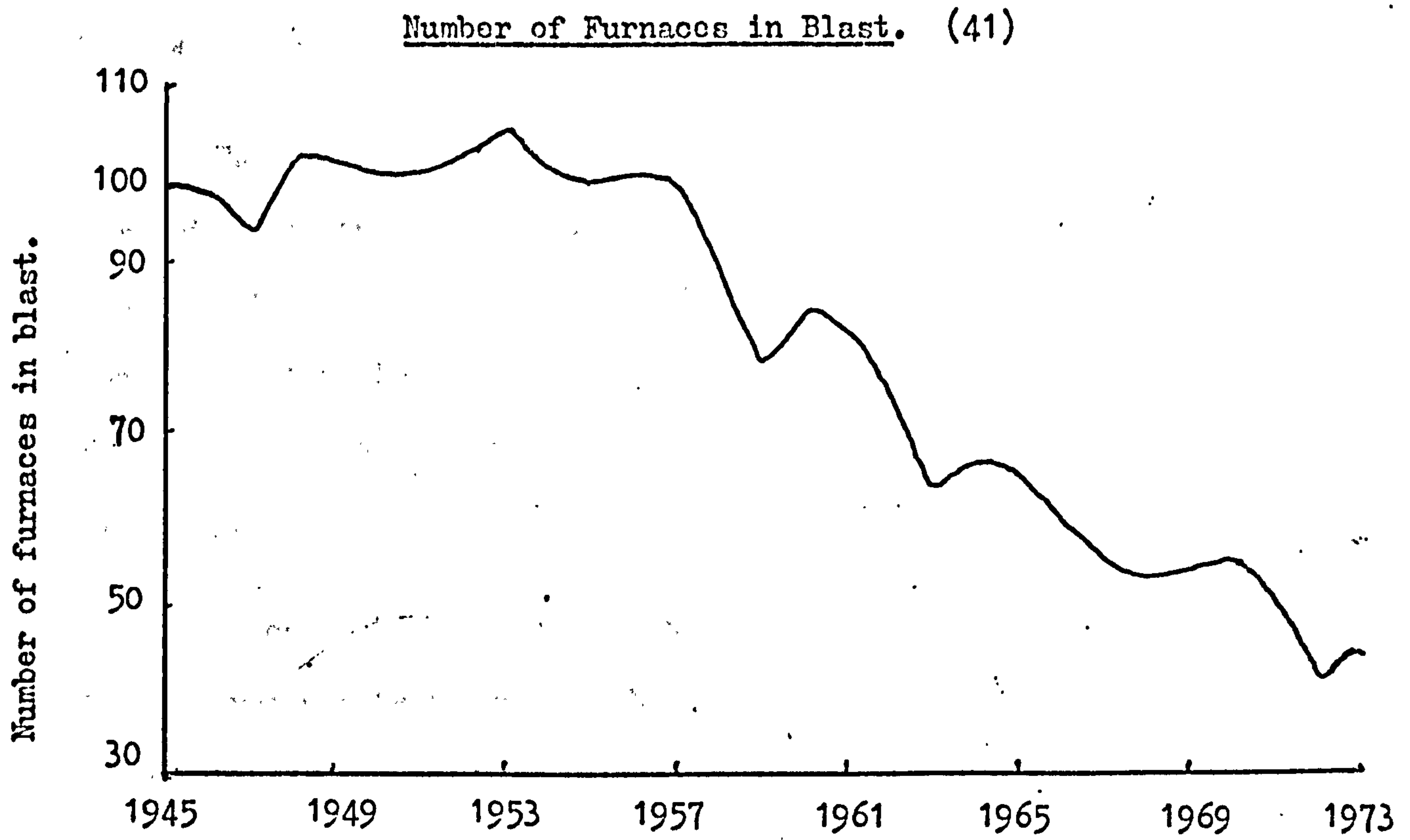
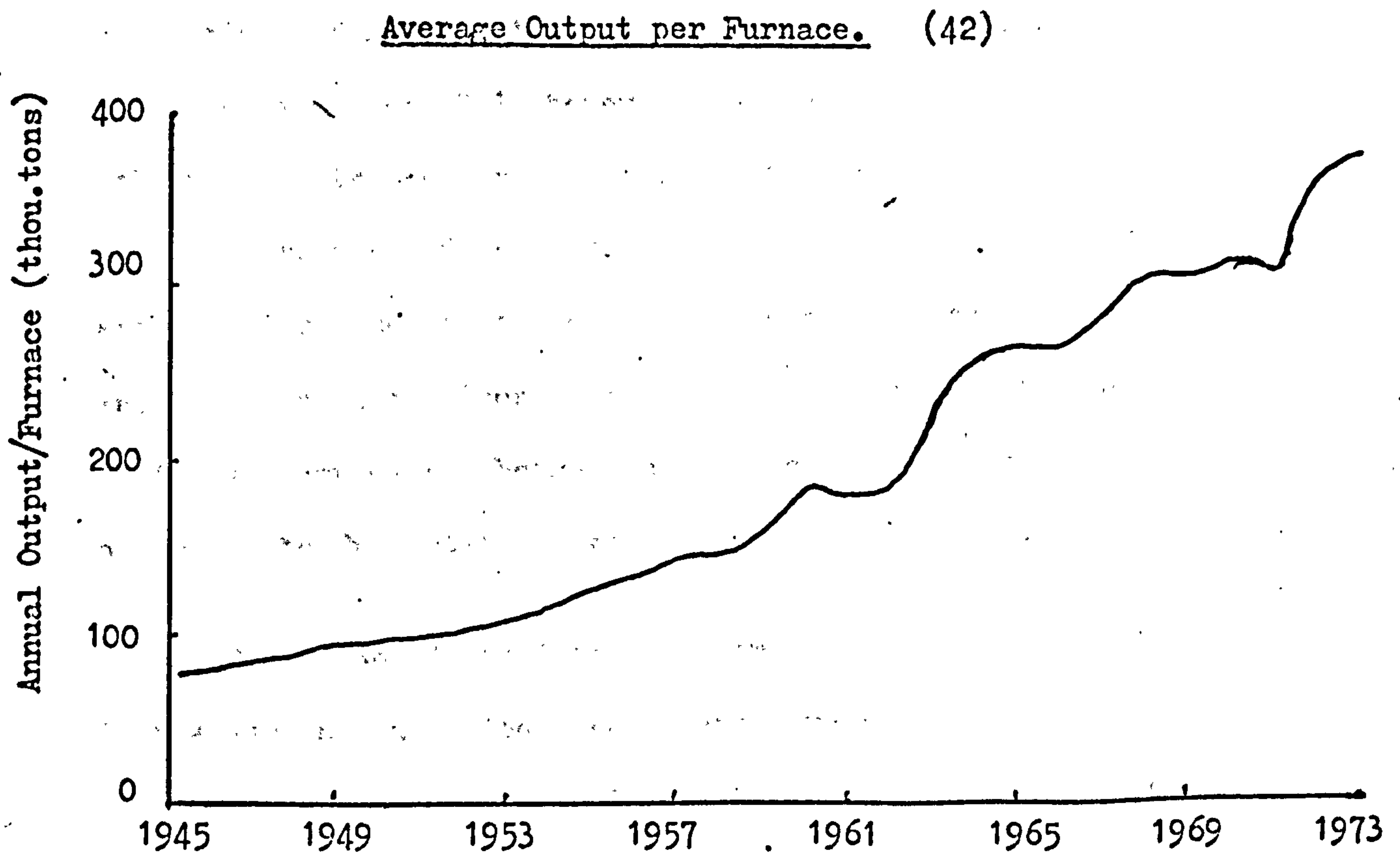


FIGURE 11.



the common war-time shortages of transport and manpower, there was never a major crisis in coke supplies.

What were the reasons for this favourable situation?

The iron and steel industry, which was both the largest producer and the largest consumer of hard coke, controlled approximately half of the production, the remainder being in the hands of the coal industry which also sold much of its production to the iron and steel industry.

Since 1938 a national 'Tripartite Agreement' relating blast-furnace coke prices to those of steel had existed between the B.I.S.F., the Foundry Iron Producers and the makers of blast-furnace coke. The agreement remained in force until 31st December 1939 and was followed by a second Tripartite Agreement which ran from 1st January 1940 until 30th June 1948 and which regulated the basis of war-time coke prices charged to the iron and steel industry.

From the middle of 1941, however, purchases and sales of coke were controlled by the Ministry of Fuel and Power, and as it was recognised that the Tripartite Agreement was not enabling increased coke production costs to be reflected in the prevailing prices, a link was established with the Ministry's agreement, between coke prices and those of coal, although the Tripartite Agreement remained in force.

During World War I the coke producers had organised themselves into a national representative body at the Government's request, but a largely free market had operated

during most of the inter-war period. When war broke out in 1939 the coking industry again formed a national association - the British Hard Coke Association - at the Government's request.

One very big problem which loomed even larger for the coking industry than for iron and steel production was that of blackout, the glare of discharging coke ovens can be seen for many miles at night in normal circumstances, and throughout the war the provision of devices to diminish this hazard at the coke oven batteries was a major concern of the Iron and Steel Control's Anti-Glare Committee.

There were three significant changes in the raw material position of the steel industry during the post war period:-

- (1) the use of pig iron increased relative to the use of scrap.
- (2) the use of imported ore increased relative to the amount of home ore.
- (3) the consumption of coke per ton of pig iron declined steadily.

What were the factors which brought about the latter?

The amount of coke per ton of pig iron decreased from 1.1 tons in 1946 to 0.7 tons in 1964, see figure 12. In consequence, although the production of pig iron increased by 50% from 1952 to 1964 (see figure 13) the overall



FIGURE 12

Coke Consumed per Ton of Pig Iron Produced. (44)

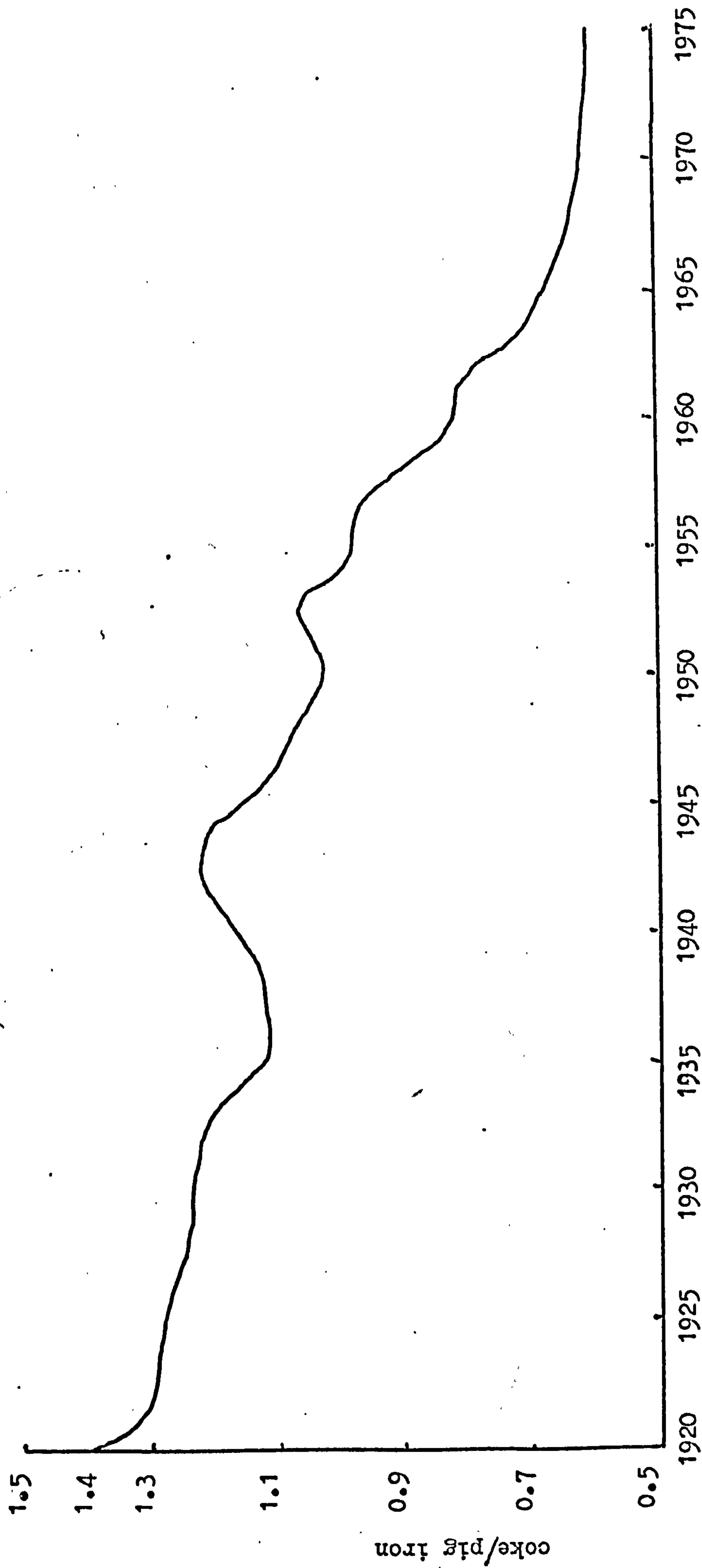
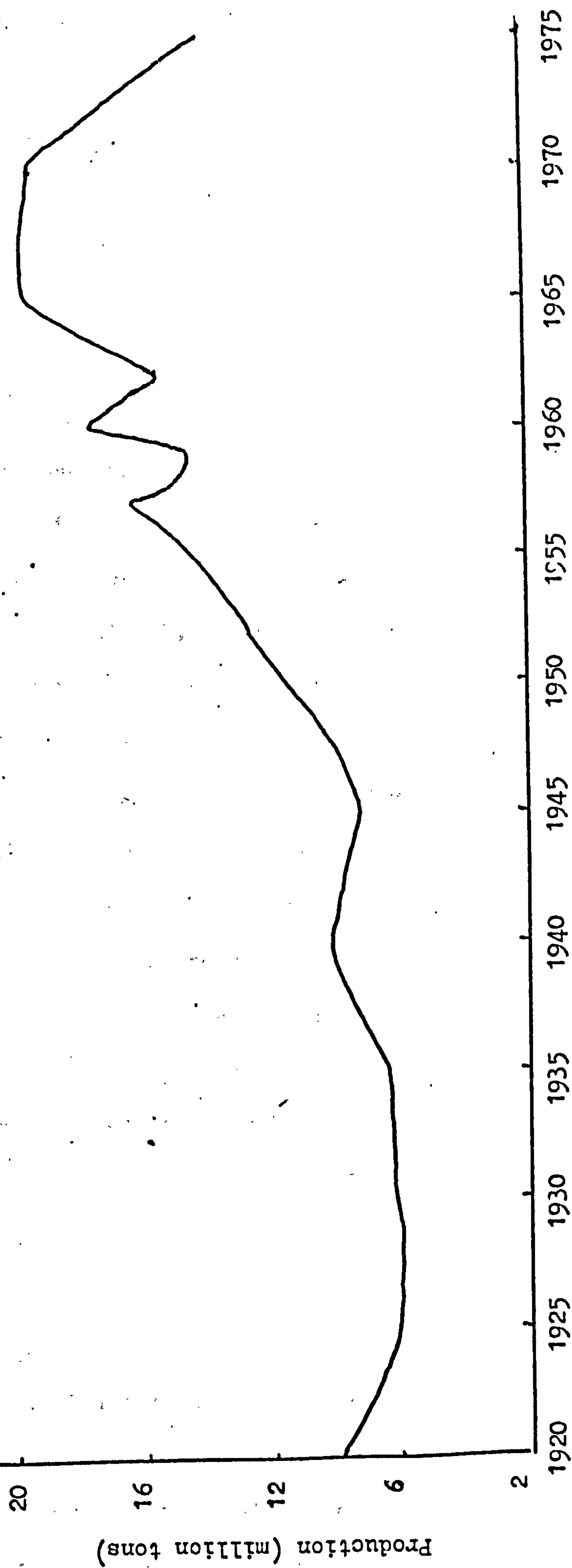


FIGURE 13

Pig Iron Produced (45)



consumption of coke remained virtually unchanged at about 12 million tons of coke per annum. This economy in coke consumption originally simply reflected the elimination of older smaller furnaces and greater efficiency in operations, but early in the 1960s a number of other factors became important. First has been the increased use of high-grade ore. Second, there was a great rise in the use of sinter from 0.3 tonne per tonne of pig iron in 1946 to 1.2 tonne per tonne in 1963-64; although each ton<sup>ne</sup> of sinter required about 0.1 tonnes of coke breeze to produce. Third, there was a further saving in coke consumption by injection of fuel oil, milled coal and oxygen. (43) Finally the temperature of the hot air blown into the furnace to burn the coke was increased considerably, thereby increasing the heat supplied from this source and reducing that required from the coke. To a limited extent, therefore, the saving in coke in the blast furnaces was achieved by the utilization of coke breeze in sinter production and by the use of fuel oil in the furnace itself. Taking all these factors into account there was still an overall reduction of nearly one-third over the post war period in the number of therms used to produce a ton of pig iron.

#### Post World War II Problems

By 1939 the coking plants attached to steel works had largely been modernised and a few colliery companies had built small modern coking plants to carbonise the coking smalls produced by the adjacent colliery. Rarely was a coking plant built to carbonise the coking smalls from



several collieries in the same group. Smithywood and Barrow Barnsley Coking Plants illustrate the exceptions. The onset of World War II virtually stopped all new coke oven constructions and the coke oven contractors were confined to essential renewals, along with any new plants to produce toluene and ammonia deemed necessary for the war effort. Consequently design progress was drastically retarded and there was little or no development carried out.

As the war continued it became clear that a programme of replacements would have to be undertaken. As a precaution against helping the German pilots to locate ground targets at night time for bombing, anti-glare coverings were built over operational batteries. The covers reduced glare from the ovens but they made supervision difficult; this coupled with low quality labour, a shortage of all but essential spares and interruptions to the pushing schedule during air raids caused premature deterioration of the batteries. Rotherham Main was untypical *in so far* as its life was not noticeably shortened by any of these criteria. After cessation of hostilities the iron and steel industries embarked on a large programme of rebuilding, modernisation and expansion. At about the same time the coal industry was nationalised and plans were quickly prepared to replace outdated coking plants and centralise production in economic units.

Up to 1945 no major change in coke oven technology could be foreseen and the defects caused by the war-time

conditions needed close examination before they could be remedied in new plants.

In 1943 the British Hard Coke Association reported that the average life of a battery of silica ovens was 13 years instead of the 15 - 20 years expectation based on pre-war experience. (46) The principle failure was found to be defects involving jamb brickwork, door frames, flashplates and backstays. The British Coke Research Association arranged for experts to be brought together to study the limitations of existing batteries and make recommendations about future designs. It was known that good coking coal would become increasingly scarce and so the panel also gave consideration to coal blending. Particular attention was paid to the design of oven ends, the distortion of buckstays and flashplates, the short-comings of self sealing doors, and the deterioration of jamb brickwork on silica batteries, improved thermal insulation, including the use of refractory and insulating concrete, methods of reducing the emission of smoke and grit, improved working conditions and improved thermal efficiency were also reviewed.

A questionnaire was prepared and sent to all the coking plants in the country and subsequent statistical analysis revealed that the factors which had the greatest importance on oven life were the type of doors used, the design of the first joint in the jamb brickwork and the battery collecting main pressure. Clay luted doors gave rise to less damage on batteries more than 10 years old and

it was concluded that a staggered first joint was better than a vertical brickwork joint, also the ideal collection main pressure was 3 - 5 mm W.G. Available evidence had shown that lower pressures had caused extensive damage to jamb brickwork and higher pressures had caused buckstays, flashplates and door frames to suffer.

It was perhaps natural that the panel should be comprised largely of practical men but there was included a proportion of research people from B.C.R.A. as well. The conclusion regarding flue pressures was not such a good one and conflicts with the accepted view of the 1970s that the collecting main pressure should be considerably higher. This is one indication that, despite good intentions, neither individuals nor committees arrived at the correct solution to practical problems every time.

The panel added that other factors adversely affected oven life but they were much less important, examples cited were the use of coal containing less than 5% moisture(47) or more than 30% volatile matter, and the use of ovens less than 16in. wide. It is difficult to justify the panel's conclusion regarding coal moisture and a much better conclusion would have been to specify the range of moisture content rather than a minimum value. The volatile content is irrelevant in respect of oven life. Finally, the panel were a little superficial in specifying a minimum oven width of 18in. At the time they were well aware of the existence of 14 in. wide ovens at Nunnery Handsworth and the purpose of them. Furthermore Avenue was the first giant post war plant to be built on a green field site



specially to produce smokeless fuel - the ovens were 16in. wide. If this panel could not come to the correct conclusions some doubt must be cast on other panels because they were drawn from the same source.

The British Coke Research Association set up panel No. 4 to consider oven dimensions in relation to coal and coke qualities. A similar questionnaire was sent out and the replies showed that the coke quality was principally influenced by the quality of the coal. (48) They went on to state that variations in oven width or height did not materially affect shatter and abrasion indices of coke but wider ovens produced a greater proportion of large coke. Increase of carbonisation rate gave a decrease in coke size and shatter index. These conclusions simply confirmed the state of current knowledge and added nothing new.

#### Influence on the chemical industry.

The coking industry can never be considered insular. It is a complex organisation whose expansion and retraction has been influenced by the demand for by-products and it is appropriate to consider the relationship between the coking industry and the chemical industry.

The earliest British patent referring to the destructive distillation of coal was issued to a German chemist, J.J. Becher in 1681. (49) who was better known for his advocacy of the phlogiston theory. (50) It was not until 1822 that the first tar distillery came into operation. (51) Why was there such a delay? During the 18th century much use had been

made of pitch derived from wood for preserving timber ships but towards the end of the century the process became increasingly expensive because most of the pitch was imported from America or the Baltic countries. As a result attempts were made to produce a similar product from coal. Archibald Cochrane, the ninth Earl of Dundonald was well aware of the problem because of his service with the Navy and he successfully obtained a patent in 1781 for making tar, essential oils, volatile alkali, mineral acids, salts and cinders from pit coal. Dundonald established the British Tar Company in 1781 and successfully produced tar, varnish and coke and gas. A series of explosions in the tar ovens led to the discovery of gas; it was therefore an accidental anticipation of Murdoch's discovery but it was put to good use in lighting several rooms in Dundonald's house at Culross Abbey. However, the company was not financially successful, Dundonald's efforts came to nothing and it is unwise to assert that Dundonald was responsible for the real exploitation of coal as a source of chemicals.

Another valuable product, ammonia, was evolved when coal was heated and it was eagerly sought as a source of nitrogen.

In 1756 James Hutton extracted ammonium chloride from soot and it was only later recognised that ammonia was a valuable artificial fertilizer, usually in the form of ammonium sulphate.

Early in the 19th century many gas works extracted ammonia and gas works chemists were more convinced of its

value than were farmers. The dyestuffs industry had a need for ammonia. All the dyestuffs in the early years of the 19th century were derived from natural sources such as insects or plants but there was an increasing need for the production of a pure dye or the fixing of it to the fabric; both of which required the use of chemical reagents, one of them being ammonia.

In 1823 this led to Charles Mackintosh producing an effective waterproof material capable of being made on a commercial scale. Mackintosh was a chemist engaged in extracting ammonia from the coal tar produced at Glasgow's first gas works which opened in 1819. He first distilled the tar and obtained a volatile oil which later became known as naphtha. The naphtha was found to be capable of dissolving rubber and this in turn led Mackintosh to produce the first effective waterproof material.

In the meantime the Gaslight and Coke Company had a problem with increasing stocks of coal tar. Samuel Clegg was the Company's first chief engineer from 1813 and he was pre-occupied with the technical improvements in the carbonisation process to the extent that he was unable to become involved with the problems of by-products. It is evident that Clegg was both powerful and respected, otherwise he would not have been permitted to shed one important responsibility in preference for another. As a result of Clegg's preference by-products started to accumulate in spite of the fact that several people, including Van Voorst, a shareholder, persuaded the company to part with the



by-products for experimental purposes. The company started to solve the problem by building its first tar refinery at Poplar in 1818. Unprocessed stock was sold for 3d. per gallon and many enquiries were received, including one for the supply of 10,000 gallons of tar to the Royal Naval Dockyard at Woolwich. During the distillation of tar volatile compounds were removed, one of the components was benzene which was used as a temporary substitute for the whale oil normally used for illuminating Waterloo Bridge.

There was a long standing awareness that stocks of tar were beginning to accumulate at a high rate and that new outlets for redistilled tar were insufficient to dispose of it all. In the meantime new problems arose and Samuel Clegg Jr., who found the whole business embarrassing, wrote 'it was tried, I believe, in the Navy, and was found to give the timber a considerable degree of hardness, but not of durability. Its smell is extremely offensive, and at the present time is used only in places of no consequence.'(52)

The Navy experimented with the use of coal-tar on its ropes but abandoned this two years later because of a health hazard. It is difficult to see why tarred ropes should have been regarded as a health hazard when the knowledge of science was premature and medical knowledge was less well developed although, by present day standards the assessment was quite correct. Lime was used to purify the coal gas and this gave rise to large quantities of pungent aqueous liquor which the Company had to dispose of directly into the River Thames because permission to allow it to enter

the sewage system had been refused. A dangerous precedent had been created and for many years there was sporadic litigation between the gasworks companies and the river authorities concerning pollution from spent liquor and also from tar.

By 1816 coal-tar had become a drug on the market and attempts were made by Clegg and others to extract more gas from it by re-cycling it in the retorts but their experiments were not very successful. It was soon decided that the best use for coal tar was as a fuel under the retorts, and George Anderson invented a furnace specially adapted to burn it. (53) This problem became important almost one hundred years later during one of the industry's recessions.

In this period ingenuity was strong and many people were working to produce a viable outlet for tar. Bethell found one satisfactory solution in 1838 when he used tar for preserving railway sleepers. Only one year earlier had George Stephenson relaid the Liverpool to Manchester railway with transverse wooden sleepers whereas up to then stone blocks had been used instead. The stone blocks could not withstand the relatively high speeds being introduced. Transverse sleepers in the tramway area were unacceptable because they were an encumbrance to the movement of horses along the track. The introduction of steam power on the railways brought a massive demand for wooden sleepers which had to be preserved if they were not to be replaced at an alarming frequency.

The changeover was not instantaneous and George Stephenson's son, Robert, continued to use stone sleepers in cuttings on the London to Birmingham line because he believed that wooden sleepers would not last long in such conditions. His attitude changed when he extended the Midland line from Derby to Leeds and the old stone sleepers were used to build the lime kilns at his iron foundry at Clay Cross - later known as the Clay Cross Company. See chapter V describing individual coking plants for further details. The Great Western Railway, under Brunel continued to use longitudinal wooden sleepers which needed preservation. In the 1840s Read Holliday had the foresight to allow the local gasworks to dump waste tar on a site he owned in Huddersfield. Some of the tar was used to heat stills in which ammonia was distilled from ammonia liquor which also allowed the gas produced to pass onto him. His next venture was to distil tar itself and he obtained two important products, naphtha and creosote oil. The former was used for lighting purposes and the latter was used as a timber preservative. Coal tar was also used for road surfacing but this did not have any real consequence until much later when the advent of the motor car created a need for good surfaces to be effectively sealed and thereby made immune to the vacuum created by rubber tyres. Several tar distilleries were started about the middle of the 19th century but there was very little attempt to extract identifiable chemicals from tar.

What were the reasons for the slow exploitation of coal tar for chemical purposes? Perhaps the main reason

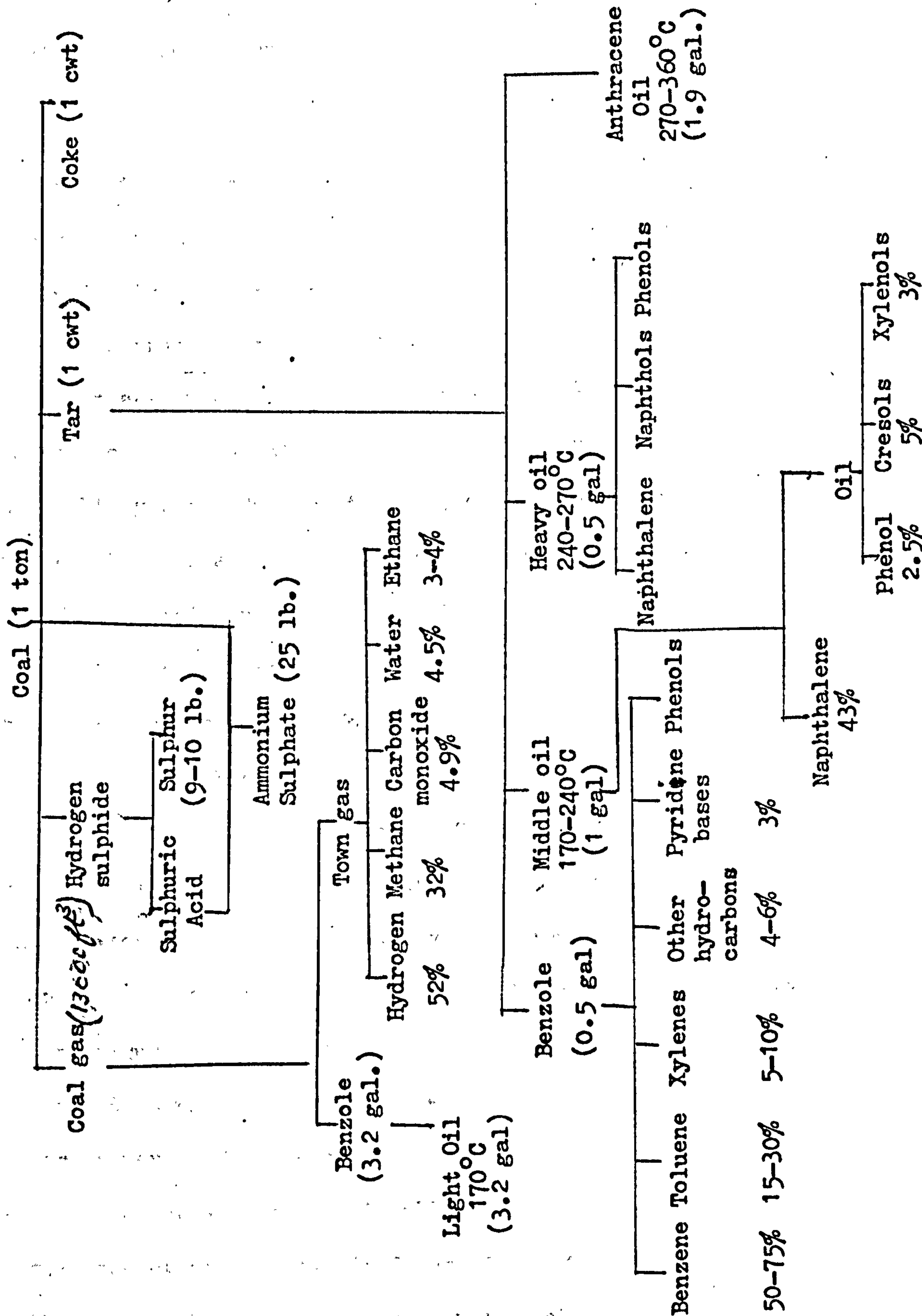


was that chemical knowledge was neither wide enough nor deep enough to understand the complexities of coal tar exploitation. In order to use coal tar as a starting point for other materials the product had to be well characterised and chemistry was sadly difficult in this area.

It is possible that the coal tar trade as a source of raw materials for the chemical industry might never have taken place had it not been for the founding, albeit for quite a different purpose, of the Royal College of Chemistry. In 1842 Liebig made a tour of the country just when considerable attention was focussed on his ideas on chemistry in relation to agriculture. A favourable climate of opinion was thus created for the founding of an institution devoted solely to chemistry and chemical education. Another reason was a lack of technique. Handling organic chemicals and separating them from complex mixtures is notoriously difficult and it is not surprising that it was almost impossible to achieve good separation early in the 19th century using crude apparatus and having very little empirical knowledge. In spite of such handicaps some good work was done, especially by Faraday, Hofman and others. Although in the industry itself and in contrast to research laboratories any hope of obtaining pure samples of many chemicals present in coal tar were very slim. Wilhelm von Hofmann was among the first to realise that coal tar, cheaply available from the rapidly expanding gas industry, could yield many different substances of great chemical interest. Among these substances was benzene. Economics figured in most commercial activities and figure 14 shows how small were the amounts of some of the

FIGURE 14.

Yield of By - Products



individual chemical constituents of coal. In good times profits were never more than marginal and in bad times the only outlet for tar was to burn it. The precarious profitability margin finally led to the ultimate replacement of coal-tar by petroleum as the starting point for organic chemicals.

Even though the coal tar industry had a slow start it did grow. The discovery of aniline dye in 1856, followed by alizarin dye from anthracene in 1864 led to the wider commercial extraction of tar and benzole and provided the basis for a new industry based mainly on gas works tar. The advent of 'by-product ovens', the first U.K. battery being built by Simon Carves at Crook, Co.Durham in 1882, increased the availability of tar and benzole in Europe. Prices fell sharply and export markets in dyestuffs and dyestuff chemicals, particularly in Germany, were lost as overseas production rose. However, the industry managed to survive this setback and slowly built up new markets, including substantial exports to the U.S.A. World War I provided an important boost with dyes, drugs, and fuel all dependent upon the coal tar industry. Figure 15 illustrates the rapid growth of crude benzole production during the inter-war years and figure 16 shows the state during World War II. The immediate World War I period saw the formation of the large and powerful U.K. co-operatives such as Midland, Yorkshire and Lancashire Tar Distilleries. The output of tar from coke ovens is shown in figure 17. Also at this time the vapour phase oxidation of naphthalene to phthalic



**FIGURE 15**

**Crude Benzole Produced between the Wars. (54)**

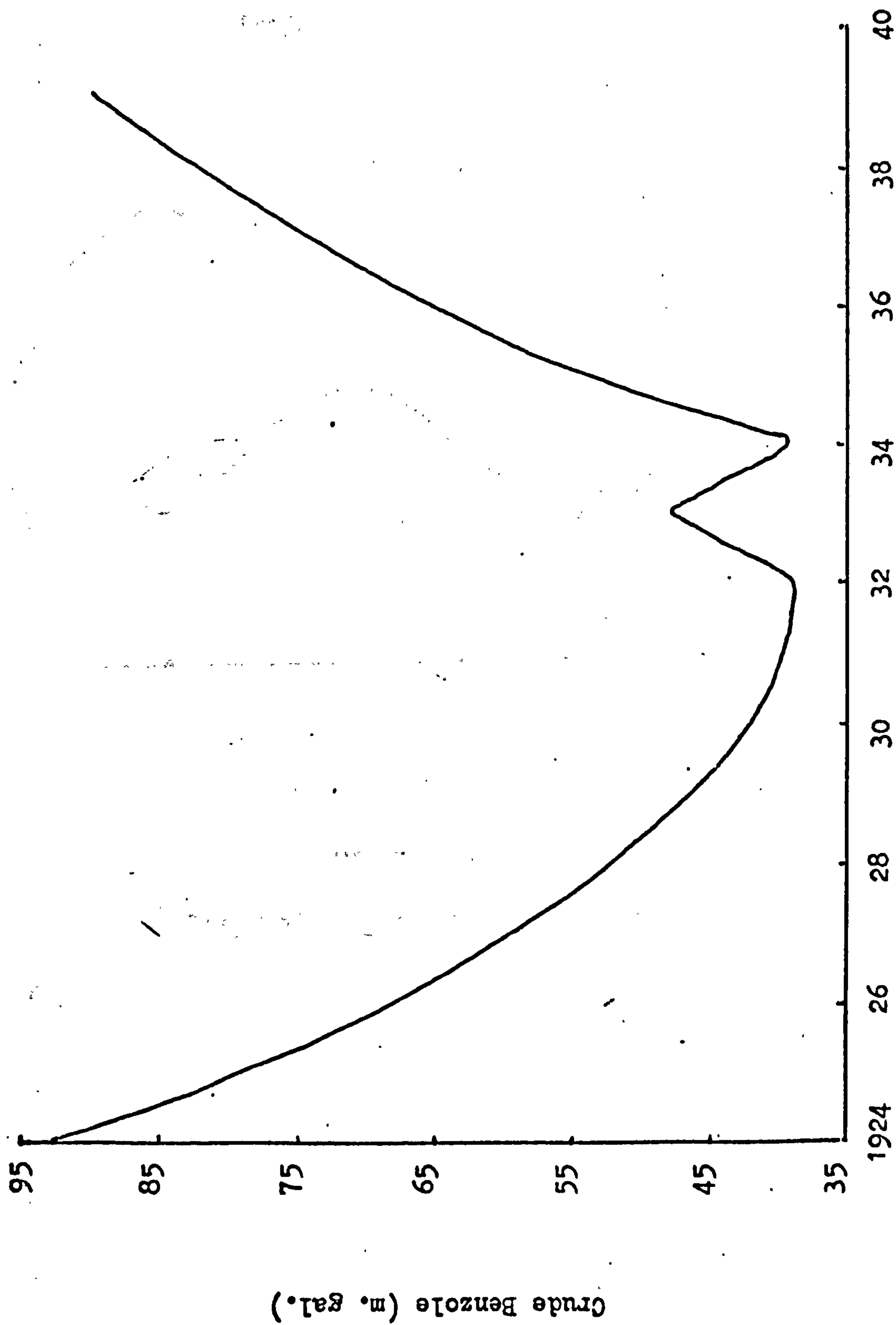


FIGURE 16

Production of Crude Benzole (55)

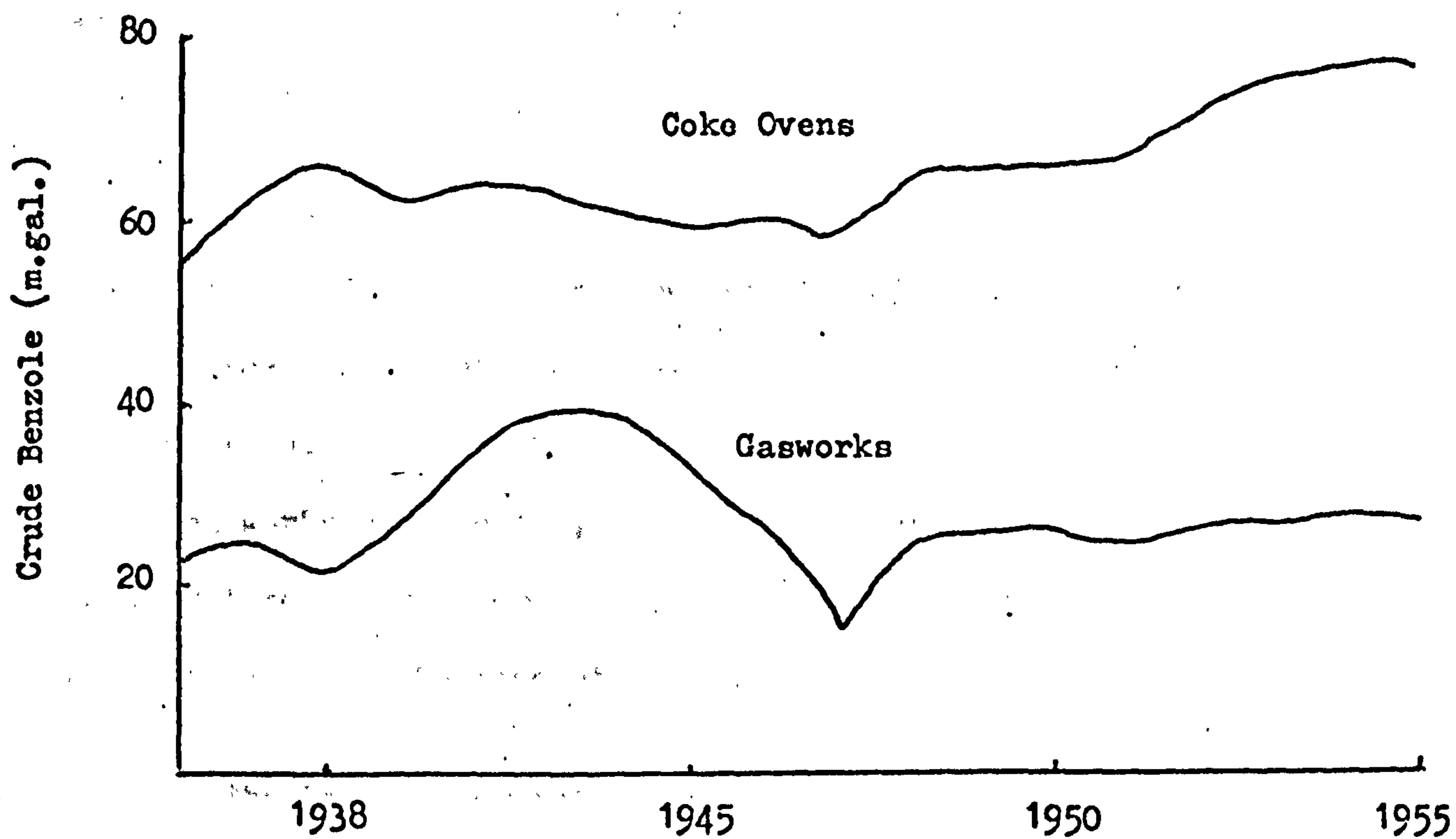
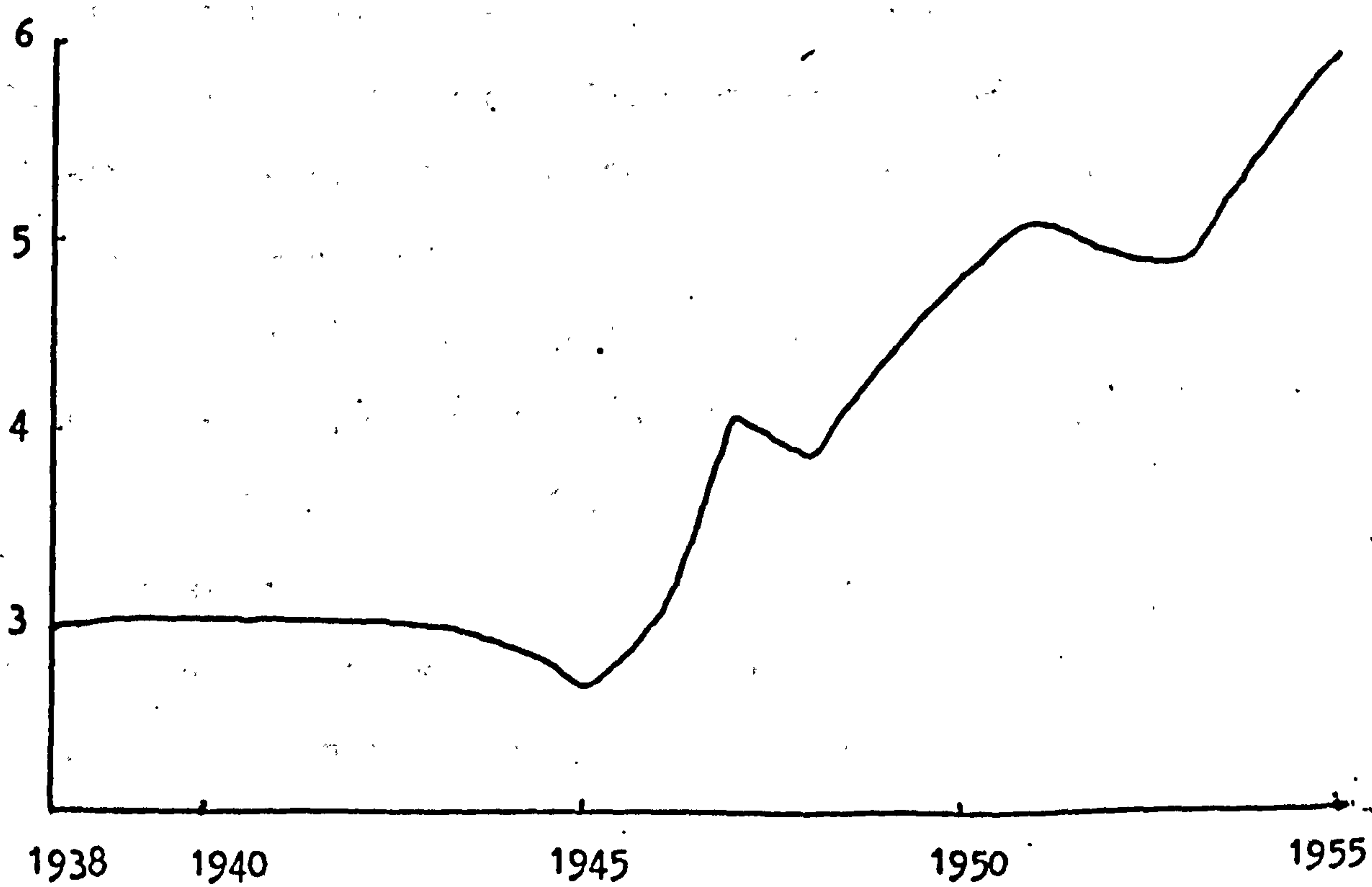


FIGURE 17

Tar Produced from Coke Ovens and Gasworks (55)



anhydride was discovered and phenol formaldehyde resins were commercially developed, providing a further demand for tar derivatives. The road making programme was by now consuming large quantities of road tar and the National Benzole Company was formed in 1919 to sell and distribute a petrol manufactured from crude benzole.

Steady growth and consolidation proceeded until the advent of World War II when once again the demand for fuels and various organic chemical feedstocks put heavy pressure on the industry. In the 1939 - 1945 period benzole recovery from gas works was doubled, coal tar fuel consumption rose to 800,000 tonnes per annum and 200,000 tonnes per annum of creosote oil were hydrogenated to aviation fuel.

The industry emerged from the war with a capacity to distil 3 million tonnes per annum of tar in modern plants and by 1957 tar production had reached 3.1 million tons and crude benzole 120 million gallons. At this time the U.K. industry was the largest in the world, matched only by that of the U.S.A. From this peak the volume of crudes from gas works started to decline, the reasons being due almost entirely to the availability of cheap oil. In 1957 liquified natural gas was first imported from Algeria and in 1963 the first petroleum naphtha gas plant was commissioned. During this period gas works tar annual production fell from 1.9 million tons in 1956 to 1.2 million tons in 1965. Towards the end of this same year the first strikes of natural gas were made in the North Sea and the coal based gas industry was no longer viable. Production of crudes from this source continued to



decline rapidly and virtually ceased by 1973.

The effect of this rapid change on crude tar supplies, particularly to the large co-operatives was traumatic.

At this same time the second and final nationalisation of the steel industry led to the formation of a Chemicals Division of the British Steel Corporation, (subsequently to become British Steel Corporation Chemicals Company) in which ownership of all B.S.C. crudes was vested and which in consequence rapidly became the largest tar and benzole distiller in the U.K.

There has been a considerable contraction in the industry which is illustrated by the following:-

In 1957 - 223 works supplied 3.1 million tons of tar  
to 46 tar distilleries.

In 1974 - 44 works supplied 1.0 million tons of tar  
to 5 tar distilleries.

A graphical presentation of U.K. tar production from 1880 is shown in figure 18. It shows that gas works tar production ~~fall~~ dramatically in the late 1950s to zero and low temperature tars have increased over the same period to nearly 250,000 tonnes per year. What is the reason for the downward trend in coke oven tar production? There are two main factors. The first is attributable to improved coke consumption in the blast furnace and the second is due to the static, if not downward trend in the demand for steel in recent times. The second item is inextricably related to the economy of the nation and indeed the economy of the world as a whole.

**FIGURE 18**

**Production of Crude Tar (56)**

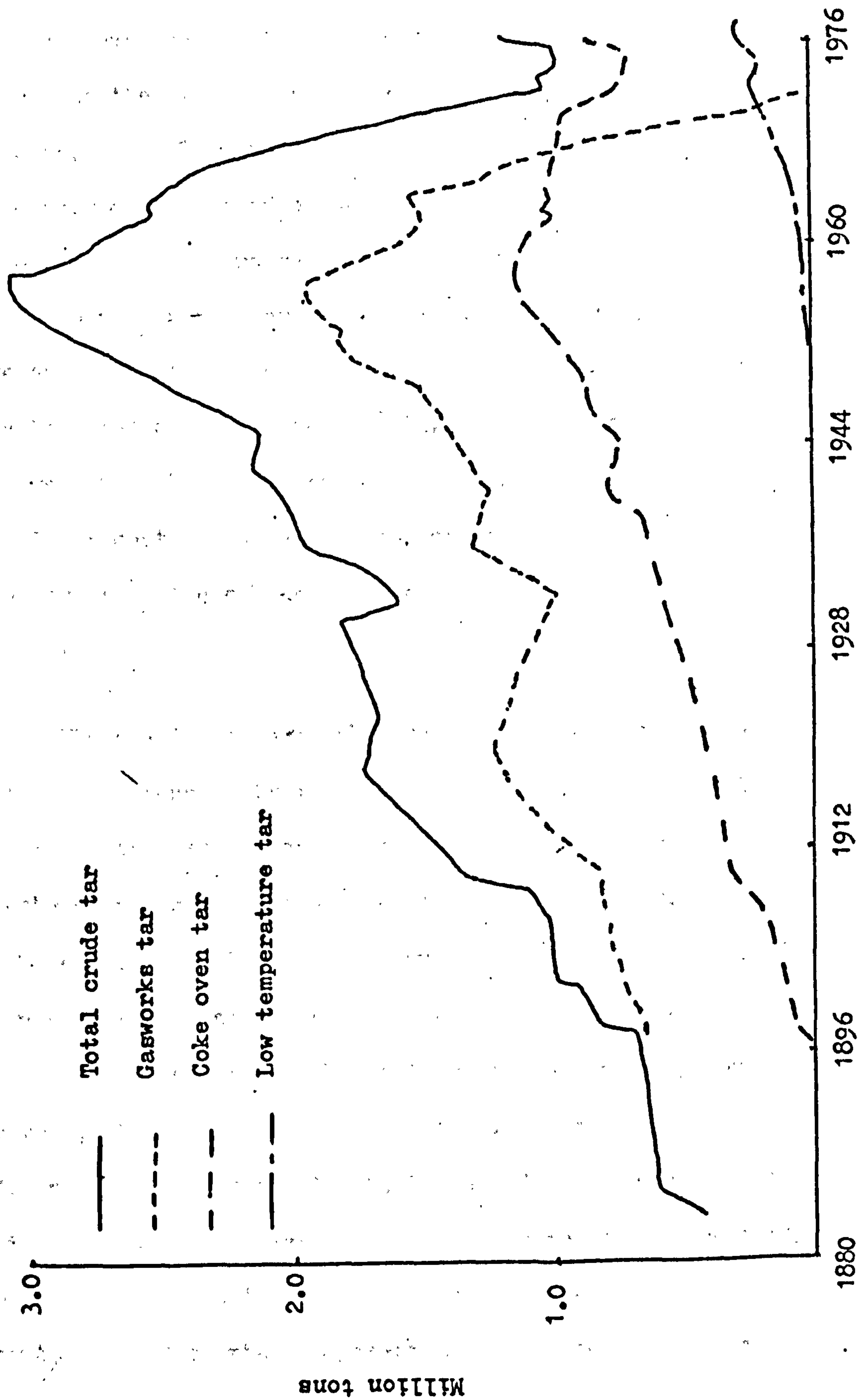


Figure 19 shows the comparable data for crude benzole production and for obvious reasons the pattern is similar to figure 18. It shows a reasonably steady rise in the total output of crude benzole for almost the first fifty years of the present century before a rapid decline in the 1960s. It also shows the growth and annihilation of the gas industry as well as the rise and subsequent contraction of the coking industry. By 1913 the desire to augment supplies of motor fuel focussed attention on benzole and after World War I benzole was used to raise the octane rating of petrol. The National Benzole Company was established in 1919 to develop the distribution and sale of the well-known National Benzole brand of petrol in Britain. Similar organisations were set up in Germany, France and America. Since World War II benzole production has depended increasingly on the level of activity of the coking industry and the profitability of recovery.

The statistics available do not separate those plants that recover benzole from those that do not. An overall picture of the benzole production and of the coal carbonized in coke ovens and gasworks is given in figure 20 for a period of 30 years. In 1955 about a quarter of the coal produced was used for carbonization. While it may be assumed that at coke ovens virtually all the coal is carbonized with benzole recovery, this is not true of gasworks. For the years 1935, 1940 and 1945 approximately 45, 70 and 90 per cent respectively of the coal was carbonized at gasworks where benzole recovery was practiced. In 1954 benzole was recovered from gas produced at 150 of the 785 gasworks and the coal carbonized



FIGURE 19

Production of Crude Benzole. (56)

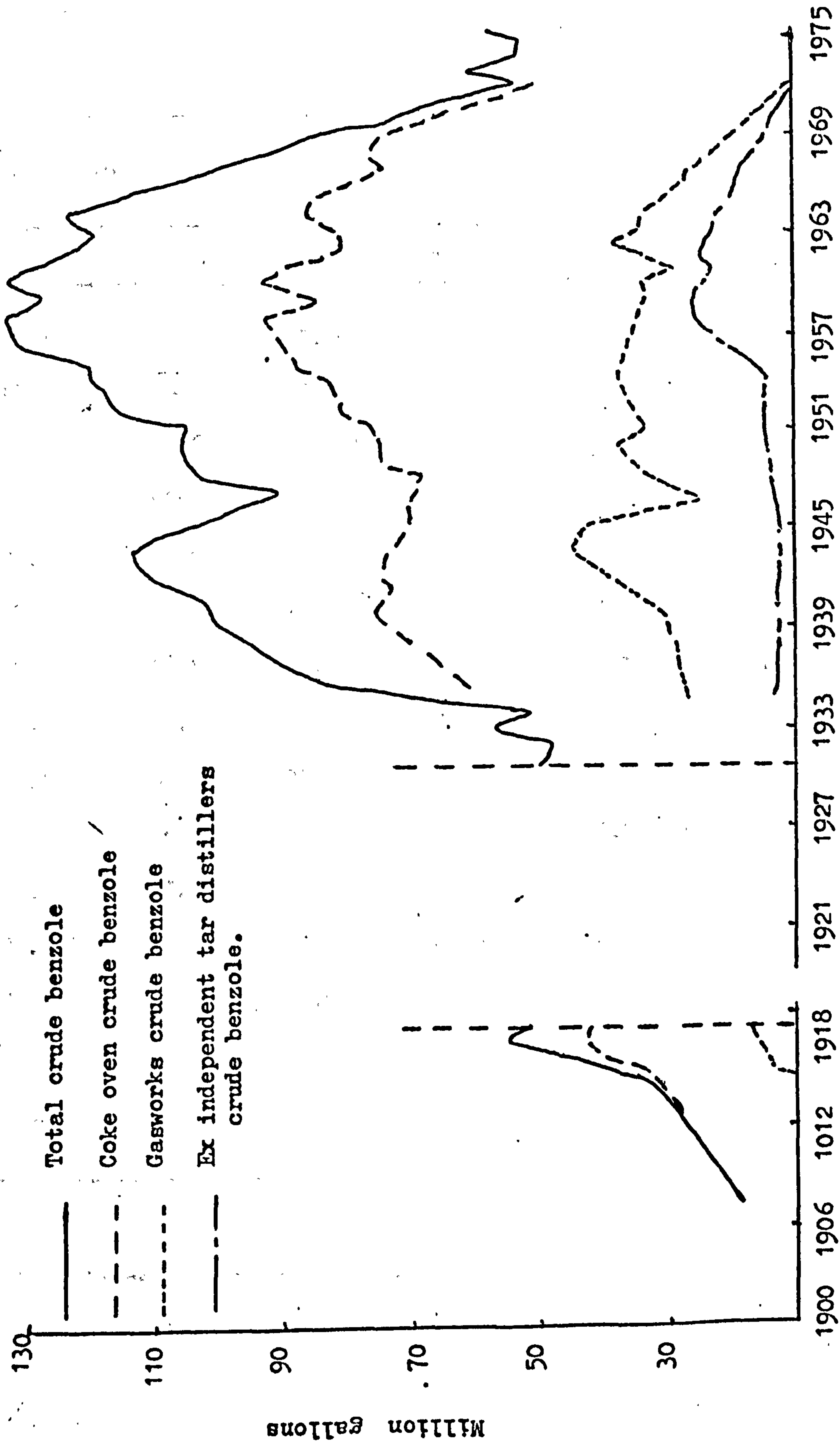


FIGURE 20.

Coal Consumption and Benzole Produced (57)

Year	Coke Ovens		Gasworks		Tar distillation	Total crude benzole produced  (m.gal)
	Coal carbonized	Crude benzole produced	Coal carbonized	Crude benzole produced	Crude benzole produced	
	(m.ton)	(m.gal)	(m.ton)	(m.gal)	(m.gal)	
1925	16.4	—	17.8 *	—	—	—
1930	17.2	—	18.4 *	—	—	—
1935	17.4	51.6	18.0 *	17.3	3.5	72.4
1940	22.3	66.8	17.8 *	21.3	3.0	91.1
1945	20.1	59.8	21.0 *	33.2	2.7	95.7
1946	20.1	60.1	22.5 *	27.1	3.0	90.2
1947	19.8	58.6	22.4	15.4	4.1	78.1
1948	22.3	65.4	24.3	24.4	3.9	93.7
1949	22.6	66.0	25.0	25.8	4.4	96.2
1950	22.6	66.4	25.9	26.1	4.8	97.3
1951	23.5	67.5	27.1	24.5	5.1	97.1
1952	25.2	73.3	27.5	26.3	4.9	104.5
1953	25.9	74.9	26.9	26.6	4.9	106.4
1954	26.7	77.2	27.1	27.9	5.5	110.6
1955	27.1	77.4	27.8	27.2	6.0	110.6

\* Data refers to the total consumption  
of coal at gasworks.

represented about 54 per cent of the coal carbonized by the gas industry. Average yield at works which recovered benzole was 1.9 gal. of crude benzole per ton of coal carbonized compared with 2.9 gal. per ton for the coking industry, Furthermore, at many gasworks, only a part of the benzole was recovered from the gas. Why has this state of affairs only existed since World War II? The answer is tied up with the fact that in the early part of the century there was a lot of empirical work undertaken in order to improve the efficiency of benzole recovery which had a ready outlet, especially in the dyestuffs industry. After World War II benzole recovery had been optimised and the variety of processes had been reduced to one. The economics became dominated by the petrochemical industry and benzole is no longer a component of motor fuel. Figure 21 shows the influence of petrochemicals in the chemical industry after World War II in relation to manufacturing in general.

Since the discovery and exploitation of North Sea gas and the demise of the town gas industry, benzole availability has been reduced and tar production approximately halved to about 1 million tons per year. It is clear that while pyrolysis processes are ancillary to coke production, their potential as sources of synthetic liquid fuels is severely limited.

Figure 18 shows a slow increase in tar production up to 1955 and figure 22 has been included to show that in general the U.K. pattern of falling tar production since 1960 is similar to that in Europe as a whole although the U.K. change



**FIGURE 21.**

**Growth of the British Chemical Industry. (58)**

Production in 1958 = 100

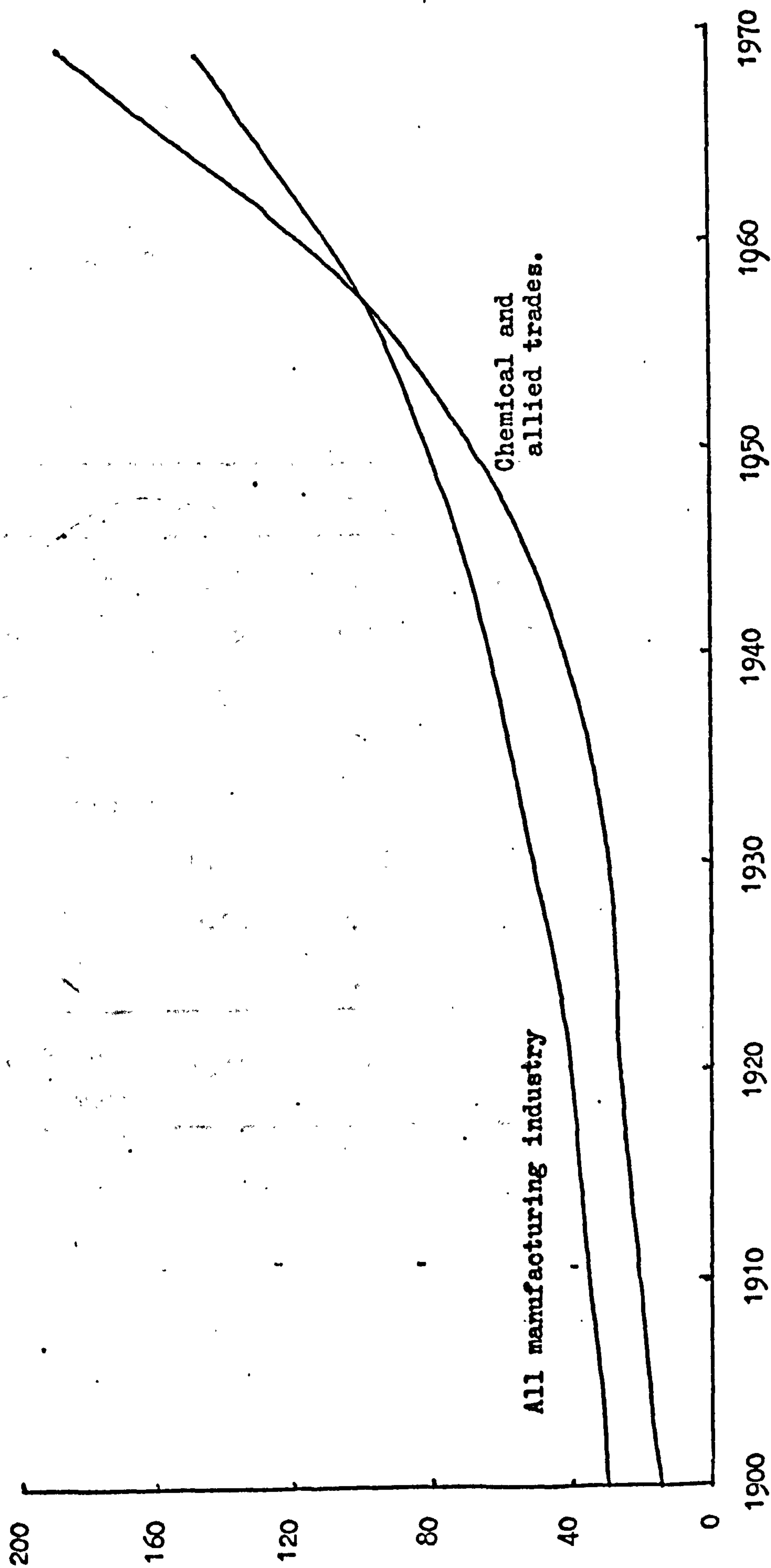


FIGURE 22.

WORLD TAR PRODUCTION (59)  
(thousand tonnes)

	1960	1970	1974
United Kingdom	2.85	1.48	1.00
West Germany	2.02	1.63	1.33
France	0.70	0.55	0.60
Belgium and Netherlands	0.43	0.28	0.30
Italy	0.18	0.26	0.30
Spain	0.11	0.17	0.20
Other Europe	0.17	0.27	0.30
Total, Western Europe	6.46	4.64	4.03

is by far the most drastic. Why is this so? One reason is that in the 1960s the U.K. tar production was almost as large as that from the rest of Europe and therefore, when coke ovens lost favour, the change was bound to be sharp.

It is important to see that the emphasis has changed from an N.C.B. based coal tar industry to one owned by B.S.C. in the last few years. This is in line with B.S.C. policy of producing their own coke instead of purchasing it from the merchant plants.



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SOME COKING PLANTS IN YORKSHIRE AND DERBYSHIRE

Introduction

This chapter examines several coking plants to show the diversity of size, equipment, location and products from the industry. The section describing the plants built in the first fifty years of the present century shows that even though the industry was highly competitive there were no established parameters for success and plants tended to progress in specific directions to meet local needs or even at the whims of the company directors. In almost every case each plant benefited from the way it developed but the unanswered question is - could plants have benefited more by moving in a co-ordinated rather than a haphazard manner?

The second section deals with the three plants built or rebuilt since 1950. (1) These plants developed in a much more co-ordinated manner to meet a national requirement but considerable freedom was retained to allow individual movement not so much in type of products but in the method by which national objectives were achieved. The effects of nationalisation are very evident, as are the internal conflicts to attain supremacy in any way possible, usually in terms of size or in optimisation of capital expenditure.

Early Coking Plants

The Devonshire Works of the Staveley Coal & Iron Company Ltd.

The originator and the date of origination of the Staveley Works, situated at Barrow Hill, Staveley, Chesterfield cannot

be traced. It is known that Staveley Works existed in 1702 and that the Staveley Coal and Iron Company, which had eight blast furnaces was registered in 1863.(2) Most of the iron produced was used by the company to make cast-iron pipes.

The Staveley Coal and Iron Company owned 250 acres of land at Barrow Hill and the Devonshire Works were built on part of the land on a 99 year lease. The Devonshire Works were initially an up-dated extension of the Staveley Works; the extensions were generous because the furnaces at the old works were more than 40 years old and their demise was anticipated. The old furnaces were not efficient by the standards pertaining when these Works were built and it was understood that the Devonshire Works would eventually take over the entire production of pig iron.

Mr. Charles P. Markham was engineer and subsequently Chairman of the Staveley Company and had full responsibility for the new works which were started in 1906. The works included three blast furnaces, ancillary plant, 100 coke ovens in four batteries, and a by-product plant. The last furnace was lighted two years after site work began in March 1908. Building the large works in so short a time was a considerable achievement.

Good rail transport facilities existed from the conception of the Staveley works, which was served by a branch line from the London Midland Railway and the Great Central Railway. The railway sidings were laid out so that the gradient favoured the full wagons.

By 1922 the Devonshire Works had become a large modern ironworks and integrated chemical plant. Tar macadam was used on the works road, except in places of considerable wear when iron plates were used. The slag from the furnaces was a constituent of tar macadam, tar from the primary gas coolers and the hydraulic mains at the coke ovens was used to produce muriate of ammonia, and the burnt oxide from the sulphuric acid plant was used in the manufacture of paints.

The coking plant as it existed in 1922 comprised three sections, each built over a time span from 1906 onwards. Initially 100 'Simplex' horizontal - flue waste - heat ovens were constructed in 1906 and commissioned the following year with a capacity of 500 tons of coal per day. The indirect system of ammonia recovery was employed. Waste-heat from the batteries was supplemented with blast furnace gas for firing the Babcock boilers. The coke wharf or bench was horizontal and after the coke had been quenched it was loaded into wagons by wheel barrows. The ovens were stamp charged and one machine only served to charge the ovens with coal and discharge the coke. Tar, ammonia and benzole were recovered from the carbonisation process.

50 'Huessener' horizontal-flue-waste-heat ovens were built in 1911-12 but they were shut down temporarily in 1922 because of a series of recessions until 1939. The carbonisation capacity of these ovens was 275 tons of coal per day; they formed an extension to the 100 'Simplex' ovens built in 1906.

One tar distillation plant, one ammonia plant and one crude benzole plant served both sets of ovens but two by-product



plants were used to scrub the benzole from the gas.

A rectification plant dealt with all the crude benzole produced.

In fact the situation was similar to that at Manvers in the 1950s and almost certainly it arose because of similar circumstances.

100 'Simplex' vertical-flued waste-heat ovens were built in 1921 and provided a carbonising capacity of 540 tons of coal per day when the coke market recovered. A new semi-direct by-product plant to recover ammonia and benzole was included in this contract.

#### Chemical Plant

The chemical plant was regarded as the most complete and the best laid out in the country and it was operated in conjunction with an ironworks to produce the following chemicals:-

Ammonium sulphate

Muriate of ammonia.

Coal-tar products - pitch, creosote oil, crude carbolic acid, cresylic acid, pyridine, anthracene, naphthalene, refined tar, benzole, toluol, solvent naphtha, aniline oil and salt, disinfectant powder.

Acids - sulphuric (B.O.V. and R.O.V.), accumulator acid, pure sulphuric acid, fuming sulphuric acid, nitric acid, muriatic acid.

Iron oxide, salt cake, soil fumigant, Staveho (a powder for mixing with cement to make it impervious to water).

Some of the items mentioned in the above list were common to all coking plants, but no other plant had attempted to enter the chemical market in such a way, perhaps because no other plant was so large. The list is remarkable for it includes a wide range of chemical products - even though some listed under separate headings were different grades of the same product. For instance, it is difficult to see why accumulator acid should be listed separately to pure sulphuric acid. It is also difficult to imagine what product from a coking plant could be used as a soil fumigant without permanently damaging the soil. 'Staveho' never 'caught on' and there have been no products sold over the last twenty five years from the coking industry which had the property of making cement impervious to water.

At the outset some of the chemicals, particularly ammonium sulphate, benzole and tar products were in great demand and Chapter IV describing the by-product coking industry illustrates the important contribution which coke oven by-products made to the chemical industry in the formative years. The passage of time meant that after World War II this plant and others were competing more and more unsuccessfully with the vast petro-chemical industry.

#### Blackwell Coking Plant

The Blackwell Colliery Company Limited owned five collieries, Blackwell 'A' Winning, Blackwell 'B' Winning, Alfreton, Shirland and Sutton. Coke was originally made by the company in bee-hive ovens at 'A' Winning colliery but in 1913 a battery of waste-heat ovens were built at 'B' Winning colliery. (3)



In 1923 it became necessary to extend the plant and a battery of Koppers regenerative taper ovens provided a noteworthy advance in the technique of by-product coking because of the uniform carbonisation of the charge. Consistent with established practice compressed cakes were charged into the ovens. Here we see for the first time proof that some practical aspects of coal science were well understood because the local coal was known to oxidise easily so that it could not be stored for long periods of time; this influenced the decision to continue stamp charging. Another important aspect was an awareness of the hygroscopic character of coal and its adverse effect on carbonisation. It was known that coal contains 6 - 7% hygroscopic moisture after normal exposure and this did not provide any binding power for cake formation. It was therefore necessary to add further 7 - 8% moisture to give a total moisture content of 15%. In spite of the relatively high moisture content the coal was charged in 18 inch wide ovens in a period of 21 to 22 hours.

The first battery of 40 Koppers ovens was built complete with by-product plant for recovering tar, ammonium sulphate and benzole. There was also a 1200 ton/shift coal screening plant and a Hunter-Baum type washer capable of handling 75 tons of coal per hour.

One exaggeration was the statement to the effect that the dimensions of the ovens were to some extent dictated by the character of the coal and the necessity for compression. This is another illustration of the awareness of the different characteristics of different coals but in this case it is an



over-exaggeration. Were Derbyshire coals so different? The logical reason for the particular oven size at Blackwell was that the contractors considered their size to give optimum results. The oven chambers constructed in silica were 32ft 2in. long, 8ft 6in. high and 18 in. wide with a charge capacity of  $9\frac{1}{4}$  tons of wet coal. The total throughput of the battery was 130,000 tons coal per annum. The ovens were built relatively late and they were therefore the standard Koppers 'half-divided' type in which the coke oven gas burned upwards from the bottom with preheated air simultaneously in all the flues situated in one half of the oven in 30 minute cycles. One interesting but regressive feature of this battery is that the by-product plant was arranged on the semi-direct system invented by Dr. Koppers some 30 years ago and another involves the collecting main being situated in the centre of the battery since the ovens were not top charged. Criticism lies in the fact that, as late as 1936, the plant should still be using stamp charging methods when many other plants were using top charging. Evidently the belief that coal in this part of Derbyshire differed markedly from other coals was well engrained - in the event it was an expensive belief.

When the plant was built surplus gas was used under the colliery boilers and some of the steam generated was used in a 1250 kW turbine. The whole of the power for the coke ovens and for some period of the day for the Alfreton, Shirland and 'A' Winning collieries, was supplied from the surplus gas. Since then however a contract was made to supply coke oven

gas to Derby. An unusual feature of the contract was that arrangements were made to purify the gas before leaving the coke ovens but the installation was supervised by a chemist from the gas works staff. Advantages claimed for this system were that purification at the coke ovens reduced corrosion of the mains and it enabled the possibility of sale to other undertakings between the coke ovens and Derby.

About 1935 the coking plant was considered for extension by adding another battery of ovens. The type of plant to be installed was governed by considerations of gas supply and the outcome was that a plant was erected which was believed to be unique in Britain insofar as it was the only coking plant situated at a colliery to be fired with producer gas. The factors which influenced the decision were (4):-

(1) All the coke oven gas made was available for sale.

There was also the possibility of increasing the yield by some 40% if the market for gas was adequate.

(2) If the demand for gas varied on a seasonal basis the ovens could be heated by rich gas or producer gas as required.

(3) The use of mechanical gas producers enabled the breeze to be used for heating the ovens.

The only other coking plants underfired by producer gas at the time were the Koppers ovens at Birmingham heated by Mond producer gas and the Koppers ovens at Beckton heated by gas from a Koppers producer plant.



The new extension comprised 18 Koppers Regenerative Combination ovens as well as a single Koppers gas producer capable of heating the entire battery. An interesting though highly dangerous piece of innovation designed to extract maximum flexibility from the system was the provision to heat some walls by rich gas and others with producer gas and vary the proportion of each sometimes two or three times per shift.

George Stephenson and Company, Clay Cross Collieries and  
Crich Limeworks.

The above company was founded by George Stephenson in 1837 and he and his son Robert each held 2/12ths of the share capital, another 2/12ths of the capital was held by Glyn, a banker. The remaining shares were held in equal amounts by three people who were never distinguished. (5) One question worth considering is why did George Stephenson of railway fame become involved with this company?

While George Stephenson was engaged in constructing the North Midland Railway from Derby to Leeds he came across five seams of coal as well as ironstone during the construction of the Clay Cross tunnel. (6) It occurred to him that if collieries were opened in the district the railway would provide ready means of transport to the Midlands and to London. He duly persuaded several of his friends in Liverpool to join him in the coal mining adventure in Chesterfield and a lease was taken of the Clay Cross Estate which came up for sale. In 1844 George Stephenson entered into a contract with the owners of the land in the area for working of the coal.



As a result large collieries were built at nearby Tapton. About the same time he built large limeworks close to Ambergate station which served the North Midland Railway. When these were in full production output approached 200 tons per day. The limestone was brought on a tramway from Crich some two or three miles away and the coal was supplied from the adjoining Clay Cross Colliery. Stephenson's works were larger than any others.

The lime kilns were still in existence in 1937, they were built entirely of stone sleepers discarded by the Railway Company when they adopted wooden sleepers. (7) George Stephenson died in 1842 and he was succeeded by his son Robert. The company acquired its present name at that date.

There is undisputable evidence that George Stephenson was ahead of his time not only as a mining engineer, but also in his endeavours to secure the best possible working conditions for his employees when it was reported that ventilation of the Clay Cross Tunnel came up to expectation. (8) The fact that Stephenson had sunk two shafts close to each other and lit a furnace at the bottom of one to create a current of air through the whole workings was also worthy of special comment.

The fortunes of the Clay Cross Collieries and the North Midland Railway were closely linked in the early days. In 1841 for example the North Midland directors reported to their shareholders that very considerable additions to traffic *might* be expected from the Clay Cross Collieries and the coking plant. The coking plant itself was expected to provide coke more cheaply than had hitherto been the case and the company was keen to see coke used for steam raising on the locomotives.

This attitude is consistent with the fact that general growth of railways a few years earlier had increased the demand for iron, and considerable quantities of coke were required for locomotive power. In 1855 George Stephenson's son Robert calculated that 1,300,000 tons of coke were used on British railways. (9) In 1858 it was estimated that for the Northumberland and Durham coalfield some 641,000 tons of coke were sold for use on railways. (10) The small combustion space of early locomotives caused it to produce dense clouds of smoke when using coal and the use of coke as a locomotive fuel was made compulsory by clauses in most Railway Acts that smoke should not be produced. Accounts of the opening of the Derby - Leeds line in 1838, which passed through Clay Cross tunnel, state that the engines were fired with coke produced at Clay Cross Works. Until the late 1860s coke was practically the only fuel used by locomotives but by 1870 due to modifications and improvements to the fireboxes it had almost completely given way to coal.

Coke produced at Clay Cross was also used in the blast furnaces and cupolas on the Works. At that time the Company was virtually self supporting with ironstone mined from the coal measures, coke produced from the coal, limestone from the company's quarries at Crich, producing pig iron in the blast furnaces and converting this in the foundries to cast iron products of many kinds, including cast iron pipes for colliery pumping mains etc. In addition, land purchased for the underlying coal was farmed in order to provide fodder for the pit ponies (11) A serious attempt had been made to establish an integrated works.



The Company's gas undertaking originated in 1853 and by 1937 it traded as the Clay Cross Gas Company Limited and supplied an area of between 30 and 40 square miles, reaching as far as Heath and Pilsley to the east, Ashover on the west, New Tupton on the north and Stonebroom on the south. It also controlled the Shirland Gas Company Limited and the Ambergate, Crich, Bull Bridge and Fritchley Gas Light and Coke Company Limited. These concerns were acquired in 1916 and 1918 respectively.

Between 1839 and 1903 some 280 beehive coke ovens were in operation near to the company's blast furnaces at Clay Cross. The number varied from time to time as rebuilding and extensions took place. The original 52 ovens were constructed in two parallel batteries. Seven batteries of ovens were built at right angles to the other four batteries. A coal crusher was included in the plant but there was no by-product recovery. (12) Evidence of the tops of some of the beehive ovens were confirmed during excavations for new developments on the site in 1979-80.(13)

In 1904, 8 Simplex ovens were built in pairs, 33ft long, 6ft. 9 in. high and 24, 26, 28 and 30 in. wide, to determine whether the coal was suitable for coke making in retorts. The narrowest oven gave the best coke but experiments with hand compressing showed that a better coke could be made, and 34 ovens, cake charged and  $21\frac{1}{4}$  inches wide came into operation in 1905. The company was aware of the lack of technical knowledge concerning coal carbonisation but it was not prepared to be handicapped by it. In order to expand and



develop successfully it was prepared to undertake applied research to meet its own particular needs. The battery was enlarged to 50 ovens by 1907. The ovens were horizontally flued and had a carbonising time of 36 hours with coking coal containing 12 - 15 per cent moisture content. (14) These were in turn replaced with regenerative ovens built in 1936. The coking plant vested in the N.C.B. in 1947 and it was demolished some three years later.

Coke produced at Clay Cross had many uses but was it financially attractive to produce? It is known that a dealer called Bennett was offered soft coke at 15/9d per ton while Ellis and Son were offered Smith's coke at 18/4d per ton. Presumably the only difference in the two grades was size and both cost the same to produce, the price variance must be attributable solely to demand. Another transaction in the same year shows that the price of coke delivered to Birmingham was to be retained at 18/3d per ton until September. (15)

If the price of coke varied according to several factors how was it influenced by coal prices? *It should be borne that* in mind, the coal used for coke production was saleable for other purposes because of its relatively large size. Perhaps the difference between the selling price of coal and coke was greater in the middle of the 19th century than at any other time in the history of the industry. It is known that the pit head price for Tupton cobbles was 4/6d per ton and they fetched 8/6d per ton delivered to Nottingham barracks. Delivered to Birmingham they cost 9/6d and 10/5d at Coventry. Jerries (16) coal was 9/-d per ton delivered to Leicester station, 10/9d to Rugby gas works and 11/6d at Coventry. Again the distinction between

the two grades of fuel is indistinct and presumably local preference influenced the name if not the quality.

Transport was not cheap and it contributed to the need to have collieries and coking plants near to markets for the main products. Stephenson's idea of an integrated plant, which included a brickworks, was absolutely sound and compares with similar ideas of C.P. Markham at the Staveley Works.

#### Grassmoor Coking Plant

Many descriptions of coking plants in the 1930s related to new installations designed as a complete unit and typifying the most up-to-date coke oven practice. The Grassmoor project was different and it is included as an example of rebuilding and modernisation of an existing plant.

The original coking plant at Grassmoor, in Derbyshire consisted of 240 beehive ovens erected between 1884 and 1903.(17) 50 Otto waste heat ovens were built in 1906 and 10 similar ovens were added in 1908. In 1912 50 Otto regenerative ovens were added so that the centre line of these ovens was set at an angle to the centre line of existing ovens because of site restrictions. This was another unique aspect of the coking industry.

The overall result was that by 1936 the plant carbonised over 400 tons of coal per day and produced 300 tons of coke for domestic and central heating boilers, baker's nuts etc. The by-products included 19 tons of tar, 6 tons of ammonium sulphate and 1500 gallons of crude benzole per day. Up to 3.3 million cu.ft. per day of surplus gas was sold to Chesterfield, Mansfield and Shirebrook but when the new battery was built only



a contract to supply Chesterfield with 0.4 million cu.ft. per day was in force. The new business with Mansfield and Shirebrook was being negotiated but it did not become a reality until 1935.

#### Robin Hood Coking Plant

The original battery of coke ovens belonging to Messrs J. & J. Charlesworth group of collieries comprised 65 waste-heat ovens at Robin Hood, near Wakefield, they were built about the turn of the century and were closed down some time before the 1930s. For some time before 1932 the Charlesworth group realised that it was essential to use the slack from collieries for financial reasons and that the existing waste heat ovens would have to be modernised in order to compete successfully with new coking plants.

The company examined three schemes in detail:-

(1) Rebuilding the existing oven walls in firebrick.

This scheme was rejected because the ovens would not be able to compete with more modern ovens which produced better products cheaper.

(2) The second alternative was to rebuild the existing oven walls with silica bricks up to the crowns. This scheme was rejected because distortion of the brickwork at the junction of the walls and crown was expected on the ground that differential expansion between silica and fireclay would take place.



(3) The final alternative was to demolish the existing battery and build new ovens on the old raft - this was often done when the old raft was in good condition.

The last named scheme was finally decided upon because it was considered to be the most economic although it was by far the most expensive in terms of capital cost. The scheme was believed to be justified subject to the existing waste heat flues remaining unaltered.

Before adopting the scheme incorporating waste-heat ovens all possible outlets for the potential sale of surplus gas were examined and it was concluded that although markets for such gas might present themselves in the future, the amount of coking slack available at the present time did not warrant the company entering into contracts which would inevitably contain clauses guaranteeing continuity of supply. In summer months, when the demand for domestic and industrial coal was low a gas contract might prove a burden such that the collieries in the group were compelled to work solely to supply coking coal. Under the circumstances it was decided to continue with waste heat-type ovens and to use surplus gas to generate electricity for use at collieries in the group.

This state of affairs shows a total lack of awareness of the present day industrial scene as well as an inability to visualise the way the coking industry might develop in the future. It is difficult to see how J.&J. Charlesworth could be so inward looking when coking plants around them had been, or were about to be rebuilt with modern regenerative ovens and produce gas to contract specification and by-products.

Having decided to move in a direction quite different to the general trend, the company selected the Gibbons-Kogag ovens built with silica bricks, (18) because the increased throughput of these ovens enabled the number of ovens to be reduced from the original 65 to 36 for the same throughput. Since greater elasticity of operation was obtainable with silica than with fireclay ovens it was decided to build the new ovens in two batteries of 15 and 21 ovens respectively so that they could be operated at different coking rates according to the availability of the coking coal which in turn depended on the demand for large coal. This is another illustration of the ~~company~~ company being far too pre-occupied with matching coke production very closely with the seasonal demand for large coal - a feature which is probably unique in the coking industry. The new ovens, brought into operation on June 19th 1932 followed the normal top charge pattern and had a capacity of 9.1 tons of dry coal carbonised in 19 hours. (19)

The steam raising plant is worthy of mention because, unlike most other coking plants it comprised eight Lancashire boilers and one Bonecourt boiler. Several of the Lancashire boilers were the waste-heat type. The Bonecourt boiler was gas fired but any additional gas could be used under the other waste-heat boilers. Most of the steam generated was used to power 1050 kW turbines which produced electricity for haulage and pumping purposes at collieries.



### Holmewood Coking Plant

The first coking plant at Holmewood in Derbyshire was built by the Coppée Company for the Hardwick Colliery Company Limited in 1910. The contract included a coal washery with a capacity of 75 tons of coal per hour and a battery of 50 waste-heat ovens with an annual carbonising capacity of 84,000 tons of coal (dry basis) and a moisture content of  $12\frac{1}{2}\%$ . The ovens were 33ft long, 8ft high and had a mean width of 24 ins. (20) The compressed cakes of coal were charged 10 tons at a time into each oven and carbonisation lasted 50 hours. The foregoing gives a coking rate of 4.8 tons of dry coal per oven per day. The coke was discharged through a Darby quencher on to a sloping bench and then loaded by fork into wagons; the fork was the only means of screening to provide high quality metallurgical coke as well as domestic coke. If the blast furnace operator had been aware of the significance of coke size on blast furnace operation a more effective screening system would have been introduced. In the event a shortfall in scientific knowledge by blast furnacemen meant that coke screening remained unsophisticated and inefficient.

The by-product plant recovered ammonia by the first semi-direct process in this country, and tar and benzole. Waste heat from the ovens was used to raise steam in six Lancashire boilers. Another 25 Coppée waste-heat ovens along with waste-heat boilers and other equipment were added in 1917 so that the total carbonising capacity reached 126,000 tons of dry coal per annum. The by-product plant



had been designed on generous lines so that in the main it could deal with the additional load with only minor modifications.

The coking plant was still in good condition in the 1930s but in the light of modern developments the operating costs were high, coke oven gas was in demand and the value of ammonium sulphate was sufficient to take advantage of the changed ideas in the design as well as the size of coke ovens.

In 1934 the Coppée Company replaced the existing ovens with a battery of 19 regenerative ovens 45ft long, 13ft 3½in. high and 16½in. wide. These ovens had an annual carbonising capacity of 135,000 tons (dry basis) with an additional capacity of 7,000 tons of breeze so that the total carbonising capacity was 142,000 tons. The ovens were top charged, had a capacity of 16 tons of wet coal (14 tons dry basis) and carbonised the charge in 15½ hours. In effect the amount of coal carbonised was 25 tons of wet coal per oven per day at an average flue temperature of 1280°C.

The new contract included the demolition of the old plant and the erection of a complete coal handling and coke screening plant. The coke breeze was finely ground and blended with the charge to improve the quality of the coke. As usual space for the new plant was limited, in this case by the L.N.E.R. main line between Nottingham and Chesterfield, the coke oven and washery sidings and the washery and power station. The decision was taken to build the new battery on the site of the old 50 ovens so that the battery of 25 ovens could remain in production as long as possible.

In order to provide for the greater length of the new ovens the ram was carried on a gantry over the coke roads. The discharge side of the ovens was on the side nearest the rail tracks so that an additional road for domestic coke could be provided. The original by-product buildings were well proportioned and they were retained for the new equipment.

#### Barrow Barnsley Coking Plant

The first battery of 35 Simon-Carves waste-heat ovens were built on the site in 1898 and 10 regenerative ovens were added in 1906. Another battery of 40 waste-heat ovens was built in 1912. Undoubtedly the regenerative ovens were very early and their efficiency could not be expected to be much greater than the waste-heat ovens they were intended to supersede. It is not known whether such an early design had problems but it is known that ultimately the regenerative ovens were converted to waste ovens. It is worthy of note that these ovens were maintained in commission throughout the depression. (21)

The Barnsley and District Coking Company Ltd. was formed for the centralisation of the coking activities of the Barrow Collieries, Barnsley Main Colliery and Wombwell Main Colliery and the site of the coking plant was at Worsborough, Barnsley. The plant had a keen interest in smokeless fuel production and eleven ovens were used for this purpose. The earliest ovens were closed down in 1936 although they were still doing a useful job. However, by standards of the time they were inefficient compared with modern ovens and



no useful purpose would have been served by any form of reconstruction. The directors of Barrow Colliery decided that the time was ripe for the development of a new installation which would take advantage of the most recent developments. The Worsborough portion of the property afforded the most convenient site because the layout would be unhampered by limitations of space and the plant as a whole would become a self-contained and independent works. An order was placed with the Woodall Duckham Company Limited for 51 Becker regenerative combination ovens and associated by-product plant.

The plant had an established interest in smokeless fuel yet the new ovens were 40ft 8in. long, 12ft. 6in. high and had a mean width of 17 inches and a carbonising time of 17 hours with a flue temperature of 1320°C. The unanswered question is why was the smokeless fuel plant built with near normal width ovens when narrow ovens would give a better quality fuel? Narrow ovens for the production of smokeless fuel had been built as early as 1928 at Nunnery Handsworth and presumably the Barnsley and District Coking Company arrived at the width as a compromise between producing good fuel and maximising output per oven in relation to minimum capital outlay.

Washed coal was transported from the Barrow colliery about a quarter of a mile away and from Wombwell Main colliery some two miles away by an aerial ropeway. The scheme also provided for an aerial ropeway to connect with Barnsley Main colliery. This was the last plant in Yorkshire and Derbyshire



to receive coal by this means. The ropeway from Barrow colliery was opened in 1876 (22) and delivered 600 tons of coal during each 8 hour shift. The ropeway was a bi-cable structure with a total of 29 buckets each holding 15 cwt of coal. In contrast the ropeway from Wombwell Main some 3 miles away was a mono-cable construction and carried 90 buckets each having a capacity of 10 cwt of coal. The buckets were manually tipped when they reached the coking plant. The ropeway was closed when Wombwell colliery closed in 1968. The only other plant to receive coal in this manner was Smithywood. At Glasshoughton dirt from the coking plant washery was transported to the stack by aerial ropeway.

Ropeways were considered to be the most economical method of transporting coal to some plants and they were very reliable under most conditions. The ropes on the Barrow ropeway and the Wombwell ropeway were changed every five years and four years respectively by the plant staff under the supervision of an engineer from the manufacturing company, Glover Brothers Limited, Manchester. Such a time interval between rope changes was quite typical and it illustrates the low maintenance costs of such systems. Aerial ropeways did not become widespread because local factors sometimes favoured traditional forms of transport.

#### Formation of a New Company.

This plant fell outside the Coal Industry Nationalisation Act of 1946 and instead a new company known as the Barnsley District Coking Company Limited was formed. The board of the new company was virtually the same as the old board, likewise the senior officials. Barnsley District Coking

Company wished to expand and an additional battery of 18 ovens were built by the Woodall Duckham Company in 1948. The capacity of the works was thereby increased by one third and additional primary gas cooling capacity and other by-product plant had to be installed to deal with the additional gas flow and associated by-products. A second ram machine and coal charging car were obtained and the capacity of the screening plant was increased. (23)

The next contribution towards increased efficiency came in 1949 when a rebuild of the original 51 ovens was commenced. The rebuild was planned in three stages of 17, 15 and 13 ovens and three of the old ovens were left between each new battery to serve as buttress walls, thereby reducing the total number of operational ovens to 63. Production was maintained from the existing ovens while each of the three blocks were demolished in turn. The rebuilds were finished in 1953 and from then on all 62 ovens were in full production and carbonised coal at a rate of 7,000 tons per week.

In 1946-47 a new coal drying plant and a new crusher were installed; the combined effect was to produce coal with a consistent moisture content of 10 per cent. There was a gradual awakening in the industry to the fact that coking coal would not always be abundantly available. This company was one of the first to react to the situation and blending bunkers were installed in the late 1940s to enable other coals to be carbonised. Welsh coal was blended with local coals to increase the hardness of the resultant coke. Experience showed that five per cent of Welsh coal blended with coal from



Barrow and Wombwell increased the shatter from 75 per cent to 80 per cent. The plant temporarily abandoned the smokeless fuel market in an attempt to benefit from the more lucrative blast furnace coke market.

During the early 1950s it became increasingly difficult to maintain pressure in the gas main to Barnsley and a new 12 inch diameter main was laid alongside the existing main in the canal towpath. The installation of the new main simplified transmission of gas to Barnsley. Examination of the old main showed that mining subsidence had caused condensate to collect in several places along the route and this had caused the progressively increasing high back pressure.

The number of personnel employed at the coking plant rose gradually over the years as new plant and equipment was installed. The original labour force comprised 200 men and the extra equipment and the introduction of a shorter working week brought the manpower complement up to 420. In general the size of coking plants remained constant and so the number of employees remained constant - Barrow Barnsley Coking Plant was exceptional because of the special circumstance.

A feature of the manpower situation was that although a 'closed shop' did not operate at the works, the only union recognised by management was the N.U.M. Cokeworkers Section. This simplified the problems involved with resolving disputes.



Re-entry into the solid smokeless fuel market.

There had been difficulty in producing and selling blast furnace coke in the past but in anticipation of an upturn in the blast furnace coke market the company decided to carry out experiments to establish an improved domestic solid smokeless fuel at the plant. The experiments were successful and a new solid smokeless fuel was launched onto the market under the trade name of 'Burn Brite'. It was made from Wombwell Main coal which had an ash content of only 3 - 4 per cent and was carbonised at a temperature of 1275°C. A small percentage of sodium carbonate was added to the coal before being carbonised and the resultant coke was sprayed with copper sulphate solution to give the fuel a characteristic flame during combustion. New equipment was installed to cut and grade the fuel.

The manufacture of 'Burn Brite' had to be terminated when the National Coal Board closed Wombwell Main Colliery. The main requirement for 'Burn Brite' was a coal having a low ash content and a clean coal similar to Wombwell Main was not available. The company undertook experiments for the production of smokeless fuel ovoids from coke breeze and a plant was installed by W.C. Holmes under licence from France to process the breeze. The ovoids were made from 'Burn Brite' breeze and a binder and passed onto a steel chain grate so that they could be heated in a 40ft. long oven. The pilot plant was later dismantled and transferred to another works owned by the group. (24)

### Closure of the works.

When north sea gas came into the area some of the resultant surplus coke oven gas was sold to a local brickworks for firing kilns and some was burned under the coke oven boilers. Despite these new outlets for gas which was no longer sold to the East Midlands Gas Board some surplus gas was always 'flared off'. The loss of remuneration from the sale of gas to the E.M.E.B. coupled with a decline in the domestic, industrial and blast furnace coke markets meant that the company was at a low ebb and in 1970 it was taken over by the National Carbonizing Company. N.C.C. acquired the plant because they had surplus capital at the time and they believed the Barnsley District Coking Company was available at the right price. In 1973 N.C.C. rebuilt 17 ovens first built in 1948.

Rising costs, old equipment and a continued low demand for coke reflected in the profitability of the plant as far back as September 1967. (25) The sales of coke had decreased by 1700 tons compared with the previous month and stocks of coke and breeze increased.

In order to ease the cash flow problems of the company the National Coal Board had offered to buy 25 - 30,000 tons of coke nuts during the summer price period in 1968 and at their current value of 162/-d per ton. The company readily accepted the offer. (26)

In an attempt to decrease coke stocks during the winter of 1967 the N.C.C. bought advertising time on I.T.V.(Granada) early in November for six consecutive weekends at a total cost of £1,200.



Negotiations took place regarding the production of 'Burn Brite' by the National Coal Board who suggested they might act as Sales Agents for all the coke and 'Burn Brite' produced by the company. N.C.C. were not happy with the suggestion and did not proceed with it because of the losses sustained by some of the N.C.B. coking plants in the district.

Helped by a surplus coal adjustment the profit for September 1967 was £10,550 and there was an overall profit on the first five months of the financial year of £7,878 compared with a loss for the corresponding period of the previous year of £71,251. But as time went by the financial position declined and on 6th November 1975 N.C.C. closed this plant and the South Yorkshire Chemical Company at Rotherham which had also been acquired by N.C.C. as an attractive proposition when it was in similar difficulties. The plants were originally scheduled to be closed on 30th September 1975 but a short respite was granted while attempts were made to save them. (27) They were offered to the N.C.B. free of charge but the offer was rejected. Unfortunately Coal Products Division had over capacity and acquisition of two more old plants would have increased their own cash flow problems. The company then appealed to the European Court of Justice in Luxembourg to see if they could overcome the problem created by the N.C.B. who were keeping their own coke prices down and making N.C.C. uncompetitive. The appeal was rejected but at least the closure date was postponed until the outcome of the appeal was known.



The Yorkshire Branch of the National Union of Mineworkers attempted to take over the works but satisfactory arrangements could not be made and closure occurred on 6th November 1975. It is believed that N.U.M. intervention was carefully orchestrated and the N.U.M. had no real intention of acquiring the plant.

For some months before the pending closures were announced recruitment of labour at Manvers Coking Works and Smithywood Coking Works was drastically curtailed by the N.C.B. so that as many suitable men as possible from the 600 people made redundant at the two plants owned by N.C.C. could be offered employment. British Steel Corporation Chemicals Division also employed some of the redundant workforce at their Orgreave Works.

#### South Yorkshire Chemical Works Limited.

A battery of 60 standard Semet Solvay double-pass regenerative ovens were built for the South Yorkshire Chemical Works Limited at Rotherham in 1927 to carbonise 6,000 tons of coal per week. The new installation, complete with by-product recovery plant was laid out on the same site as, but independently of, 85 ovens and by-product plant which were to be demolished. The original by-product plant was inevitably out of date as well as having insufficient capacity for the proposed new ovens. (28)

An advantage of the Semet Solvay ovens from the operator's point of view was that the heating flues to each oven were totally independent of the heating flues of adjacent ovens. This meant that a completely new battery could be built on

the same site simply by demolishing the old ovens one at a time and rebuilding them until every oven had been replaced. Although the principle was excellent in many ways it made the cost of the original battery so expensive that it was commercially unattractive.

The Semet-Solvay and Piette Coke Oven Company Limited, with Headquarters in Sheffield, had associated companies in America, Belgium and France at that time and the Parkgate plant at Rotherham was the last activity of the Semet Solvay Company in this country. This was one of two plants ever to be built in Yorkshire or Derbyshire to have its own coal washery. The other one was at Glasshoughton and is referred to later in this chapter.

Mention of the disposal of gas is made because it typifies a situation common to two plants later owned by B.S.C. (Chemicals) Ltd., and two owned by N.S.F. Ltd. South Yorkshire Coking Company, as it became known, was the only independent plant involved with a special gas grid in the 1970s. Early in the 1930s gas was sold to both Rotherham Corporation and the Sheffield Gas Grid but most other plants sold to only one or other gas undertaking. The gas contract was taken over by the East Midlands Gas Board after nationalisation of the gas industry and terminated by them on 31st March 1971, so the National Carbonising Company, who had taken over the company, installed a Stretford gas purification plant and negotiated a contract to sell purified gas to the British Steel Corporation. The contract commenced in June 1972 and terminated when the plant closed.



One interesting feature of the plant was that up to February 1956 it was the sole supplier of gas to Rawmarsh Urban District Council. Earlier in the century this feature was quite typical but by 1956 most other districts were interlinked to some extent to allow greater flexibility of supply and demand.

The plant became victim of other economic circumstances. Up to 1970 all the coal requirements, which amounted to approximately 1,000 tons per day, were emptied by hand from rail wagons. Slack emptying was carried out on a two shift basis with each slack emptier handling 100 tons of coal per shift on a piecework basis. One result of the plant being acquired by N.C.C. was that a rotary wagon tippler was commissioned in 1970 to replace the traditional end tippler, one of which can be seen in figure 20 in chapter VI.

Private rail sidings linked up with New Stubbin colliery in one direction and B.S.C. (formerly Parkgate Iron and Steel Company Limited) in the other direction, as well as British Rail. Parkgate Iron and Steel Company discontinued taking blast furnace coke from the plant on 31st March 1970 and this brought to an end a long standing relationship between a private coke producer and an independent user whereby rail transfer charges were minimal. (29) This situation was unique and it worked to the benefit of both supplier and user. Instead an agreement was made with B.S.C. to take most of the blast furnace coke for a period of four years commencing 1st July 1970. Although the majority of the coke was expected to go to Parkgate, B.S.C. had the option to send the



coke to any of their other works. At the end of the contract with B.S.C. most of the coke was exported.

The South Yorkshire Chemical Works Limited had been in financial difficulties for some time and acquisition by the National Carbonizing Company Limited on 1st October 1969 gave the works a new lease of life which lasted until 6th November 1975 when, despite the strenuous resistance of the N.U.M. and Politicians, it was closed down. (30)

The original Union agreement was made between the South Yorkshire Chemical Works Limited and the National Union of Enginemen, Firemen, Mechanics and Electrical Workers. (Power Workers Group of the Transport and General Workers' Union). The negotiating union became the T and G.W.U. towards the end of the life of the plant. Why should the N.U.M. have taken such an interest in the proposed closure of this coking plant when the labour force belonged to a different union? There are two reasons which figure prominently in the circumstances surrounding the closure. The main one was fear that closure of the plant without opposition might easily lead to other closures which would involve N.U.M. membership. Another reason was anxiety by the N.U.M. to maintain the coal market at a time when the coal industry was in difficulty. A third reason which had some credence was the fact that Yorkshire Miners are notoriously militant and an element was anxious to be seen to be fighting what was believed to be a just cause. In spite of strong opposition their cause was hopeless because coal costs were increasing, the coke market had been lost, and the National Carbonizing Company was having to undergo a major contraction

in order to remain viable.

During the lifetime of  $48\frac{1}{2}$  years the Semet Solvay ovens carbonised nearly 16 million tons of coal with an average throughput in excess of 260,000 tons of coal per oven. This throughput cannot be compared with throughput of ovens built by other contractors such as Simon Carves or Woodall Duckham Limited because of their different method of construction. It is probable that the Semet Solvay ovens were rebuilt piece-meal several times during the life of the plant. The greatest throughput per oven belongs to Rotherham Main Coking Plant, described in detail in chapter VI.

#### Nunnery Handsworth Coking Plant

The period after World War I saw advances in coke oven practice which included larger capacity ovens, shorter coking times and more efficient heating arrangements. Increased capacity ovens had been attained by increasing the height and length within the limits dictated by the problem of temperature regulation in order to maintain uniform heat distribution, and the design of the structure in order to ensure strength and solidarity. The use of high-grade silica bricks enabled flue temperatures to be increased and provided most of the increase in throughput. The coking plant built for the Nunnery Colliery Company at Handsworth, Sheffield was the first Becker oven plant to be built by Woodall Duckham and Company in this country. (31) The plant was important because it was built specifically to produce smokeless fuel and it therefore had 14 inch wide oven chambers



instead of the normal width of 18 inches. (32)

Traditionally smokeless fuel has been coke which was too small for blast furnace requirements so it was sold as domestic and industrial coke. The fact that this was the first battery of Becker ovens to be built in this country as well as having a special feature of narrow ovens raises two important points. For a long time 18 inch wide ovens had become the accepted width because it was believed that wider ovens would not discharge without damage to the chamber walls and sole. (33) Nunnery Colliery Company was courageous insofar as it was prepared to sacrifice throughput in relation to capital expenditure in order to improve the reactivity of the fuel. Although there was merit in the idea of narrow ovens they were not repeated elsewhere solely because of the higher capital cost and the relative financial unattractiveness of the domestic and industrial coke market in relation to the blast furnace coke market. Perhaps there was also some indifference towards the domestic coke market.

The plant comprised 25 ovens each 40ft 8 ins. long, 12ft. 6ins. high and having a capacity of 12 tons; the ovens were relatively long in order to achieve what was, by the standards of the day, a large chamber capacity. The following weekly quantities of by-products are given to show typical quantities which had to be handled:-

Coke	2,800 tons
Ammonium sulphate	50 tons
Tar	36,000 gallons
Benzole	13,600 gallons

The surplus gas was sold unpurified to the Sheffield Gas Company at the volumetric rate of 27 million cubic feet



per week and with a calorific value of 550 B.Th.U.

per cu.ft.

Figure 1 has been included because it gives a typical impression of an overall coking plant as it existed in the 1930s or thereabouts, though untypically the coal was supplied from an adjacent drift mine rather than a deep mine. The plant was located adjacent to the North Eastern railway line linking Sheffield and Nottingham and the company took advantage to advertise its main products 'cobbles and nuts' on the coke oven battery chimney. (34) The early plant was typically small, neat and compact - features which changed appreciably with the construction of later plants.

Figure 2 was taken later in the life of the plant when, for some unknown reason 'cobbles and Nuts' had been removed from the chimney. The figure is quite typical of other coke oven batteries in the district in relation to size and appearance, and the fact that it was parallel with and close to the main railway line. Soon after the plant was built a unique situation occurred when the service bunker collapsed. Traditional inventiveness saved the plant and temporary conveyors were constructed so that the coal charging car hoppers could be filled with coal at the opposite end of the battery while the service bunker was re-built. The modified coal charging process was slow and throughput was drastically reduced but it enabled the ovens to remain in working order until full throughput could be restored.



FIGURE 1

Nunnery Handsworth Coking Plant. (35)

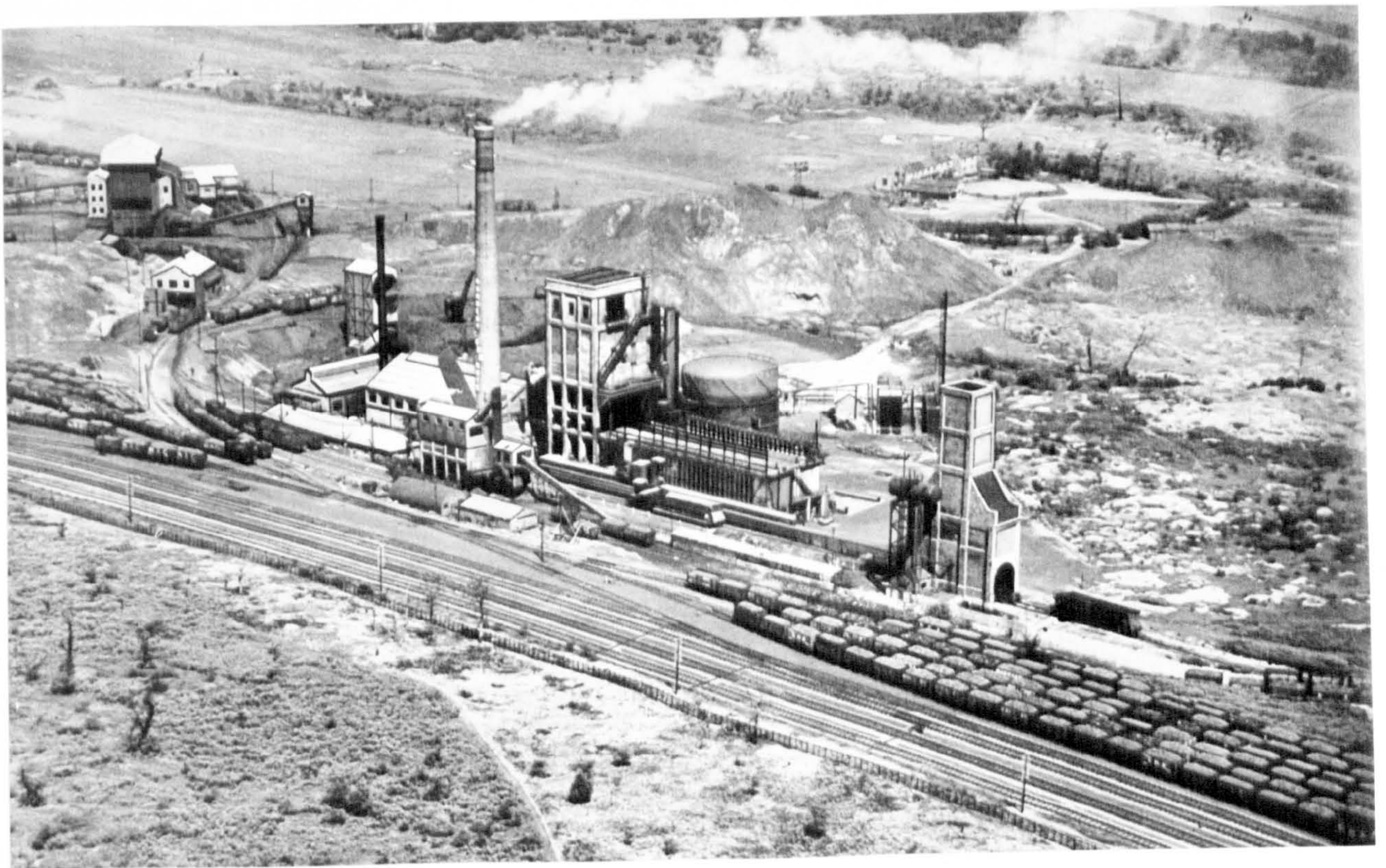
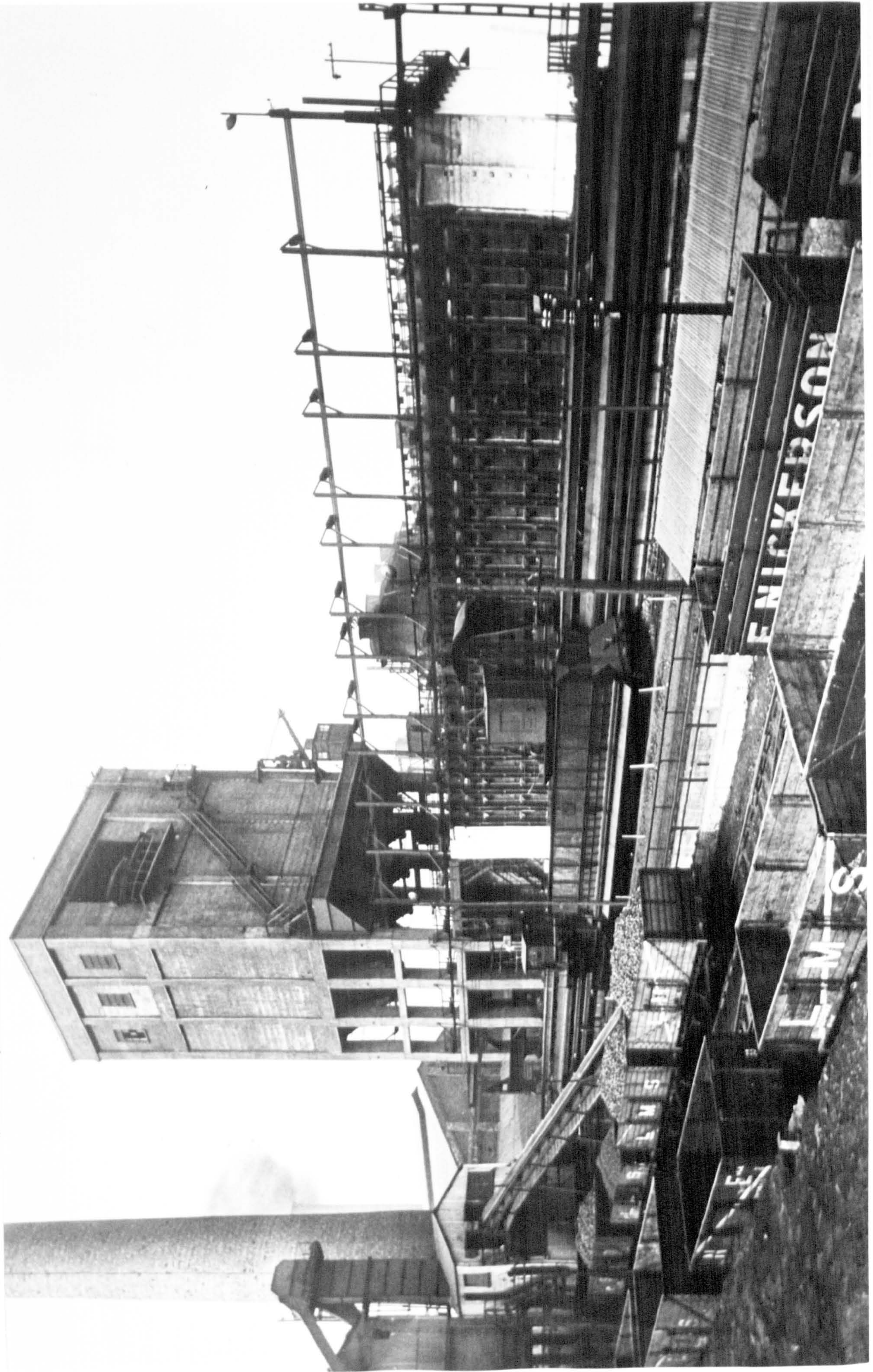




FIGURE 2

Nunnery Handsworth Coke Oven Battery. (36)





### Smithywood Coking Plant.

A new by-product coking plant was built in 1929 by the Woodall Duckham Company at the Smithywood Works of the Thorncliffe Coal Distillation Company at Sheffield to replace the old beehive ovens at Rockingham and Thorncliffe.(37) The plant had a carbonising capacity of 1200 tons of coal per day and it was about three times larger than other plants built in this period. This large size was attributable to the fact that coking coal was supplied from Rockingham and Thorncliffe collieries (by aerial ropeway) as well as Smithywood colliery because they were owned by Newton Chambers and Company Ltd.

The Thorncliffe installation was the second battery of Becker ovens to be put into operation in this country (38) but by the time the plant was started in September 1929 a third was in full operation at the Bedwas works of the British Benzol and Coal Distillation Ltd. The 59 ovens at Smithwyood were designed for a weekly output as follows:-

Coke	5,800 tons
Ammonium Sulphate	97 tons
Tar	68,000 gal.
Crude Benzole	29,600 gal.

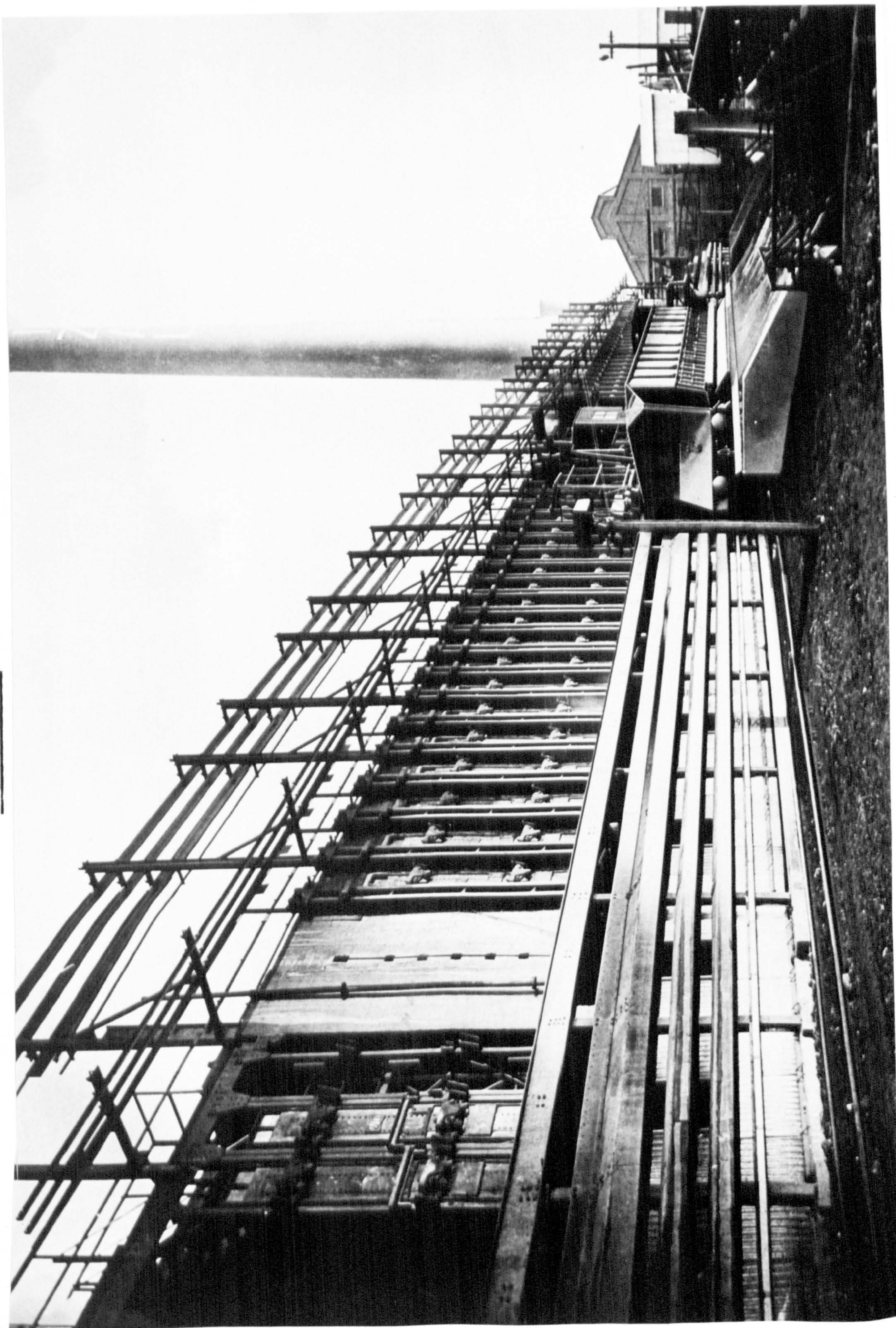
In addition some 28 million cu.ft. of gas were supplied to the Sheffield Gas Company for purification and re-distribution. Figure 3 was taken soon after the plant was started up. The view of the coke side of the ovens, the coke car and coke wharf with the end of the ammonium sulphate plant building shown in the distance is quite typical but reference to the

main product of the parent company 'Izal' on the battery chimney and facing the N.E. railway is unusual. 'Izal' was built into the chimney structure with white tiles and it can be seen today. The only other plant to advertise its products in a similar manner was Nunnery Handsworth.

One feature not readily observed from figure 3 is the fact that the oven doors were clay luted instead of being self sealing. The on-going debate about clay luted doors versus self sealing doors largely concerns running costs but it has special significance at Smithywood. The plant was unfortunate in that it acquired a militant labour force and undoubtedly adoption of clay luted doors preserved the life of the plant up to and during World War II. The ovens were rebuilt in the 1950s and the question of the type of door seal was again considered; the outcome was that clay luted doors were again adopted at a time when all other plants had abandoned them in favour of a self sealing type. Subsequent events proved the decision was wise because the labour problems of earlier years continued and may have even deteriorated. An inherent problem was that the number of ovens at the plant was large for one team of men. By the 1950s there were larger plants but they had several teams to operate the ovens. The result was that Smithywood oven men had to work harder than any other oven men in the country and in comparison with the small Cortonwood coking plant only a few miles away they had to work three times as hard for the same wages. For a long time the Smithywood men had requested bonus payments but their pay and conditions were inextricably bound by inflexible national agreements. The N.C.B. were



FIGURE 3





determined not to introduce two sets of oven men per shift even if it had been feasible. The controversy was not resolved until the late 1970s when productivity bonuses were introduced throughout the industry.

Full use of the compound ovens was not taken until 1952-53 when a battery of six gas producers and ancillary equipment built by Simon Carves Ltd. provided lean fuel gas for heating the ovens in order to liberate a corresponding amount of rich gas into the grid. (39) The plant was started up in January 1953 and worked on a five day week basis in readiness for the guarantee test in October that year. (40) The coke oven batteries were rebuilt about the same time.

Installation of the producer gas plant solved two problems; it enabled more rich gas to be liberated for the grid when demand was high without adding to the large stocks of coke which were causing the N.C.B. concern. The producer plant came into being as a result of a unique arrangement between the E.M.G.B. and the N.C.B. whereby the former paid for the capital investment but the latter operated and maintained the plant and transferred the charges to the E.M.G.B. The arrangement worked well for a long time until it was realised that practical problems were created when the ovens were fired with producer gas. By the time local resentment of the dual fuel system had built up because of technical difficulties the national coke stocks had decreased and the supply - demand ratio for gas had changed so the producer gas plant was shut down and dismantled.

On 3rd September 1979 the coking plant celebrated its 50th Anniversary and to mark the occasion a group of seven original employees had drinks with the present manager, Mr. J. Lunn. One further person who is still employed at the plant after 50 years service and is now Chief Foreman also attended. (41) The celebration was a unique event in the history of the industry.

#### Waleswood Coking Plant.

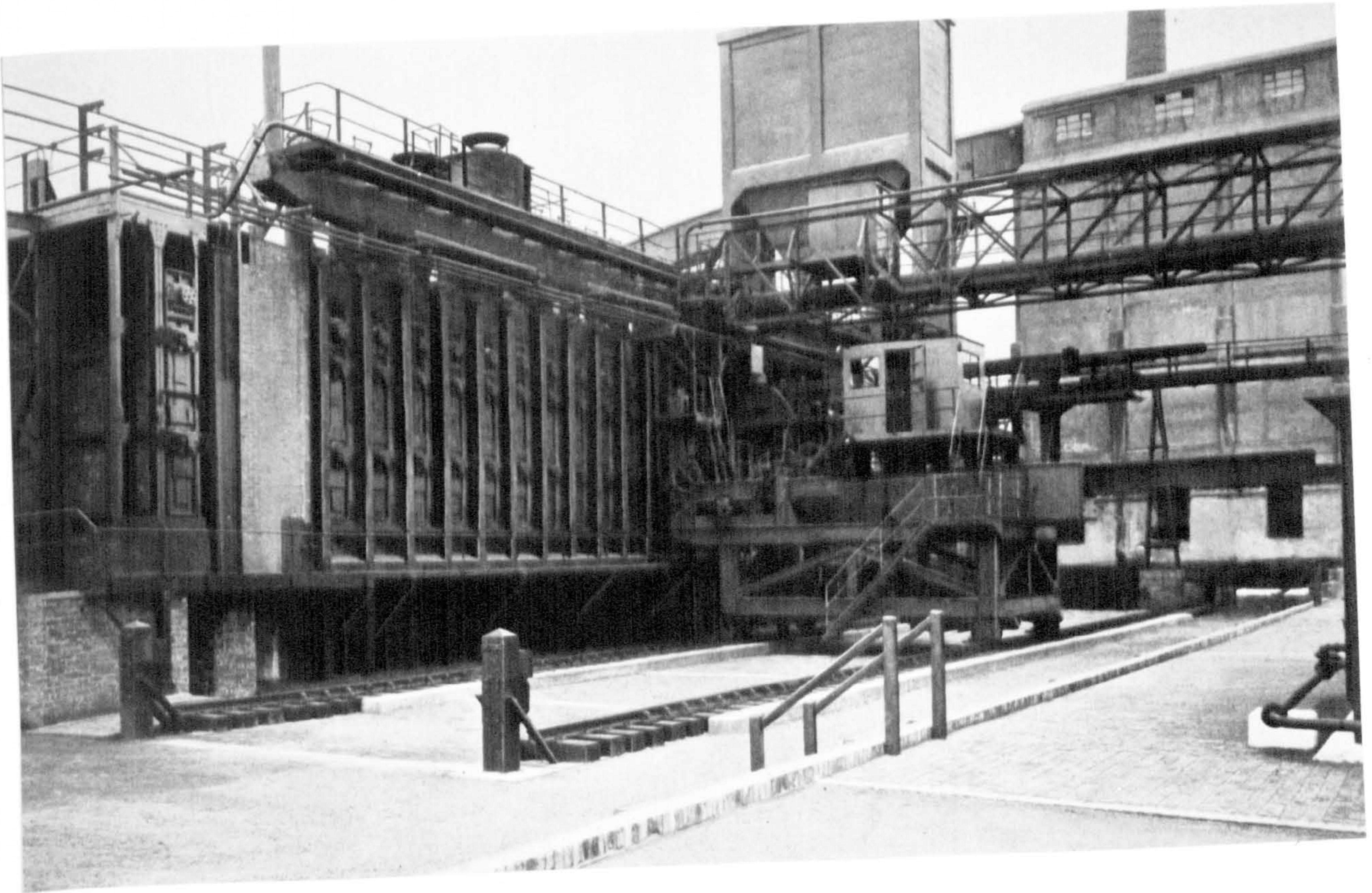
The Waleswood Coking Company took over a new coking plant at Waleswood, Sheffield in 1938. The plant was one of the last plants to be built between the wars with the advantage that it incorporated all that was best in coke oven equipment. It comprised a battery of 23 W-D Becker Regenerative Underjet ovens which were novel at the time. The indirect by-product plant provided for the recovery of crude tar, concentrated ammonia liquor and crude benzole. This plant differed from others built in the district because the Waleswood Coking Company took responsibility for the design and erection of the exhauster house, a new office and laboratory building and the electric power and lighting arrangements. (42)

Figure 4, taken soon after the plant was built, shows the ram side of the battery and the combined pushing, levelling and door extracting machine. The figure also indicates the smallness of the plant which eventually brought about its downfall. The oven chambers themselves were typical of the period at 23ft 8½in. long, 12ft 6in. high and 18in. wide but there were insufficient of them, with the result that



FIGURE 4

Waleswood Coke Oven Battery (48)





throughput was only 267 tons of coal per day. The size of the coking plant was dictated by the output of the colliery which was itself small and the economic viability of the unit was doubtful. (43)

The plant was badly managed early in its life and in 1952 it was losing money at the rate of £1 per ton of coal carbonised because of low throughput. (44) The manager had a survey carried out to see if the flue temperatures could be increased but it was found that the riser pipes were partly blocked with sediment, also there was not a suitable Askania type fuel gas regulator. Both shortcomings were rectified so throughput could be increased, whereby a profit of 2½d per ton was returned in one month.

The closure of the colliery early in the 1950s was another blow to the viability of the plant and it even operated the washery for a short time. (45) Eventually coal was brought in from the Brookhouse colliery. The closure of the plant came in 1956 when the coke sales were lagging behind production. Several other plants had to close over the next few years. In retrospect this small plant did well to survive the colliery by four years because costs were bound to rise when the colliery ceased to bear a relevant portion of the fixed charges and operating costs. For instance, the coke ovens became responsible for the three Babcock and Wilcox water tube boilers as well as the shunting facilities. (46) Evidently there was hope that the coking plant would at least break even.

What were the special features of the plant?

One unique feature which militated against its survival was the fact that when output from the batteries was raised coal had to be emptied on two shifts and conveyed to the 150 ton capacity service bunker. Another feature, unique in Yorkshire but not in Derbyshire was the use of a haulage driven coke car. (49) Rope haulage was relatively cheap but the shortcomings meant that alternative electric locomotive haulage superseded it except at Glasshoughton which used another unusual form of transport and is referred to later in this chapter.

Perhaps because of its small size the plant was free from labour troubles. It was untypical in that it had its own sports facilities and welfare ground - the plant manager, another nominee from management and two workmen were trustees. Grants were obtained from the Coal Industry Social Welfare Organisation (C.I.S.W.O.) for repairs to the cricket ground and the pavilion in the 1950s because of the enthusiasm of the coke oven manager. Frequent social events organised by the plant were held at the nearby Wales Bar Hotel. Waleswood Coking Plant had a better record for sports and social activities than any other plant in the district.

#### Brookhouse Coking Plant.

The Sheffield Coal Company decided to expand their activities by sinking a new mine shaft and owning a new coking plant at Beighton, a small village to the south east of Sheffield, adjacent to the London and North Eastern Railway and the river Rother.



The 18ft dia. shaft for the new colliery was nearing completion in September 1930 and in due course the output from the mine was expected to be 15,000 tons of coal per week. The colliery was an important part of a small integrated complex which included a central steam and power plant as well as a coking plant. The colliery winding gear was designed to be operated electrically, showing the faith the company placed in the projected power plant and also the fact that it was a progressive company which was prepared to instal relatively new methods of winding equipment. (50)

The coking plant is a typical Simon Carves design and almost a duplicate of the one built at Rotherham Main.

An important difference is that the Rotherham Main battery was built to a TX design while Brookhouse was a less complicated Underjet Regenerative type. It had a capacity of 430 tons of coal per day from a battery of 25 ovens and the by-product plant included indirect ammonia recovery, crude benzole and crude motor spirit recovery.

Like Rotherham Main the plant was laid out so that it could be duplicated at a later date but unlike Rotherham Main the old battery of 25 ovens was replaced with two batteries of 25 Simon Carves Otto twin flue underjet ovens. (51)

#### Preheating Plant

A series of successful coal preheating trials had been carried out at the British Coke Research Association in 1968 and in consequence the British Steel Corporation authorised a development project to charge two batteries of coke ovens

with preheated coal on an experimental basis. (52)

Why was Brookhouse selected for the trials? One reason was that it is relatively small by B.S.C. standards and any loss in production which might result during the trials could be offset at their much larger plants. Also, a new by-product plant, scheduled for completion at the same time as the construction programme, would handle the increased gas production expected from the use of preheated coal.

Brookhouse coking plant is located near to the British Carbonisation Research Association and it delivered gas into an industrial grid along with Orgreave Coking Plant, also owned by B.S.C. and Smithywood and Manvers Coking Plants owned by National Smokeless Fuels Limited. The grid could cope satisfactorily under normal circumstances with the extra gas load attributable to the preheating trials.

Another factor which was regarded as important by the staff of B.C.R.A. was the fact that Brookhouse represented a 'scale up' factor of eleven compared with the B.C.R.A. test plant and this was considered to be a suitable size increase.

In retrospect the coal preheating trials were successful and coal preheating is considered to be a serious alternative to tall ovens as a means of increasing productivity.

For some coking plants preheating may be the only means of increasing throughput because of site limitations or financial constraints. In general, ovens using preheated coal require at least 30 per cent less ovens to carbonise the same weight of dry coal.



As a result of the trials at Brookhouse a coal preheating system has been built at a much larger coking plant owned by B.S.C. (Chemicals) Ltd. and situated at Orgreave some 4 miles from Brookhouse. It is ironical that the full scale coking plant which developed coal preheating may one day be closed because of it.

### Modern Coking Plants.

#### Introduction

Many of the coking plants which vested in the N.C.B. in 1947 were old and small and the time was right to re-examine the coking industry as an integral part of the coal industry which was itself examined in the light of anticipated post war needs.

In 1947 it was recognised that there were three basic industries concerned with the carbonisation of coal:-

- (1) Coal mining
- (2) The iron and steel industry
- (3) Gas and smokeless fuel production.

The early post war chemical industry depended to some extent on each of these industries because it was based largely on derivatives of coal for its feedstock. The inter-related nature of these industries and their total dependence on coal attracted attention towards their economy. It was already apparent that transport costs were becoming an increasing factor in the economy of the coal industry, as well as other industries, and this undoubtedly influenced the case for the centralisation of carbonisation plants.

The following points were presented by advocates of

carbonisation plants at the coal source (53) :-

- (1) The characteristics of the coal mined at the colliery or group of collieries.
- (2) The daily output of coal.
- (3) The types of products that could be made.
- (4) Local demands for these products.
- (5) The proximity of other collieries mining suitable coal for blending.
- (6) The geography of the site in relation to large centres of industry.
- (7) The economic size of centralised plants.

The coking plants supplying hard coke for the iron and steel industry were considered to be best sited at the point of utilization rather than the point of production on the grounds that collieries supplying the raw coal were in the neighbourhood and that coal blending from several collieries was becoming more important. The size of the coking plant was matched to the size of the blast furnaces it was to serve and not to the size of any colliery. Large centralised coking plants for the steel industry were therefore considered a desirable feature insofar as blast furnace gas could be used effectively for underfiring the batteries and thereby liberate coke oven gas for other purposes.

The demand for town's gas had started to increase in 1947, see figure 1 given in chapter III and methods of increasing the availability of gas from coke ovens for town's use were



being considered. Attention was being paid to the discriminate use of valuable coking coal and the possibilities of coal blending to enhance the quality of both domestic and industrial coke and to improve the gas yield. The case for centralised installations where the coal throughput was in the order of 800 - 3,000 tons per day was beginning to emerge. Large units would enable the preliminary refinement of by-products to give way to the economical production of a variety of purer products for the chemical industry.

In 1951 the Gas Boards were thinking of coking plants of 1,100 - 1,200 tons per day as being the most economical units. (54) This view was developed almost entirely from gas production costs and flexibility of gas production by the use of holder capacity, variable load and the production of electrical power.

The distribution of British coking plants in 1935, 1946 and 1955 in throughput increments of 500 tons of coal per day is shown in figure 1 in chapter VII. Emphasis after World War II clearly lay on larger units and few of them as a means of reducing costs.

Synonymous with a change in size was an attempt to become more fully self contained so that the large post war plants had electric power generation sufficient or nearly sufficient to meet their requirement independent of the electricity grid.

Another feature of the new plants was that they were designed to receive several coals and blending facilities

were incorporated as original equipment. By the 1960s the blending facility became invaluable because an increasing shortage of prime coking coals meant that coals which, on their own were unsuitable for carbonisation, were being blended and used to give high quality coke. (55) The range of coals available for carbonisation was thereby extended.

#### Manvers Coking Plant

The original coking plant at Manvers, near Rotherham, comprised 36 Koppers regenerative ovens built for the Manvers Colliery Company Ltd. and commissioned in 1906. The by-product plant was simple and included primary gas condensers and scrubbers for the recovery of ammonia by the indirect process. The alternative semi-direct process was first used 4 years later at the Holmewood coking plant in 1910, this has been described earlier in the chapter. The ovens were designed to carbonise 7 tons of dry coal per charge but between 1911 and 1913 the crowns were raised to increase the capacity of the chambers to 7.75 tons. (56) Why were the oven crowns raised to increase throughput? Perhaps the first answer was decided by site limitations which appear to have prevented increasing the number of ovens. A second answer comes from the fact that, superficially at least, increasing the chamber size by raising the crowns was feasible and logical. It should be borne in mind that very little was known about the behaviour of refractories at high temperatures, otherwise the alterations would most certainly not have been undertaken. In retrospect the method of increasing the capacity of the chambers by raising the crowns would be quite unsatisfactory from a technical point of view and research by the author



has shown that no other plant in the district tried to increase the throughput in this way.

The batteries were extended in 1913 with the addition of 14 Simon Carves waste heat ovens built onto the end of the existing Koppers ovens. Two interesting points arise, it is interesting that waste heat ovens were built when the use of regenerative ovens was gaining popularity and it is assumed that they were built because there was increased demand for coke without a corresponding increase in the demand for gas. More foresight by the Manvers colliery company would have shown the wisdom of building regenerative ovens. The other important feature is the unique step of installing Simon Carves ovens when the Koppers company already had ovens there. This is the only known instance of changing to a rival coking plant contractor and it is concluded that the Manvers colliery company attributed some of its early troubles to the Koppers Company. Following this battery extension Simon Carves built a crude benzole plant and in 1917 they built another battery of 22 ovens. In 1916 the production of concentrated ammonia liquor replaced the production of ammonium sulphate and in 1917 a plant to produce high grade toluol and benzole was added, showing that Manvers Colliery company were willing to be adventurous and enter new industrial markets for by-products. The effect of World War I must have been a big influence with respect to the building of the high grade benzole and toluol plant. After the war the rectification plant was used to make motor spirit and additional gas cooling capacity was added to cool the extra gas produced from the increased number of

ovens. The war-time production of motor spirit is referred to in more detail in chapter IV. The question whether the war prevented the installation of extra cooling capacity when the additional ovens were built or whether pious optimism regarding existing cooling capacity at the plant abounded remains unanswerable. Evidently war conditions dictated that additional gas coolers were not immediately essential, possibly because of a shortage of steel, a shortage of contractors to make the coolers rather than war machines, or both.

At the start of the plant the ovens were cake charged but top charging with hand levelling was introduced in 1913, consistent with the general trend. The old stampers and cake boxes were scrapped in 1922 and replaced with two Buchanan ram machines, one of these ram machines remained in service until the ovens which it served were closed down in 1978. The cautious approach in changing from stamp charging is similar to that mentioned in the section describing Glasshoughton coking plant later in the present chapter.

Evidently the relative demand for ammonium sulphate and concentrated ammonia liquor changed after World War I because a new ammonium sulphate plant was built in 1923. This is consistent with a growing awareness of ammonium sulphate as a fertilizer and the need to increase agricultural output to meet the demands of an expanding population. The challenge of the nation's agricultural needs was seen to be urgent at the time and there was a general increase in the use of artificial fertilizers.



In 1932 the entire plant was scrapped and 30 Simon Carves 'Underjet' coke ovens of the twin flue type were built on the site of the old battery of 36 ovens and the boiler plant. Location of some of the new plant was dictated by the continued existence of some of the old plant. The scheme allowed for a throughput of 1,000 tons coal per day and provision was made for the addition of another 15 ovens at a later date.

The iron and steel industries in this country expanded in 1933 and more blast furnaces were started up. In anticipation of an increased blast furnace coke market 15 more 'underjet' ovens were built in 1934. Chapter VI describing Rotherham Main coking plant in 1928 also shows that the coke market was expected to increase.

One interesting feature of the coking plant built in 1932-34 is that the contract included equipment for grinding coke breeze and re-cycling it back to the service bunker. Further details of coal blending are given in chapters I and VIII. Breeze commanded a low price and it was already known that the hardness of coke could be increased by blending it with the coal charge. This is an important illustration of the empiricism and practical 'know how' on which the coking industry was so dependent. Some thirty years afterwards the British Carbonization Research Association carried out blending trials in their test oven and concluded that the logic of earlier pioneers of the industry was sound and they were able to quantify the results more precisely. Maybe it was fortuitous that the phenomenon had been discovered first on the full scale plant because it is unlikely that much

attention was paid to the physical problems of blending a small amount of one solid with a large amount of another; particularly when the solids have different bulk densities. In fact the problem of segregation in bunkers did not attract the attention of the Universities until much later; in the 1960s Loughborough University, with its keen interest in powder technology, made an important contribution to the advance of knowledge in this frontier. (57)

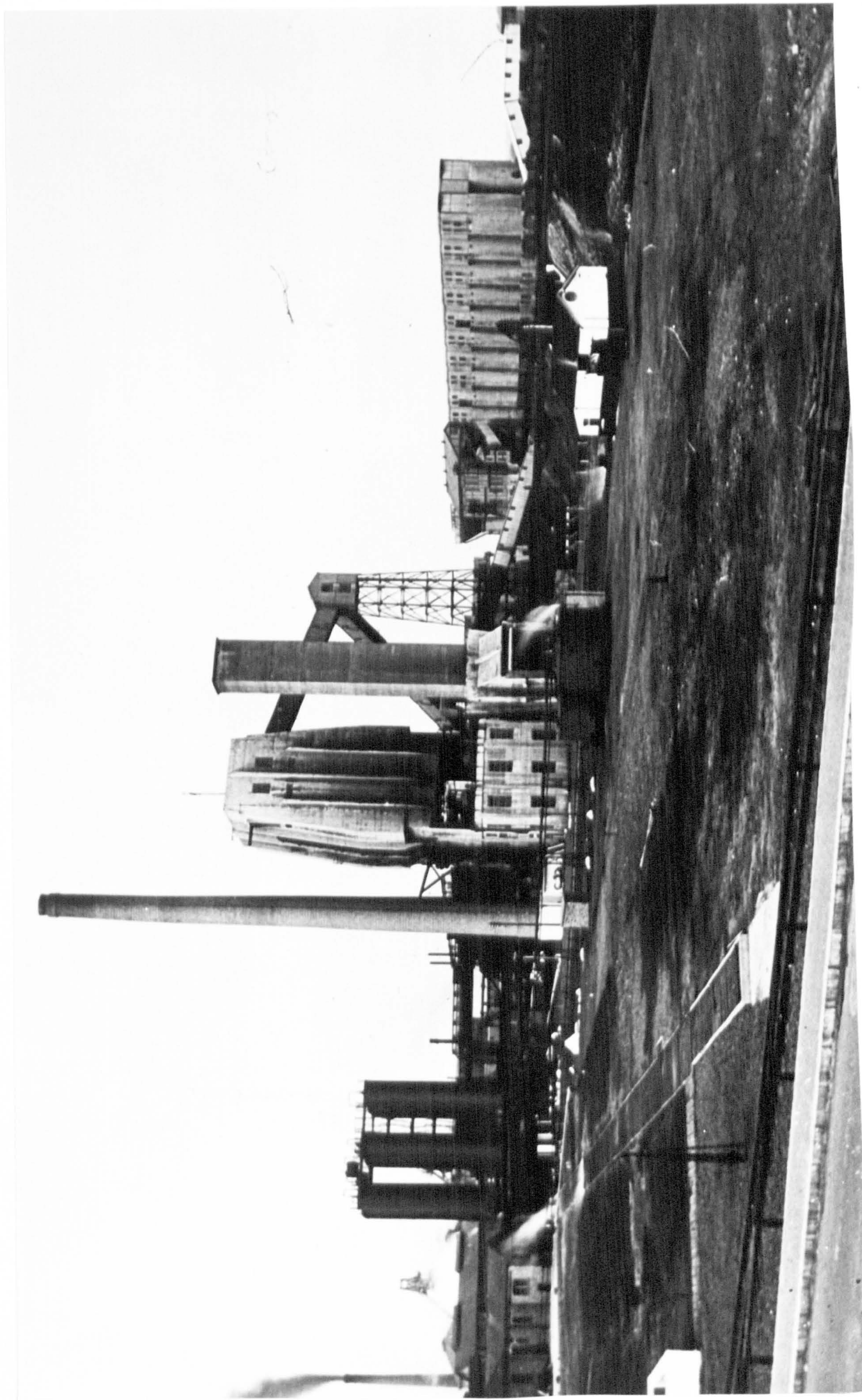
Manvers coking plant, as it was in 1933 and shown in figure 5, was built at the appropriate time historically to incorporate all the latest design features, including electrostatic tar precipitation equipment, mechanical disposal of spillage from the ram leveller beam and de-breezing screens at the outlets from the domestic screening plant. The figure shows two rows of the blending bunkers which were quite untypical of the industry at this time, and it was not until the large plants were built towards the end of the 1950s that coal blending generally gained importance. It was claimed that Manvers had an automatic crude benzole plant but it is difficult to see what components could be automated in the 1930s when crude benzole plants in the 1970s, with the possible exception of the Murton plant in Durham, are not automated. (58)

Unlike most other plants described in this thesis the picture of Manvers so far shows that it suffered spasmodic, if not erratic changes, sometimes forced upon it prematurely. The driving force of maximum production, almost without regard for all the implications is apparent, and it will be



FIGURE 5.

Manvers Main Coking Plant. (59)





shown that at Manvers, more than at any other plant in the history of the industry, the same theme has continued into the 1970s.

#### The Modern Manvers Coking Plant.

Many of the coking plants which vested in the N.C.B. in 1947 were old and small and so a scheme was prepared which would enable groups of small coking plants in Yorkshire and Derbyshire to be replaced by one large complex in each county; the boundaries of which approximated to the arbitrary boundaries of the North Eastern Division and the East Midlands Division respectively of the National Coal Board.

Much consideration was given to the optimum size of a modern plant and it was decided that Manvers should be rebuilt and enlarged to a capacity of 3,000 tons of coal per day. The size of Manvers Coking Plant was influenced by rationalisation of the mines in the area, and the need to carbonise the coking coal produced at the large Central Coal Preparation Plant built to serve collieries linked underground to the Manvers shafts and the Barnburgh colliery, whose coal was transported overland by private railway. Coal blending was expected to become increasingly important in the future and a Central Coal Preparation Plant was fundamental to meet this criterion efficiently and to eliminate the cost of rail transport between the washery and the ovens. The underground modernisation scheme was massive and involved the collieries at Wath, Kilnhurst and Manvers as well as Barnburgh. The C.C.P.P. serving the collieries was arranged with a triplicate system so that three classifications of



coal could be prepared simultaneously and yet have optimum sized washing plants. The scheme was the largest of its kind to be undertaken in Europe and it attracted much attention throughout the world. The question of how the coking plant adapted to meet the needs of a greatly enlarged underground system is worthy of examination in detail.

The re-construction of the coking plant enabled six of the small old and uneconomic coking plants in the North Eastern Division to be closed down without decreasing the availability of coke for the domestic, industrial and blast furnace markets, and the supply of gas to the East Midlands Gas Board. A prime consideration in the Manvers complex was the reduction in costs and the same consideration applied to the coking plant which became the largest in Europe.

It has been stated that the first re-build and modernisation of Manvers coking plant in 1933 took place on a restricted site; the same was said of the vastly enlarged Manvers in 1957. The Manvers re-build was so ambitious that the Wath-on-Deerne road was diverted to increase the amount of land available to the N.C.B. This did nothing to alter the fact that the site was divided into four parts by the intersection of the London Midland Region main railway line linking Leeds and Sheffield and a local line, also belonging to British Rail. The choice of site for the coking plant was unfortunate to say the least and it is evident that consideration of the whole integrated complex was the over-riding factor. The fact that the coking plant would effectively be divided geographically into four components was expected to increase the running costs but it is suspected

that the full effect could not be foreseen at the time of the reconstruction. Supervision was made more difficult and the movement of men and maintenance materials from section to section contributed to a loss of work effectiveness. (60) There was also more duplicated plant than would have been necessary on a green field site and the capital cost must have been high - the overall cost did not look excessive because of the reductions brought about by the existence and retention of a considerable amount of plant and equipment associated with the existing coking plant.

The difficult site provided a challenge to the contractors, Simon Carves Ltd. and they, as well as the N.C.B. gained valuable experience. Perhaps the first disadvantage was that the coke oven batteries were built on two split sites. The old site (last re-built in 1933) had relatively small ovens holding a charge of only 14 tons of coal. The existing batteries were re-built to the same dimensions and additional batteries added to give five batteries in total. This enabled the existing service bunker and the oven machinery to be re-used and serve a total of 71 ovens. The five batteries were a conglomerate, one battery comprised 17 compound ovens, two of 13 and 15 ovens were re-built as rich gas ovens and one battery from the final 14 of the old 30 oven battery was rebuilt with 12 compound ovens. (61) The assortment was brought about in order to re-build and extend the number of ovens while maintaining throughput and for technical reasons it was not possible to have five batteries each with the same number



of ovens per battery. The scheme required that a new coke oven chimney was in the way of the extension. These ovens, known as the '71 side' had a throughput of 1,320 tons of coal per day and mostly served the existing by-product plant. The throughput from these ovens alone was larger than any other plant owned by the N.C.B.

In contrast, construction of 66 completely new compound regenerative ovens was incorporated in two batteries of equal capacity. These ovens were longer and taller than those on the '71 side' and had a charge weight of 17.8 tons of coal. Progress since World War II had brought about an awareness of the financial advantages to be gained from operating larger ovens. There was now an awareness that it is no more costly to use a ram machine, coke guide, coke car and top charging machine for charging a large oven rather than a small one, in terms of labour and wear. Increased power consumption with this arrangement is minimal.

Because of site restrictions the ram track for the two batteries was elevated almost seven metres above ground level so that accommodation could be provided for workshops, canteen facilities, shower and changing facilities as well as offices for the shift foreman and plant shift manager. This made the site compact without adding much to the capital cost.

Two charging cars were used on the battery tops and this alone was a departure from the single unit and was brought about solely because of the large number of ovens which had to be served. One technical advancement with these machine

was the incorporation of three point suspension, formed by mounting the travelling wheels in bogies. The bogie frames were riveted to the chassis on one side and mounted on the other side in pin bearings with hydraulic dampers to prevent 'crabbing' and vibration. This most useful development was suggested by the contractor. Hitherto, vibration from the charging car had not been a problem because earlier cars weighed only 30 tons loaded whereas these modern machines weighed over 50 tons.

Carbonisation Department were well aware of serious accidents which had occurred over the years when the ram machine and the coke guide had been inadvertently lined up for different ovens. Consequently experiments were made with a magnetic locking device which would prevent movement of the ram beam if alignment was incorrect. The experiments were not successful because the electro-magnets were required to operate in hot conditions. Some years later a more successful gamma ray interlock system, pioneered by the Woodall Duckham Company Limited had to be installed.

It had long been realised that many accidents were caused by men falling off the coke side bench - a distance of some 7 or 8 metres, onto the coke car track. Opportunity was taken with the two new batteries, each containing 33 ovens, to design a coke side bench with a hand-rail. This desirable feature could not be incorporated in the re-built and extended ovens on the '71 side'. In like manner the new plant at Avenue and the rebuild at Glasshoughton both had coke side benches fitted with handrails. These plants are described later in the chapter and figure 10 provides visible evidence.



### By-Product Plant Rebuild 1958.

It has already been shown that rebuilding and extending the number of ovens was not a simple operation and the final result was a combination of oven types and sizes which cannot be found elsewhere. The re-building of the by-product plant was almost as complicated and the more unusual features, together with those indicating the modern trend are described.

The by-product plant from the 1930s was designed to cope with gas produced from 45 ovens and it had to be considerably expanded to meet the needs of 137 ovens. The original exhaustor house, tar precipitator, primary gas coolers, ammonia scrubbers, and benzole scrubbers were retained to deal with part of the gas load while all these units were duplicated on a much larger scale on the 'new' side to deal with the rest of the gas. Undoubtedly some saving in capital expenditure was made, but it was made at the expense of running duplicate plant for some 20 years and in retrospect the wisdom of the scheme was doubtful. Not all items were duplicated, for example a completely new crude benzole plant was built which recovered crude benzole from three parallel streams, two served the new side and one served the old side. A new exhaustor and compressor house contained an exhaustor to deal with the gas from the new side and compressors to handle gas from all the ovens. A new ammonium sulphate and concentrated ammonia liquor plant processed the liquor from both sides but in different ways. A unique feature was that ammonium sulphate was produced by combining the old indirect process with the new semi-direct process in one building. The merits of semi-direct and indirect recovery systems have fluctuated over the years according to changes in costs and

also attitudes towards effluent problems.

During the 1950s and early 1960s the effluent from the ammonia stills was pumped approximately 3 miles to lagoons on the disused colliery tip at Barnburgh. The traditional method of disposal had been to discharge it into the nearest stream or river but the <sup>River Pollution</sup> Act prevented this practice. Since the end of World War II there had been public awakening to the need for improved effluent control and the cost of pumping and operating the lagoons was accepted as part of the cost of running a coking plant. Following more stringent controls by the River Authority in the late 1960s and internal changes in attitude within the N.C.B. towards effluent disposal a biological effluent plant costing half a million pounds was built to treat all the works effluent. (62) This marked a turning point in the attitude towards effluent treatment so that thereafter capital and running costs of processing effluent in a biological effluent plant became an integral part of coking plant operations and expenditure.

#### Rectification Plant.

The coking industry was well aware of the advantages of scale regarding the rectification of crude benzole and the lesson was brought home even more sharply by the meteoric growth of the chemical and petrochemical industries since the end of World War II. Hitherto all rectification plants, like the coking plants themselves were old, small and outdated. The birth of Manvers coking plant presented an unparalleled opportunity to develop an entirely new rectification plant.



The Manvers refinery, as it became known, enabled the pure products which had been made during World War II to be produced more economically and for a while at least, remain competitive with similar products from the oil industry.

This refinery was built away from the coking plant and it had its own laboratory and refinery manager. Much consideration was given to the merits of batch versus continuous distillation for the plant which would process 15,000 gallons of crude benzole per day from Manvers and also one million gallons of crude benzole per year from other coking plants; the outcome was that batch stills were used. The decision must have been borderline because the section describing the Avenue plant, which was smaller, shows that rectification plant built was continuous.

The Manvers refinery, unlike existing rectification plants, was equipped with an extensive system for fighting fires and cooling tanks containing spirit in the event of a fire. (63) The refinery was served by a fireless locomotive, similar to the one referred to in the section describing Glasshoughton coking plant and shown in figure 10.

Following the general trend to move relatively small quantities of spirit by road rather than rail in the 1960s refinery rail traffic was abandoned.

By the late 1960s the refinery was becoming relatively small and uneconomic and its conventional use was terminated when the large refinery built by Staveley Chemicals Limited became operational. This refinery processed the crude benzole produced by all the N.C.B. and the B.S.C. (Chemicals) Ltd.

coking plants. The N.C.B. and B.S.C. own 45% each and Conoco own the remaining 10% of Staveley Chemicals Limited.

#### The Rebuilding Programme

Early in the 1970s National Smokeless Fuels Limited, a division of the N.C.B. considered rebuilding several of their plants and Manvers headed the priority list.

The condition of the ovens had deteriorated at an alarming rate since 1960 because of the emphasis placed on production, sometimes at the expense of maintenance, lack of supervision, poor management, and site difficulties. Primarily because of the scale of operations at Manvers it became a major source of atmospheric pollution and the controversy between National Smokeless Fuels Ltd. and its predecessor, Coal Products Division of the N.C.B. and the local authority raged unabated from 1947 until the final closure of the works in 1980.

In view of the deep concern by the local authority over atmospheric pollution, why did National Smokeless Fuels Ltd. decide to embark on a programme of battery rebuilds?

Coke stocks in the country had dwindled generally over the last decade and it was decided to rebuild the batteries in such a manner that full production could be maintained during the period of reconstruction. It was decided to rebuild Manvers rather than Smithywood or Glasshoughton which were only half as large because of the amount of capital already committed. Another factor was the general contraction of the coking industry and the attendant plant closures - it may well have been anticipated that



in the 1980s Manvers would be the only plant remaining in the area. Since economic considerations suggested this plant ought to be rebuilt the question of its suitability for rebuilding is worth examining if only because it reveals a series of avoidable planning mistakes. Past experience had not been heeded when the plant was reconstructed in 1957 and so the two oven chimneys were built at the extremities of the batteries and in line with them. (64) Unnecessary expenditure was incurred with the extension of the two batteries, each having 33 ovens, a new chimney had to be built off-centre from the battery and connected into the existing system before the old one could be demolished.

The expenditure of building a new quenching station and demolishing the old one could likewise have been avoided. Because the site fell away at the end of the proposed new battery an elaborate lift was installed to enable the coke car to be taken out of service and replaced by a reconditioned vehicle, an operation which usually takes place at intervals of 9 or 12 months. The fulfilment of the concept of maintaining production during the rebuilding programme was of paramount importance and itself responsible for heavy capital expenditure. A further question of whether it was so essential to maintain full throughput during the rebuild needs to be answered. The industry has a history of stocking coke during periods of low demand and reclaiming it when the market is buoyant. In fact Manvers had very extensive facilities provided for coke stocking and reclamation during the reconstruction programme of 1957.

Perhaps the state of the coking industry early in the 1970s can best be judged by the fact that for a long time capital expenditure had been avoided (see figure 5 in chapter VII) and some rebuilding was becoming unavoidable. With hindsight it would have been far better to allow coke stocks to increase in a controlled manner in readiness for the rebuild. Soon after the new battery was built a slump in the industry started in 1975, continued until 1980 and resulted in the 'old side' of Manvers being permanently closed down with consequent decrease in throughput of one third or more.

The new battery of 25 ovens was brought on stream in March 1974 at a total cost of over 2 million pounds, the battery itself cost one million pounds. (65) The cost per oven, in real terms, must be the highest on record. The building of this battery was intended to be the start of a long rebuilding programme but this ambition has never been realised. Prolonged industrial depression forced the closure of the rest of Manvers Coking Plant on 3rd December 1980. (66)

#### Management Problems.

Since Manvers became the largest coking plant in Europe, Carbonisation Department of the N.C.B. faced many unanticipated problems. Manvers came into being in the late 1950s as a result of an underground reorganisation of the North Eastern Mining Division's collieries in the area, it was intended to fulfil the modern concept that a large coking plant was a profitable one. Within limits this statement must be true



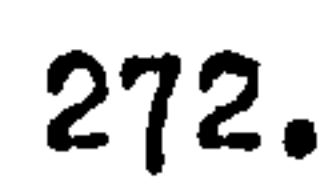
but the skill is to define the limits in relation to other local circumstances. As an oversimplification the plant can be considered to be an enlarged version of a traditional coking plant carbonising some 400 tons of coal per day and with this premise, it is not surprising that the staff plan shown in figure 6 was simply an enlarged version of a very simple and traditional staff plan. The result was that mechanical and electrical engineers had far more responsibility than they would have had at a small plant though their salary was only marginally greater. The coke oven manager was also underpaid but to a smaller extent. This was an unfortunate start and these and other similar shortcomings ought to have been adjusted much earlier.

The post of Group Manager was anomalous because the birth of Manvers meant that the other plants in the group, namely Cortonwood and Dalton coking plants, were closed down. It was inevitable that the group manager's technical officer eventually devoted all his attention to Manvers although he soon became assistant manager as part of a rationalisation scheme.

Within a few years operational problems at the plant began to increase. Even though there were several reasons for this the Divisional staff tended to blame local management and vice versa. Divisional control went through several changes over the next fifteen years and successive plant closures made the operating plants more responsible in the first instance through Regions to Headquarters in London and finally direct to Headquarters.

LINE MANAGEMENT 1957. (68)

**N. E. DIVISIONAL CARBONISATION OFFICER**



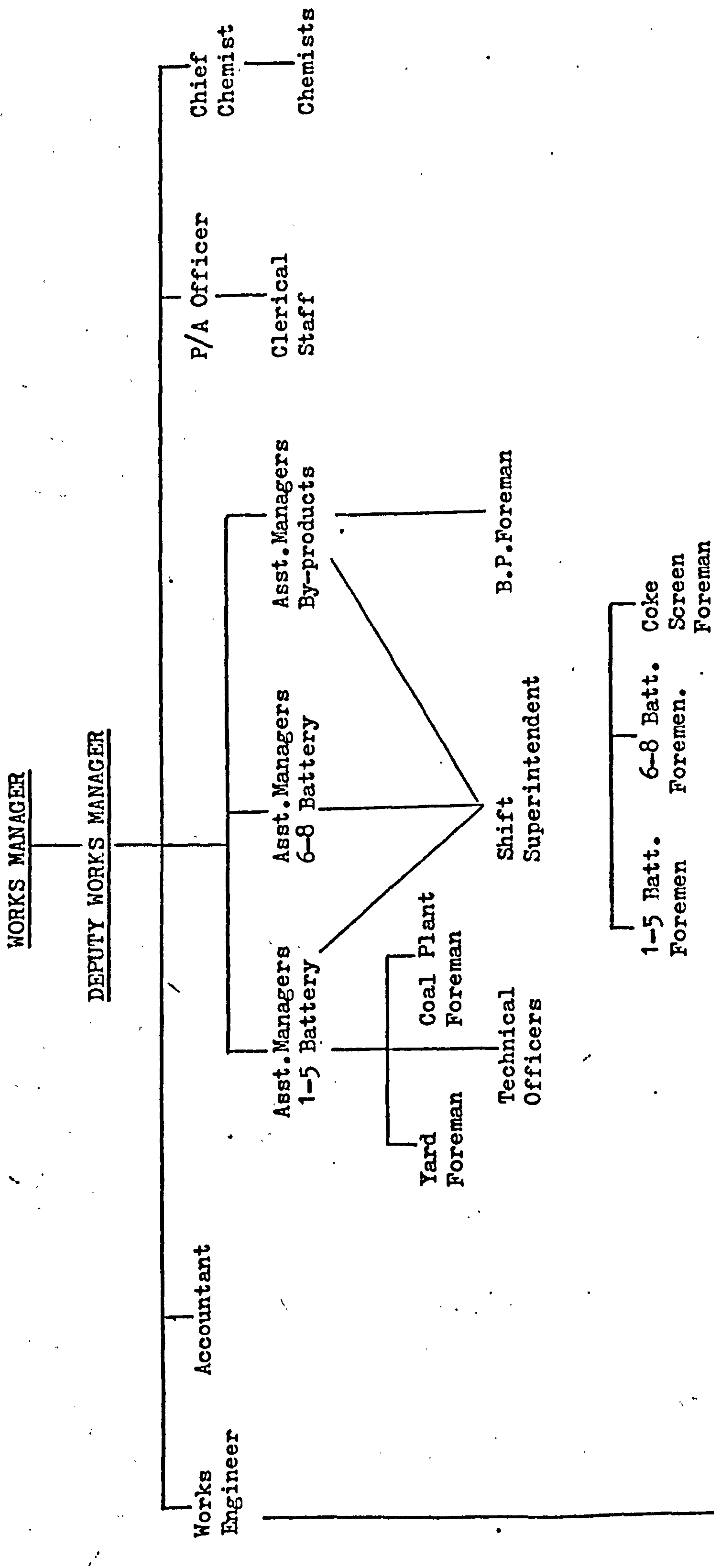


Many changes at plant level took place and figure 7 shows the final structure at Manvers in 1978 before 1 - 5 batteries were closed. Perhaps the most notable feature is the vast re-organisation of the engineering section under a works engineer and the inclusion of new posts of instrument engineer and planning engineer in recognition of sophistication. (67) Another important change was the creation of three new assistant manager posts, one for each set of ovens and one for the by-product plant. The acceptance in principle that such posts were necessary was acknowledgment of the fact that the former control between the coke oven manager and the shift manager was at best tenuous. Lower management was strengthened by the upgrading of chargehand posts and the creation of new foremen posts. What had changed on the plant to bring about such a radical alteration to the staff plan? The answer is that there hadn't been any change, simply a realisation of the hopelessness of the original scheme and pressure for improved operating techniques and better financial results, together with an awareness that only a considerable reinforcement of the management structure might lead to fulfilment of such objectives.

In retrospect the long delay in changing the management structure probably contributed to the demise of the plant, though marketing prospects must have had the greatest influence. Had the plant been maintained in better physical condition batteries 1 - 5 inclusive would not have been closed down in 1978. Neither would the declared intent of N.S.F. to cease their carbonisation activities at Manvers in 1980 have been made.

FIGURE 7.

LINE MANAGEMENT 1978 (69)



1978 Prior to closure of  
1-5 Battery.



### Avenue Carbonisation and Chemical Plant.

Historically Avenue is interesting because it is the latest plant to be built and it differs from all others; one feature of which is reflected in the title of the plant. It incorporates all the techniques and equipment which have proved satisfactory since the early part of the present century together with modern improvements to give a plant which was in tune with the requirements of the late 1950s. The following paragraphs show how post World War II attitudes to the coking industry were interpreted in this instance.

The integrated smokeless fuel and chemical plant is almost completely self-contained; in its original concept the only necessary raw materials were coal and a small amount of lime and soda. Later expansion of the chemical plant to include a factory for the production of damp course material under the trade name 'Hyload' in later years necessitated the purchase of some supplementary electricity from the East Midlands Electricity Board.

Avenue Carbonisation and Chemical Plant covers an area of 188 acres which was almost all agricultural land before site work began in 1951. It lies about 3 miles south of Chesterfield between the main railway line from London to Sheffield and the A.6 road linking Derby and Chesterfield and has access to the river Rother. In fact the parameters used for selecting the site are the same as those used for locating early collieries and coking plants. Some of the site already belonged to the National Coal Board and it included two disused mine shafts suitably sealed off.

The plant was designed specifically to supply fuel for the domestic market and the layout is such that its capacity could be doubled by adding additional batteries and ancillary plant but the option to extend has never been taken up. Provision for doubling capacity is a typical feature of many of the early coking plants and Rotherham Main Plant described in chapter VI is one example. The idea of building a plant solely to supply the domestic solid fuel market isn't new either, the first plant built to meet this need was Nunnery Handsworth in 1928 (71) Nunnery Handsworth had oven chambers only 14 inches wide and those at Avenue were 2 inches less than the normal width of 18 inches. The increase in chamber width must have been decided purely on economic grounds.

As well as being the last plant to be built Avenue is also the most expensive and cost £10 million. The contract was prestigious because it enabled the successful tenderer, the Woodall Duckham Company Ltd. to show how an integrated chemical works could be arranged on a green field site in the light of technological advances and changed market demands after World War II. A further incentive for the contractor, if any was needed, was that the successful tenderer would also receive contracts to build the East Midlands Divisional Carbonisation Department and the British Coke Research Association establishment.

Unlike other coking plants, the size of Avenue was not governed by the output of an adjacent colliery washery. The optimum size in relation to overall efficiency coupled with the local requirement for gas and the demand for solid smokeless fuel were therefore major controlling factors.



Avenue was in effect designed to replace the output from pre-war plants at Grassmoor, Harworth and Hardwick with some extra capacity. Since these plants had been built in the late 1920s increased size had become a means of counteracting higher operating costs and Avenue was designed to carbonise some 2,250 tons of coal per day. It is the only plant not to be built on the site of a working colliery and therefore extensive sidings were provided to accommodate the large amount of incoming coal as well as outgoing coke nuts. The coal was supplied from several local collieries.

It is interesting to observe that even though Avenue is a large post war carbonising and chemical plant built for the National Coal Board in 1957 and creating a new image for the industry, the link with the church had not been forgotten. The General Manager in charge of the East Midlands Division, of which Avenue was a part, had previously spent many years at the Grassmoor coking plant and he also had connections with the church. As a result of this local relationship the altar rails for the new church being built in the same parish of Wingerworth at the time, were made in the Avenue joiners' shop. Similar early links between the industry and the church are illustrated in detail in chapter VI describing Rotherham Main.

What features were incorporated in the plant as a result of experience to meet the demands of the 1960s and were they successful? Early in the 1950s increasing attention was being paid to the advantages of coal blending, primarily as a means of improving the characteristics of the resultant

coke, but also with an awareness that in the longer term there would be a shortage of coking coal. Coal blending had not been carried out to any great extent before nationalisation because coke ovens were designed to carbonise the output of coking coal from a particular colliery or, less frequently, from two or three collieries in the same group. Also, the industry was very fragmented and there was little point in buying an otherwise waste product from a rival colliery even if facilities for blending had existed. Perhaps the most important reason for the absence of coal blending was the failure to appreciate subtle differences in the characteristics of coking coal because of a lack of qualified and quantified data about it and the resultant coke. By way of proof of this statement one of the first tasks of the N.C.B. Scientific Department was to supersede the old and inadequate attempts to classify coal, e.g. Seyler's classification. The N.C.B. classification was rigorous and it came to be relied upon heavily.

Avenue is equipped with two rows of 9 concrete blending bunkers with a combined capacity of 20,000 tons of coal. Capital expenditure on blending was high but the principle was good. In the event coals have been drawn from such wide ranging sources that it is doubtful if the blending bunkers have ever been able to blend in the desired manner.

Initially coal for Avenue was drawn from local collieries in the traditional manner but the time had come when history could not be relied on to indicate the future pattern. On the one hand local collieries were approaching, if not



exceeding 100 years old and the coal seams were becoming exhausted. On the other hand the pattern of mining was changing, the age of underground mechanisation had arrived and thin coal seams could not be worked by machinery. Cost effectiveness in mining, as well as in industry generally was also beginning to take on a new meaning. As a result the N.C.B. started a large series of colliery closures soon after Avenue was built to eliminate uneconomic units and the original sources of coal supply for the plant vanished. There remains the unanswered question - ought not the colliery closures<sup>to</sup> have been foreseen and the carbonisation plant built nearer to collieries with a sure life in the foreseeable future? Coal is now transported up to 15 miles to the plant at freight charges whose magnitude could not have been anticipated in the 1950s. In view of the adverse cost of coal to Avenue it is unlikely that the plant will be rebuilt.

An important feature of the Woodall-Duckham Becker Combination underjet ovens is their arrangement in two batteries, each having 53 ovens and supplied from a service bunker located in between the batteries. The size of the batteries is very important because it represents the maximum number of ovens which can be served with one set of machines. This is the first time in the history of the coking industry that there has been any attempt to optimise the number of ovens in relation to the machines needed to service them. The policy is in direct contrast to the way Manvers was re-built and extended only 12 months earlier and where such optimisation was physically impossible.

For several years after World War II there was a shortage of towns gas and coking plants were an important supplier. On past experience therefore it was obvious that a set of gas producers would be incorporated in the Avenue scheme. In fact six gas producers were installed with the capacity to underfire one third of the 106 ovens and to dilute the purified gas so that it left the plant at the minimum calorific value specified in the gas contract. Even though gas producers had been used to underfire coke oven batteries since 1935 the technical problems had never really been solved by the time the demand for towns gas eased in the 1960s and the producers at Avenue were shut down. The sections describing Blackwell coking plant and Smithywood coking plant relate to other circumstances requiring the use of producer gas for underfiring purposes.

Avenue is the only plant owned by National Smokeless Fuels Ltd. to have a sulphuric acid plant. From the outset the intention was to make the plant as self contained as possible with respect to raw materials. The objective was a reasonable one but could it have ever become a commercial proposition? The intention was that the acid plant should burn spent oxide from the gas purification plant at Avenue as well as from those at Manvers and Glasshoughton, and in return these and other coking plants would use the sulphuric acid to produce ammonium sulphate. It was believed that if private acid manufacturers could operate successfully in this manner, so could the N.C.B. In the event this was an oversimplification and it ignored the fact that private sulphuric acid manufacturers had advantages which could not apply at Avenue; they could blend spent oxide which was low in sulphur with richer oxides, they had the advantage of



being able to operate on a larger scale and in general their haulage distances were smaller. In spite of these disadvantages Avenue had a sulphuric acid plant and every effort had to be made to try and make it remunerative.

One difficulty with the plant was that the sulphuric acid from it contained finely divided grey suspended solids which were not present in other commercial acids. These solids tended to discolour the ammonium sulphate and consequently the managers at Manvers, Glasshoughton and Smithywood tended to buy sulphuric acid on the open market. This could not be allowed to continue or the Avenue acid plant would have had to close down - these managers were instructed by the regional headquarters to give preference to the use of N.C.B. acid.

The Kachharoff sulphuric acid plant was installed by Simon-Carves Limited and the design was provided under licence by the Chemical Plant and Sulphur Extraction Company, London. It is one of two similar plants in this country, the other being at the South Eastern Gas Board Works at Phoenix Wharf. The Flixborough rotary burners were installed with the object of treating the spent oxide so that the resulting cinder, when mixed with peat and sawdust, could be used for re-charging in the oxide towers or boxes at Avenue and the other plants. The oxide burners were designed to burn spent oxide containing 46 - 48% sulphur because such a level of sulphur content was generally accepted by the sulphuric acid industry as being suitable for economic burning.

Coke ovens producing town gas for sale into the grid are charged in law with the responsibility for removing hydrogen sulphide in the sales gas down to a fine limit and at the time Avenue was built, and indeed up to the early 1970s the iron oxide process was the only one suitable for this task. Removing virtually all the hydrogen sulphide from the gas and at the same time producing a saleable by-product are not always compatible, particularly during periods of extreme weather conditions. Surplus gas from the plant is now sold direct to Glass Tubes and Components Limited, Lamp Caps Limited, Staveley Chemicals Limited and the B.S.C. Foundry at Staveley. (72). From time to time it is necessary to change the oxide in the towers prematurely to prevent fouling the sales gas and this adversely affects the economics of sulphuric acid production because the spent oxide is low in sulphur content. Spent oxide was sold to the acid industry on a sliding scale and at 42% sulphur content acid manufacturers were prepared to transport the oxide but not pay for it. Below 38% sulphur content they imposed a penalty for transporting it. These tower purifiers were sometimes overworked and this caused a decrease in efficiency. Since the termination of the gas contract with the East Midlands Gas Board the load on the towers decreased with a corresponding increase in the efficiency of conversion of iron oxide.

Operation of such a relatively small plant has not always been financially attractive and soon after the formation of Coal Products Division in 1963 considerations were given to closing down the plant in an attempt to increase the profitability of Avenue as a whole. However the plant continues in production to date despite an unanticipated threat to its



future in 1966 from the residents of Wingerworth. A side reaction to the production of sulphuric acid from spent oxide is the emission of dense brown fumes into the atmosphere and at Avenue they were discharged from a stack only about 30ft tall. One of the inhabited parts of Wingerworth lies on a hillside adjacent to the plant and rising some 200ft. or more above it. A local Action Committee met the Midlands Management Unit several times regarding the source of pollution and its effect on residential property; the outcome was that the height of the stack was doubled to 60ft - this satisfied the Action Committee but it did nothing to eliminate the pollution.

It is often true that high production rates and hence greater financial return are not usually compatible with reduced atmospheric pollution and in the case of the Avenue sulphuric acid plant, visible emission are often directly proportional to throughput. Consequently there have been times when it was prudent to cut back production. Possibly the most notable instance was during the visit by Lord Robens to open the adjacent Hyload Plant in 1969.

One reason why the plant is so often worked at high capacity is that it is subject to frequent breakdowns, another is that it undergoes an annual overhaul and in consequence there is almost perpetual striving to meet budget productions.

The rectification plant is mentioned because it differs markedly from the one at Manvers which was designed for a large throughput a year earlier. It was located in the main

by-product recovery section, rather than on its own, and it was designed for continuous throughput though the larger refinery was considered insufficiently large for continuous throughput. Evidently the size of both plants was borderline in relation to batch versus continuous distillation. Local preferences along with recommendations of the main contractor became overriding factors. The plant was shut down when the Staveley refinery was brought on stream in 1968 to process the entire crude benzole from N.C.B. and B.S.C. coking plants.

In the middle 1960s a benzole washer had been used for defronting crude benzole at a time when one of the ram side oven doors was removed from one of the ovens nearby, prior to discharging the coke. A spark from the oven ignited the crude benzole and the plume of smoke from the resultant fire was some three or four times taller than the 240ft. high coke oven chimneys. Because of the risks of a major fire at the rectification plant Avenue headed the list of fire brigade priorities and appliances from as far away as Matlock attended this incident. What might have been the largest and most disastrous fire in the history of the coking industry was therefore prevented from reaching proportions similar to those attained in the Flixborough disaster some 10 years later.

There is evidence to show that when Avenue was built only 12 months after Manvers the N.C.B. were much more aware of the problem of pollution from coking plants and the need to contain it. Opportunity was taken to reduce atmospheric



pollution during the charging of the ovens by incorporating two ascension pipes per oven whereas traditionally only one had been used. The additional expenditure on capital equipment enabled the hot gases to have two outlets from the oven and ideally half the gas from the chamber went up each ascension pipe thereby increasing the yield of by-products and reducing emission of smoke to the atmosphere. The ovens at Manvers are 3ft. long, 1ft 9 inches taller and 2 inches wider than those at Avenue and hold almost two tons more coal. It would therefore have been wise to incorporate two ascension pipes in the new ovens at that plant. The unanswered questions are - was there a difference of opinion between the two divisions on the merits of two ascension pipes per oven? If so why did headquarters fail to adjudicate?

Avenue staff pioneered sequential charging and the magnetic removal of oven lids; (72) the former was adopted gradually by other plants in the late 1960s and the latter was introduced elsewhere in the early and mid 1970s.

There was an awareness of the problems of effluent disposal when the plant was built and even though the effluent plant itself was a failure, it should be remembered that the chemical plant was attempting to come to terms with effluent treatment in a bold way when other plants were doing little or nothing about the problem. The Permutit Company designed an ion exchange plant based on experience gained from a pilot plant at the Corby works of Stewarts and Lloyds Limited. The ion exchange pilot plant was later augmented with an active carbon plant for the removal of higher tar acids and phenols remaining after treatment by the ion exchange process.

The intention at Avenue was not only to remove thiocyanates and phenols from the effluent but also to ensure that maximum volumes of ammonia, hydrochloric acid and benzole were recovered and distilled for further use. This fits in with the overriding desire to have a very efficient chemical plant but in retrospect the scheme was probably too ambitious. In the event the plant was abandoned within two years of start-up in favour of the much simpler system of percolation through a disused and biologically active colliery spoil heap. The latter system was becoming widely adopted because it was effective, simple to operate and required minimal supervision. Conflicting interests of technical desirability and the economics of successful operation were coming to the fore.

### Glasshoughton Coking Plant

#### Introduction

A coking plant has existed on the same site at Glasshoughton in North Yorkshire for over half a century. Like other coking plants built from 1910 onwards the main objective was to utilise the small coking coal mined by the Glasshoughton Colliery but, like some of the other plants built at about the same time in Yorkshire and Derbyshire, it was not in close proximity to its competitors. Glasshoughton was the most northerly coking plant in Yorkshire, but other coking plants further north existed in the Northumberland and Durham coalfields. The plant was situated almost mid-way between Pontefract and Castleford and it was the nearest coking plant to Leeds. The location must have



been a considerable advantage in the early days, not only because of the proximity of a large industrial market for its products, but because of an abundant supply of local labour. There were many other collieries in the area such as Whitwood, Wheldale, West Riding, Fryston and Prince of Wales, though none of them had coking plants. (73)

Bearing in mind the date of the coking plant the design was primitive compared with those built in the late 1920s and it was particularly labour intensive. Some 600 men were required to operate the plant and probably as many men were also employed at the colliery. The plant had some features which attracted the attention of the technical press at a time when the use of electricity in industry was making tremendous progress. (74)

The first battery of 60 ovens was built by the Koppers Coke Oven Company for the Yorkshire Coking and Chemical Company at Castleford, Yorkshire in 1915 and 60 more ovens were added the following year. (75) It is not known whether this company was cautious or not in respect of its venture into coke production but evidently it was well satisfied with the first two batteries, because another 20 ovens were added by building 10 ovens onto the end of each of the existing batteries in 1917. Perhaps cautious optimism can best describe the attitude because the by-product plant was designed to cope with the output from 140 ovens at the outset.

### Use of silica bricks. (76)

The coke oven batteries built at Glasshoughton were the first batteries in this country to be constructed with silica bricks. The use of silica brought about a significant advance in coke oven technology and it marked a turning point in the economics of the industry. Hitherto battery temperatures had to be kept well below the softening point of firebrick or semi-silica brick used in the construction of ovens. The use of silica enabled the working temperature of the flues to be increased and this had a twofold effect; it enabled throughput to be increased and it also produced a harder coke.(77)

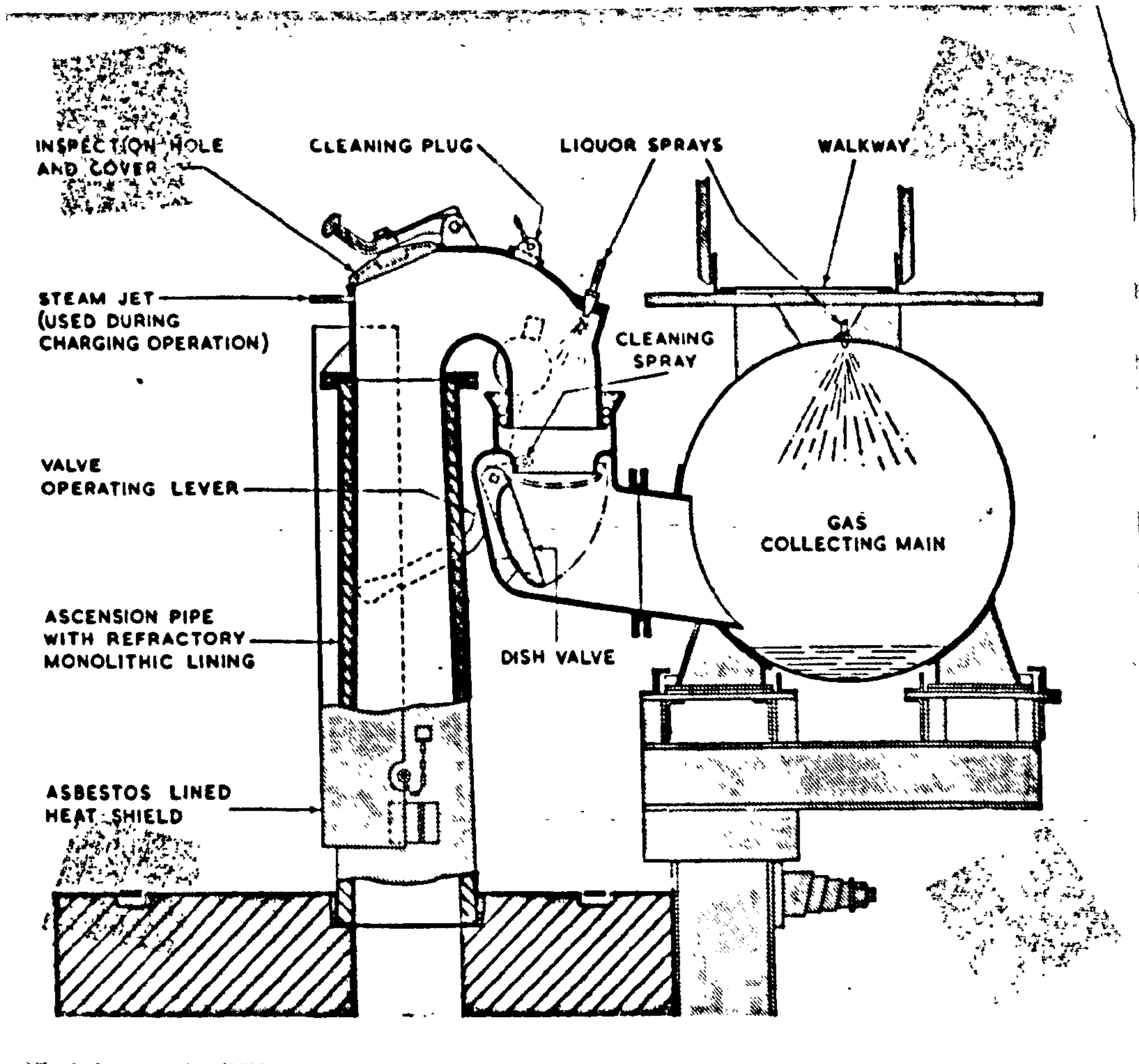
Did the use of silica as a material of construction in coke ovens gain popularity rapidly? When the first battery of silica ovens was built considerable doubt was expressed about its ability to withstand attack from the notoriously salty Yorkshire coals. The success at Glasshoughton, in spite of a total salt content of the coal of 0.3% meant that all future batteries would be built with silica bricks. Hitherto it had been believed that salt attack was brought about by the reaction of sodium and potassium chlorides because some ovens, built during the first World War and constructed of 82% silica, were badly attacked and had to be rebuilt after only 7 months' service. The Glasshoughton battery contained 95% silica and after eight years service salt corrosion was not detected.

In retrospect high moisture content of the coal has been found to cause damage to silica brickwork though this does not appear to have been considered during World War I,



Fig 7a.

Ascension Pipe and Liquor Sprays



let alone understood. When Cortonwood Coking Plant closed down on 31st March 1960 the lower courses of oven brickwork were found to be seriously damaged by moisture combined with chlorides present because of the overflow of ammonia liquor into the chambers from the ascension pipes. Excessive moisture alone causes silica brickwork deterioration and moisture in the presence of chlorides is even more harmful. At plants where coal moisture is controlled to 10 - 12% no harm is caused by the presence of salt. Numerous plants bear testimony to this statement but the long life of Rotherham Main provides the most impressive evidence.

Early scepticism about the use of silica instead of firebrick and the normal life-span of a coke oven battery of about 25 years meant that, even after silica had become accepted its use was slow to spread in the industry.

Since Glasshoughton was the first plant to use silica it is worthwhile to make comparisons with some of the other plants described in the chapter. The data given in figure 8 is disturbing in some respects. For a plant carbonising almost 1,000 tons of coal per day and two or three times larger than all other plants built for more than a decade afterwards, except Smithywood which was about the same size, the fact that 9 ovens were out of service only 7 years from the start-up suggests that serious problems existed. The long coking time contributed towards the low benzole yield.



FIGURE 8

Production Data for June 1923. (78)

Coal carbonised	25,623 tons
Average number of ovens in operation.	131
Coking time	29.9 hours
Yield of coke	66.86%
Yield of breeze	4.45%
Yield of tar	3.45%
Yield of ammonium sulphate	1.31%
Yield of benzole	2.81 gal/ton

The carbonising time at Glasshoughton is worth comparing with those obtained from some other plants during the first half of the present century. The Holmewood plant in 1910 and constructed of firebrick had a carbonising time of 50 hours. Rotherham Main had a coking time of 19 hours in 1928, Manvers coking time was 16 hours in 1933 and Holmewood coking time was  $15\frac{1}{4}$  hours in 1934. It can be seen that for the three other plants having silica ovens a carbonising rate of about one inch per hour had become established. There is no reason to believe that the width of the Glasshoughton ovens were any wider than 18 inches and the question of the apparently excessive coking time needs answering. One possible answer could be due to an element of caution in increasing the flue temperature above that accepted for firebrick, another reason could simply be a shortage of coke orders or a third might have been a temporary shortfall in the supply of coking coal from the adjacent colliery company.

#### Cost of Coal.

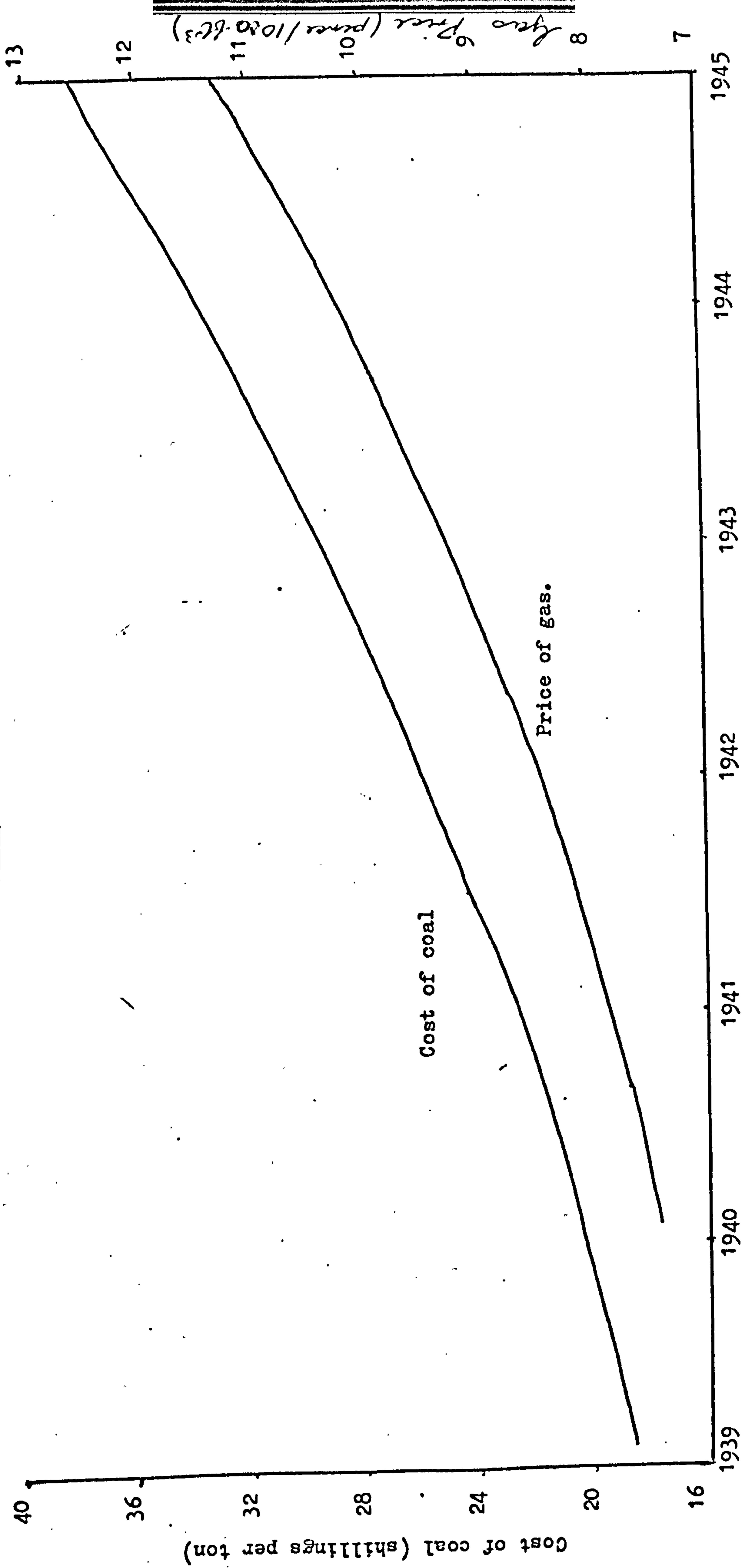
Coal is by far the most expensive raw material used on any coking plant and figure 9 shows the trend in coal prices and the price of gas throughout World War II. In a period of six years the cost of coking coal for the plant more than doubled but the revenue received for the gas for the same period increased at a slightly slower rate. Evidently the company expected coal prices to rise because the plant was extensively modernised in 1928 with the object of using venture capital to reduce revenue expenditure. Extrapolation of the gas and coal price trends, coupled with an ageing plant and a



FIGURE 9

Cost of Yorkshire Coal and the Price of Gas

1939 - 1945. (79)



large coke market in the Leeds, Huddersfield and Bradford area provided incentive for the plant to be rebuilt to modern standards in 1958.

### The Rebuild

Early in 1950 the National Coal Board realised that the plant, and the batteries in particular, had reached the end of its economic life; in fact it had probably reached this stage 10 years earlier but a lack of money in the industry and the prospect of nationalisation must almost certainly have delayed the renewal.

In the 1950s the National Coal Board undertook a modernisation and rationalisation programme and the rebuilding of Glasshoughton formed part of the plan. A total 42 ovens in two batteries (80) were built by the Woodall Duckham Company, the successor to the Koppers Company, in 1958. The ovens were built on the centre line of the old batteries but independent of them. This proved to have been an important decision when the new wooden quenching station was blown down by freak gales in 1962, because the old quenching station at the opposite end of the coke car track was used temporarily. The old batteries had been demolished but quite fortuitously the brick quenching tower and the coke car track to it remained in tact.

If Glasshoughton was to be rebuilt capital expenditure on new batteries, oven machines, as well as a new chimney, quenching station and coke wharf were unavoidable. The new ovens were large and held a charge weight of 18 tons,



demonstrating an awareness of capital expenditure in relation to throughput but it did not go far enough. Ram side and coke side benches departed from traditional practice by being constructed about 1 metre below oven sole level. This enabled handrails to be fitted on both benches without interfering with the movement of the ram beam into or out of the oven and the operation of the coke guide. Hitherto none of the older plants had been so equipped and numerous accidents involving operators falling 7 metres to ground level have happened during the life of slot-type ovens. The intentions were sound but the lower bench level and taller oven doors which required to be slackened and tightened with long spanners caused other problems, including accidents. For technical reasons each oven door has two latch bars, one at the top and the other at the bottom and it is difficult to see why they were not operated by electric motors especially as electric motors were used to slacken the oven doors at Manvers and Avenue Coking Plants when they were built at the same time. The top and bottom spanners were 4 metres and 1 metre long respectively and intended to be operated by one man. The long spanner was so heavy that in practice two men handled it until a protest to management enabled the steel spanners to be replaced by aluminium spanners with steel heads; thereafter one man handled the spanner albeit with difficulty. Such clumsy equipment was not conducive to good coking plant practice and accidents with the lighter spanners continued but with less frequency.

Regular failure to tighten the doors properly caused leakage of gas which ignited at the door frames, and later in the carbonisation cycle air was drawn into the oven chambers through the badly fitting door seals. As a result destruction of up to three flues at the coke side and the ram side of the oven became commonplace. The situation was aggravated by the failure of the operators to clean the seals on the tall doors each time they were removed; instead they opted for the malpractice of spot quenching the door fires until it became the accepted way of dealing with the problem. The impact of cold water on the hot cast iron door frames often caused them to crack which in turn led to more fires and more spot quenching. The technique of metal stitching(81) was carried out on the damaged frames but within a few months they had to be replaced. The task of replacing door frames was very expensive, not only because of the high cost of the casting itself but also because of the cost of hire of a large mobile crane and the loss of throughput from the affected oven and adjacent ovens. The situation nearly went out of control when replacement frames were subjected to the same misuse and they in turn had to be replaced. Management at the plant attracted unfavourable criticism because of the high cost of this remedial work which was considered in some quarters to be unnecessary.

The same malpractice of spot quenching was also well established on the 71 side ovens at Manvers and it was becoming more widely used on the 66 side ovens built at the same time as the ovens at Glasshoughton. Glasshoughton management were aware that the management at Manvers were



not subjected to the same internal criticism as themselves though by this time both plants were directly responsible to the same General Manager. Why did this state of affairs exist? Undoubtedly one answer lies in the relative lengths of time over which the malpractices had developed. Another answer lies in the fact that Glasshoughton had been involved with a heavy oven repair programme because of the unsound ovens and the capital expenditure alone attracted unfavourable criticism; on top of this some of the renewed door frames had cracked, leading to an untenable situation. On first examination the criticisms appear to be justified but could management have been so bad? Accepting that there had been failures on the part of the managements at Glasshoughton and Manvers there were important differences between the plants which militated in favour of Glasshoughton. Glasshoughton management had for a long time claimed that their door frames were inferior though this view was not supported by the Management Unit. Eventually the local theory was put to the test and a small sample of metal was taken from each frame and sent to an independent analyst. It was proved conclusively that very nearly all the 84 door frame castings were below specification for grey cast iron in a way which would upset their resistance to thermal shock. Coupled with this the door frames were much larger than those at Manvers and this did not help; it is probable that had the same inferior grey cast iron been used in the construction of the smaller frames at Manvers the effect would not have been so dramatic. Discovery of the faulty material came far too late for the matter to be taken up with the main contractor, Woodall Duckham Company but the question of whether inspection

of materials by the contractor and by the N.C.B. overseeing the rebuild was sufficiently rigorous is very doubtful. From the time the defective specifications were proved, the main contractor kept a careful check on the quality of replacement door frames from the same foundry and they all met the specification. The frames were ordered through Woodall Duckham and Co.Ltd. because they had retained the drawings. If they had been ordered direct from a foundry the cost would have been much less than the £500 charged by Woodall Duckham Ltd.

The ingress of air into the oven chambers towards the end of the carbonising cycle had a tremendous effect on the batteries and therefore it is worthwhile to say more about this state of affairs. The principal reason for the situation was the one which was instrumental in bringing about the cracked door frames - unwillingness of the operators to clean the door seals and the frames each time the doors were removed in readiness for the discharge of an oven. Why were the operators not prepared to carry out cleaning duties which were traditionally accepted at other plants? There are several answers to this question and no specific reason was wholly responsible. In chronological order, the first contributory factor was the inability to attract good quality labour in the 1950s and 1960s because comparable rates of pay could be obtained from many other industries in the Pontefract, Castleford and Leeds areas which were more acceptable to the work force. By custom and practice every new employee was engaged as a yard labourer in the first instance but he had to undergo six weeks compulsory oven



training; thereafter he was required to 'fill in' on the ovens and then become an oven operator before progressing to more pleasant, and in some respects, more responsible jobs on the by-product plant. Glasshoughton was in a dilemma from the time the new battery was commissioned because throughput targets had to be met regardless of the shortage of labour. How was this objective achieved? The only way throughput could be maintained was to allow men to work excessive overtime; this in itself was a hazard and management were forced into the situation of hoping that a short term solution would provide long term remedy. The men became blasé with the routine of long hours and sought a partial solution by taking short cuts with their work and, because of the need to retain shift cover, management were unable to do anything about it. What were the short cuts which later brought tremendous heartache and proved to be extremely expensive? The ram side and coke side door men stopped cleaning the doors and frames unless the shift foreman stood over them and they sometimes failed to tighten the doors properly on the grounds that a 4 metre long spanner was not conducive to good workmanship. Likewise oven top men were slipshod in sweeping coal into the chargeholes after each oven had been charged and they did not clean the ascension pipe necks properly so the gas evolved during the carbonisation cycle could not escape freely.

It can be said that the bad operating conditions which became a source of contention between the men and management on numerous occasions were created by the men themselves. Headquarters staff were anxious that maximum throughput should be maintained but they were equally anxious that atmospheric

pollution should be minimal.

This coking plant bounded Pontefract race course and it was close to Pontefract golf course. For local government purposes the plant was inside the Castleford borough boundary and in the 1960s the Castleford public health inspector was responsible for atmospheric pollution from the plant. By coincidence the public health inspector played golf at Pontefract frequently and from this vantage point he was able to observe the atmospheric emissions and duly report them to the council. In defence of accusations about atmospheric pollution plant management pointed out that they were alternately asking the men for maximum throughput and granting excessive overtime and then asking that the oven jobs be carried out properly when throughput was less important. Headquarters refused to listen with much sympathy to such conflicting demands because they too were being subjected to similar pressures. The seeds of friction between management and workmen had been sown and this disadvantage was never fully overcome.

An important side effect was the progressive deterioration of the oven brickwork adjacent to the oven doors, often for a depth of 3 or 4 flues into the chamber. The situation was so serious and quite unparalleled in this country that the main contractor brought a team of specialists from Germany to repair the most badly damaged oven. Plant management were unhappy with the high cost of this repair and the traditional attitude of self help determined that all future repairs should be carried out by the plant's own bricklayers and fitters.



Both bricklayers and fitters had seen the use of outside labour as a possible erosion of their own security and as a means of limiting potential overtime earnings. The men enjoyed the challenge of carrying out work which in the first instance could supposedly only be carried out by the Germans. In time the labour force became proficient in carrying out extensive oven repairs with minimum interruption to throughput from the remaining ovens. Their methods aroused considerable interest in the coking industry and the techniques used formed the basis of the first technical paper to be presented to a large audience of the Midland Section of the Coke Oven Managers' Association at the University of Sheffield in 1972. (82)

In fairness it must be pointed out that not all the silica failures were due to the ingress of air into the oven chambers, although some headquarters staff would have liked this to have been the case. Soon after warming up the new oven batteries, cracks appeared in some oven chambers but they did not attract much attention in 1958-9 and attracted still less attention when the origin of some failures was expressed by plant management in the early 1970s. The oversight was made more widely known when mounting costs of repairs at the plant were attracting adverse comment from headquarters staff, some of whom had earlier held overall responsibility for the Glasshoughton rebuild. It became clear that presence of cracks in the early days indicated that the oven brickwork was not all it should have been, neither was the site supervision during the battery reconstruction. Perhaps the validity of this statement is best supported by the failure of some people to recognise

the symptoms some 12 or 13 years later when the situation became very serious.

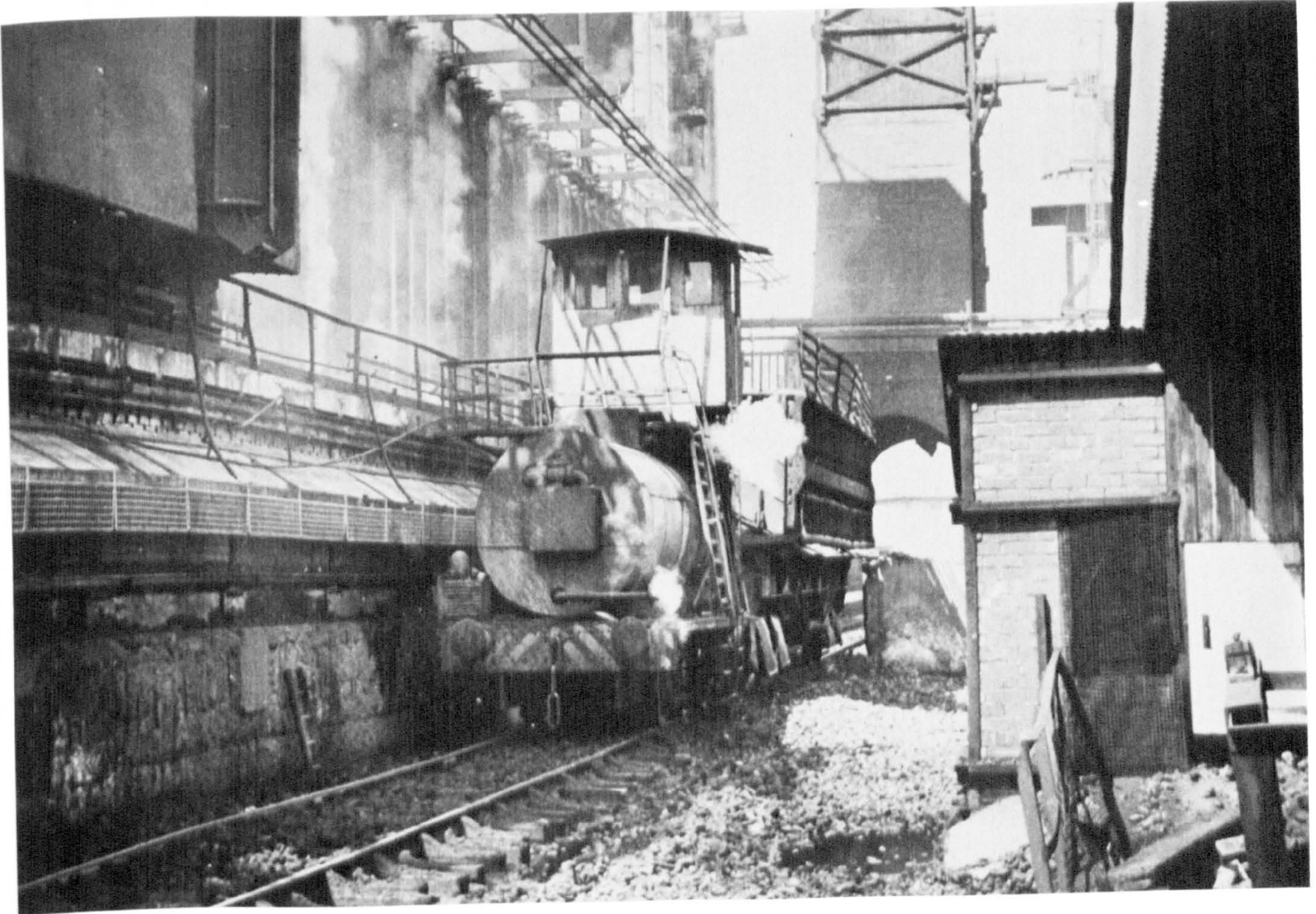
The new batteries included a complete set of oven machines, a new chimney and a quenching station, because the new ovens were much larger than the ones they replaced and in any case all the old equipment was obsolete. A novel feature, unique to the coking industry, was the use of a fireless locomotive built by Robert Stevenson and Hawthorns to haul the coke car, as shown in figure 10. At the time Glasshoughton was rebuilt safety in industry was gaining importance and the coking industry was no exception. A high incidence of lost working days through industrial accidents, coupled with acceptance of the welfare state caused some of the dangerous situations to be examined with a view to reducing industrial injury and consequent absenteeism. There had been several serious injuries and fatalities caused by people falling off the coke side bench and being electrocuted by the power conductors for the electric coke car. It has already been stated that Glasshoughton benches were designed to be fitted with handrails and this should have been enough, though perhaps there was evidence of people being electrocuted while working near to the coke car track.

In the event a fireless locomotive appeared to provide the ideal solution. Several other organisations operated such locomotives, including English China Clay Ltd. at Plympton in South Devon, the Skinningrove Iron Company Ltd. in the North Riding of Yorkshire, the C.E.G.B. at Castle Meads Power Station in Gloucester and Reed's Empire Paper Mills at Greenhithe.



FIGURE 10

Fireless locomotive and coke car  
proceeding towards the quenching station. (83)





A similar locomotive had existed in Germany for a long time but British builders were unable to copy the fireless locomotive's method of propulsion until World War I when the Germans naturally were unable to enforce their patent rights. (84)

In retrospect much broader vision would have shown that using steampower instead of electrical energy would not eliminate other accidents on the coke car track and the problem needed to be tackled quite differently. For instance, the use of an electric locomotive with an overhead pantograph similar to the one in existence at Cortonwood Coking Plant would have provided a better solution. When Glasshoughton was rebuilt a similar fireless locomotive had just started duties at Manvers refinery where it was essential to have a safe form of propulsion in a flame-proof area. The unanswered questions are - had diesel propulsion been considered, and if so why had it failed to be adopted?

Experience in operating the fireless locomotive at Glasshoughton was most unfavourable; it was difficult to control precisely and the cost of maintenance was high. An unforeseen problem was caused by a perpetual shortage of steam at the plant with consequent lower boiler pressure. This meant that the fireless locomotive had to be recharged with steam twice per shift instead of the planned rate of once at the end of each shift. The re-charging process lasted about an hour and it gave rise to an irregular pushing schedule, lost throughput, and contributed to a lack of discipline with oven operators which grew in magnitude as



time went by. While the locomotive was being replenished with steam the oven operators had an extended tea break and an indifferent attitude developed. The operators were well aware that a cardinal rule of good coke oven practice is that ovens should be pushed and charged to a strict schedule. Nevertheless at Glasshoughton each shift finished half an hour early and started correspondingly late with a one hour interval mid way through the shift so that the locomotive could be re-charged. As if this wasn't enough, the locomotive had to travel much greater distances to the old quenching station after the new one had blown down in 1962 and so an extra break for re-charging with steam became even more essential. The net result was the oven pushing schedule decreased in importance and ultimately the labour problems increased. Why was this situation allowed to develop? The answer is bound up with a series of complex circumstances and other problems at the plant were bound up with the oven problem. For instance why was there a permanent shortage of steam? If the steam pressure could be increased the fireless locomotive ought to achieve its design capacity and run for a full shift before being re-charged. Regardless of the merits of this locomotive under normal operating conditions it ought to have been replaced by a conventional steam locomotive for the 18 month period while the quenching tower was being rebuilt.

As the mechanical components of the fireless locomotive wore the performance of the machine decreased and it was not unusual for the pistons to be locked on dead centre at start-up; the remedy was to prize the rail wheels with a long steel bar until the locomotive moved slightly to change

the dead centre position of the linkage. The frequency of the wheels locking increased and on one occasion when the locomotive was being prized along the track by the driver with the regulator slightly open, it ran out of control and demolished the buffers at the end of the track.

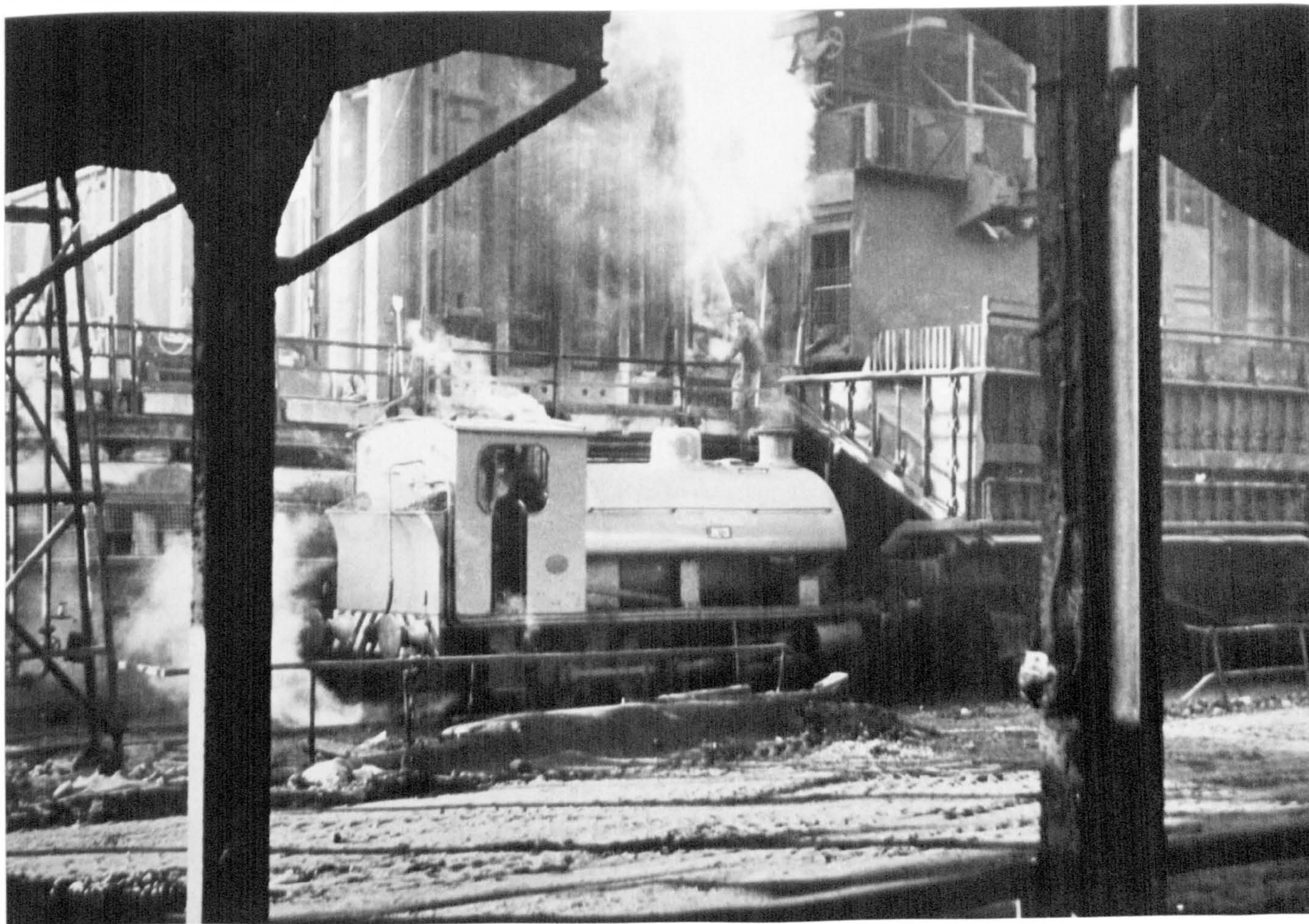
Another incident which was not due to the mechanical operation of the locomotive involved the premature discharge of coke from an oven at the moment when the locomotive was passing. The intense heat from the red hot coke which fell onto the elevated cab damaged the aluminium cladding which had been used to minimise the weight. If the driver had not jumped from the machine in time he would have been cremated. The aluminium sides of the locomotive cab were later rebuilt with steel sheets.

High cost of maintaining the fireless locomotive, its unsuitability for the duty required, together with other inter-related problems and the above mentioned incidents led to the fireless locomotive being replaced by a conventional electric locomotive in 1969. Why did eleven years elapse before this change was made? There was some dogmatism between local management and divisional headquarters and eventually the manager was transferred. The new manager, E. Morgan, was well respected and he was more able to influence headquarters towards his point of view. Another factor was the longer the fireless locomotive was tolerated without any improvement in performance, whatever the reason, the more damage was being done directly or indirectly to the plant as a whole. Figure 11 shows an alternative form of propulsion when the fireless locomotive was withdrawn. This temporary



FIGURE 11

Shunting engine modified  
for temporary service with the coke car. (86)





source of motive power was traditional at all coking plants whenever the electric locomotive was out of service.

#### By-Product Plant Rebuild in 1958.

Replacement of the batteries and the oven machines was essential but it was different with the by-product plant. At Glasshoughton, which, like Manvers formed part of the North Eastern Division of the N.C.B., there was a very definite attempt to minimise capital expenditure, (85) but in retrospect all the apparent savings on the by-product plant were unwise. In broad terms as much of the old by-product plant as possible was retained though even at the time its obsolescence must have been apparent. It is almost inconceivable that after the turn of the mid 20th century a major capital expenditure programme could be considered without making provision for roads and drains. In the event the roads and drains were provided a few years later and at increased cost.

It has already been mentioned with respect to plants built around the 1920s that the merits of semi-direct versus indirect ammonia recovery often depended on local conditions and in 1958 that situation was still true. The early plant at Glasshoughton had a semi-direct ammonia recovery system but by 1958 it was in such poor condition that it had to be replaced. This time the indirect system was chosen. The plant was bedevilled by low ammonia recovery from the time it was commissioned because of insufficient capital expenditure and this had a marked effect on the rest of the by-product plant. One major cause of low recovery was due



to the retention of the original two preliminary gas coolers and the five primary gas coolers which were fifty years old and designed for a plant having a smaller capacity. They proved to be quite inadequate for cooling a daily gas load of eleven million cubic feet per day. A design fault was not necessarily the case because the tubes were never brushed so the coolers were always inefficient. The reason put forward for the lack of cleaning was the fact that yard labourers were tied up with other jobs which should not have been necessary.

In the mid 1960s experiments with cleaning the coolers on a regular cycle showed that while a cooler was out of service the temperature of the gas leaving the other coolers actually increased, the objective was therefore self defeating. Also, age alone brought frequent leakage from the tubes and this overloaded the ammonia still and aggravated the effluent problem. Towards the end of the 1960s three new primary coolers were purchased at a cost of some £30,000 and these proved to be quite satisfactory. This solved the cooling problem but it did nothing to increase the yield of ammonia because only one ammonia still was available for the new plant and during annual shut down for cleaning, ammonia liquor flowed to waste. Historically this is the only plant not to have two ammonia stills from the outset although thirty years earlier a standby still was considered essential. In the 1960s a second hand still was obtained from Grassmoor coking plant in Derbyshire and this solved the liquor effluent problem. The Rivers Board were concerned about the quality of the effluent leaving the plant and this most

certainly hastened the installation of a still which was built in the 1930s and had been available since the closure of Grassmoor early in the 1960s. Another shortcoming was that only one saturator was provided when traditionally two were the norm. Although the saturator was not taken out of service regularly, when it did undergo maintenance another source of effluent contamination occurred. Of course there were idealists at headquarters who claimed that if the ammonia plant was run properly the storage system should be adequate to retain the liquor for periods of maintenance and they were probably right. The reality was quite different because the gas was too hot and required extra water on the ammonia washers so that extra liquor was produced, primary coolers leaked and produced more extra liquor. The arrangement for liming the liquor had not been modernised so it was quite inefficient by modern standards not contributed to extra shut downs of the ammonia still when, at all other plants the spare still would have been used. Likewise, at any other plant the spare saturator would have been used wherever the need arose. The situation had become impossible and eventually the Rotherham Main saturator was transferred to the plant in the late 1960s. The capacity was only 7 tons of ammonium sulphate per day whereas the required capacity was 9 tons per day and it was only good fortune which prevented the small saturator ever being used for long periods. By the same token a spare centrifuge was eventually provided and a modern liming plant was installed. All this expenditure came far too late to be effective.



All the effluent from the ammonia stills was pumped to the Glasshoughton Colliery tip until the middle 1960s when tip stability gained importance following the disaster at Aberfan in 1966. (87) The local tip was considered unsuitable to receive effluent because of its height and proximity to a British rail main line. Another reason was that the colliery wanted to sell the red shale for motorway construction. The outcome was that a new effluent line some 3 miles long was laid to the burned out tip at Ackton Hall colliery so that the pumped effluent could percolate through the tip and then find its way to a stream. The changeover was carried out with such haste that during the months the pipeline was being laid, road tankers were hired on a continuous basis to transport the effluent by road to Ackton Hall where it was then pumped a short distance to the lagoons. Also round the clock supervision was carried out at Ackton Hall for many months because of the remoteness of the lagoons from the plant and the risk of them being overfilled. During the early days there had been the death of a child by drowning in one lagoon and continuous supervision was a pre-requisite safety precaution until they could be adequately fenced. Such drastic measures not only had practical difficulties, they were also extremely expensive. The unanswered question is - could the high capital and revenue expenditure have been reduced or perhaps avoided?

One other important side effect of having a high ammonia slip was the excessive corrosion of the mild steel rich oil heaters at the crude benzole plant. Rather than face the problem of ammonia slip head on Simon Carves cast iron heaters, which were much more resistant to attack from

ammonia, were obtained from the closed down plants at Rotherham Main, Dalton Main and Nunnery Handsworth. All these heaters were about thirty years old but they were in good condition when they reached Glasshoughton in the 1960s and under normal conditions they would have lasted another 50 years. Glasshoughton plant was not normal and it was found that even cast iron could not withstand the corrosive conditions; daily plant shut downs resulted so that the cast iron heater tubes could be replaced. The normal frequency of shut down is annually for cleaning the tubes - the tubes usually have an almost indefinite life. When the stock of spare tubes had been used a situation was reached where new tubes could not be obtained fast enough to keep up with the failure rate. This was disastrous because of the loss of crude benzole, the fact that two fitters were permanently tied up with this maintenance, and excessive steam consumption.

#### Boiler Plant

Glasshoughton was unfortunate in the fact that the original plant was supplied with steam from Lancashire boilers. Lancashire boilers were traditional sources of steam for colliery winding engines because their outstanding merit was an ability to cope with intermittent high steam demand; poor efficiency took second place under these circumstances. In contrast, coke ovens have a fairly uniform steam demand so efficiency is more important than rapid steam raising capability. Perhaps the idea of free coal for the boilers when the first plant was built drew attention to the need for obtaining cheap boilers. There is no direct mention of



boiler efficiency in the coking industry literature though later plants invariably had water-tube boilers.

When the plant was rebuilt in 1958 it was easy to save capital and leave the existing boilers. Within 10 years the cost of steam raising in general became important and the cost at Glasshoughton was much higher than elsewhere. What were the reasons for this? These were the only Lancashire boilers in the N.E. Divisional Carbonisation Department and their operating costs would never compare with those of water-tube boilers at other coking plants. Furthermore the Lancashire boilers were badly maintained and they were hand fired. Eventually chain grate stokers were fitted but these did nothing to reduce the manpower in the boiler plant because the coal hopper to each boiler had to be continually filled by hand. Installing chain grate stokers was not enough; it would have been much better to look at the scheme from the point of view of reducing manpower as well as increasing efficiency.

It is doubtful if any of the staff at the plant understood the principles of combustion and if they did they failed to apply them. The net result was that the chain grates broke down frequently and contributed to a low working steam pressure. Excessive demand by the fireless locomotive the benzole plant heaters, and the retention of the original steam driven oil circulation pumps long after other plants had installed electrically driven pumps, meant that the boiler plant was always overloaded. A portable gas fired boiler was purchased but this failed to improve the situation because often there was insufficient spare gas to burn on the boiler.

The N.C.B. were contributors to National Industrial Fuel Efficiency Service (N.I.F.E.S.) *who* were brought in to examine first the steam demand situation, and then the steam raising capacity. Numerous steam users were metered and the final recommendation was that all intermittent steam ejectors and the steam pumps should be replaced with electric pumps and that extensive insulation of the steam ranges should be carried out. Estimated financial savings were given but the report was not implemented with vigour. Instead piecemeal implementation was carried out over a period of years and the N.I.F.E.S. recommendations were never really checked against their indicated financial savings. The attitude at the plant centred on conserving steam to increase the supply pressure.

Steam pressure remained at an unacceptably low level and several years later N.I.F.E.S. were requested to examine the efficiency of the steam raising plant. Output from each boiler was metered and calculations showed none of them were more than 45 per cent efficient. The recommendation to install superheaters to those boilers which did not already have them were carried out and some technical recommendations were implemented. Manpower in the boiler plant was reduced drastically by installing mechanical coal feeder for each boiler and automatic ash removal equipment.

Termination of the gas contract with the North Eastern Gas Board in 1976 was a natural development of the extension of the use of North Sea Gas and it meant that the plant had to find new outlets for some 7 million cu.ft. of coke oven gas per day. Jackson's glassworks at Castleford agreed to take a considerable proportion of the gas from the beginning of



1976 at a price which was sufficiently attractive to prevent them using the alternative North Sea Gas. Almost simultaneously with this contract two gas fired water-tube boilers each having a capacity of 18,000 lb. steam per hour were built at a cost of £110,000 to use the rest of the surplus gas. (88) In consequence most of the Lancashire boilers were shut down but two were retained as stand-by along with the economic boiler.

#### Gas Purification

Box purifiers were installed early in the life of the old plant when the contract to supply the North Eastern Gas Board with some five million cu.ft. of gas per day was made. These boxes, like those at other coking plants in the 1930s onwards were discharged and re-charged by plant labour. Glasshoughton developed a system of contract labour which was cheap to operate yet sufficiently attractive to the team of contract labourers drawn from the rest of the plant on their 'rest days'. The captain of the team selected the men he wanted and as a result the team became elitist; every man had to be very fit and willing to work hard because the self set target was to empty and refill each box in the minimum time. The contract team remained almost unchanged year after year because those who were initially selected for it received first options thereafter.

#### Coal Washery

This plant was unusual insofar as it was the only plant which vested in the N.C.B. to have a coal washery. (89)

When the coking plant was rebuilt in 1958 the washery was modernised. It proved invaluable in later years as a means of preserving the life of the plant because the coke oven manager had control over the quality of the washed coal delivered into the service bunker and this gave him extra freedom to buy the cheaper raw coals. Originally the washery was built to wash raw coking coal transferred from Glasshoughton colliery by internal rail wagons, but a change in marketing policy by the N.C.B. meant that an increasing proportion of this coal was diverted instead for use in Yorkshire power stations. Towards the end of the life of the plant the washery became uneconomic because raw coal was having to be imported greater distances due to the need of the N.C.B. to sell local raw coal for power station use. Eventually the washery was closed and the plant lost its competitive edge regarding the supply of suitable coking slack.

#### General Review of the Pattern of Development.

##### Pioneers

Towards the end of the nineteenth century the effects of an on-going Industrial Revolution were very much in evidence. Demand for coal was increasing because of the growth of the iron and steel industry, and advantages of steam power over other less reliable forms of power and the growth of the electricity generating industry were much in evidence.

All these factors and many more meant that new colliery shafts were sunk to meet increasing demand for large coal and the output from the mines increased; the output of coal continued to increase until a maximum of 287 million tons was produced



by more than one million coal miners in 1913. The record remains unbeaten.

Coke ovens came into being to provide carbon for blast furnaces which were growing in size and number and to provide an outlet for the small sized coking coal which otherwise had almost no value and attracted little demand. Although the number of collieries was increasing profits varied widely and they became increasingly dependent on coking plants to increase revenue. The result was that the size of the coking plant was generally dictated by the size of the colliery which it served but in a few cases it served two or three collieries belonging to the same company.

In many cases blast furnace coke production was the reason for having a coking plant although some plants were built to produce domestic and industrial coke from the surplus coking coal.

Beehive ovens were widely used in the nineteenth century to make coke but as time went by they were gradually replaced by slot-type waste heat ovens built by a variety of contractors. (90) These ovens were better suited to mechanical charging and discharging, they were thermally more efficient and they had a higher rate of throughput. Advances in the coking industry were gradual and on-going, though a small number of important changes dominated the scene. The move from beehive ovens to slot-type waste heat ovens was one such instance, though the transition was long, mainly because of innate conservatism of the iron masters. Another milestone was the changeover from waste heat ovens to by-product ovens when the demand for gas and other by-products was realised. The demand for gas

grew steadily but the need for some of the by-products was accentuated by World War I; greatest impetus was provided for the production of toluene because it was required in nitrated form as an explosive. The demand for benzole was not directly influenced to the same extent by the war and it continued to depend on the increase in the supply of motor vehicles although this was accentuated by wartime demand. Fertiliser production in the form of ammonium sulphate had for a long time been supplied as a by-product from the gas industry but increased demand was met from the by-product coking industry.

A further milestone in the industry was the use of silica bricks in the construction of the oven chambers. It had long been realised that throughput was directly related to the temperature of the heating flues and this could not be increased because of the relatively low softening point of traditional firebricks. The break through came in 1915 when Glasshoughton coking plant became the first plant to use silica bricks despite scepticism by some coke oven managers. The use of silica bricks was universally adopted in coke oven construction thereafter.(91)

These three changes each had a marked effect on the progress of the industry though none of them had instantaneous impact. Coke oven batteries require high capital outlay and have a useful life of some twenty five years although in particular cases the life span can be altered. Because of the long depreciation period it was never a simple matter to adopt the latest technique in coke production and generally



any major changes were incorporated when the battery became due for rebuilding, although evidence shows that in some instances knowledge of the existence of better equipment brought renewal forward. It was inevitable that a colliery company could sometimes find itself with a new coking plant which was out of date within a few years and it had to continue in competition with more fortunate colliery companies. Those less fortunate companies were able to survive due in part to the fact that most of the products were sold locally so that competition was not as fierce as it may seem. Local preferences abounded, often without any scientific basis but as a result of personal contact by the company. The classic example is the slight differences in coke nut sizes between competing plants and the strong feelings held by customers about the quality of the products in respect of combustibility. The situation was rationalised in the 1950s though not without customer opposition. Also, notwithstanding periods of depression, the demand for coke and by-products was expanding. The result was a fragmented coking industry which had a variety of *batteries* whose size ranged from twenty three ovens carbonising 270 tons of coal per day to fifty nine ovens carbonising 1,500 tons of coal per day. The average size was twenty five ovens with a daily throughput of 430 tons of coal. Not only did throughput vary widely, partly as a result of the size of the colliery or group of collieries within the company, but the height and length of the ovens varied as well. In the main oven chamber widths remained unaltered at 18 inches or thereabouts. The fact that so many variations and deviations from the norm existed was often due to the influence of

local factors so that each plant had its own characteristics.

Grassmoor coking plant, for example, had 240 beehive ovens in 1884, 50 Otto waste heat ovens in 1906 and also 50 regenerative ovens by 1912. The latter were built uniquely with the centre line at an angle to the first ovens because of site restrictions. In contrast Robin Hood coking plant had 65 waste heat ovens built at the turn of the century and these were replaced at the end of their useful life in 1932 by another battery of waste heat ovens. The company did not feel justified in entering into gas contracts which would need to guarantee continuity of supply, especially during the summer period when demand for coal was reduced. The colliery company had a particular marketing problem and even though it tended to be regressive while others were progressive, it survived until nationalisation in 1947 and beyond.

In the main coke oven managers were entrepreneurs and this approach was reflected throughout the industry. (92) Early in the century the British chemical industry was ripe for development and the products of coal carbonisation were by far the greatest source of raw materials; often they were the only source. It is not surprising that as early as 1910 the first by-product plant was built using the semi-direct system of ammonia recovery and the credit goes to the Coppee company for building Holmewood coking plant in Derbyshire. Although the contractor is credited with the achievement, in all probability the problems of the indirect system and the solution would be discussed at length with the plant manager, perhaps because of a particular problem or maybe because he was more adventurous than his colleagues.



The growth of the Staveley complex illustrates some unique features, the main one being the fact that the blast furnaces and the coking plant were built on the same site, presumably because the Staveley Coal and Iron Company owned collieries and an iron works as well as engineering works. The company was fortunate in securing the services of C.P. Markham initially as engineer, but later as chairman. It was largely through his ambition and inventiveness that the company thrived. He was a practical man who, for example, adapted reject cast iron plates produced from his furnaces to give hard wearing road surfaces in vulnerable places on the works. He was one of the first people to have a tar plant and later he developed an ambitious chemical plant, although some of the chemicals were only variations on a theme. It is reasonable to suppose that C.P. Markham created demand in order to fulfil demand.

There was a tendency for larger works to develop in their own field; some extended manufactures in the direction of purer products such as benzene, toluene, naphthalene, carboric and cresylic acids, and others went further into the domain of organic chemical manufacture by the production of intermediate products such as nitrobenzene, nitrotoluene, aniline, B-naphthol etc. The manufacture of such required producers to be in a position to supply the heavy chemicals such as sulphuric and nitric acids. Such progress was confined to the more advanced coking plants.

By 1936 the market for coke oven gas was well established and there was a trend towards increasing the size of coking plants when they became due for rebuild because of a ready gas market. In fact they had to be increased in keeping with greater output from the colliery as a first requirement and greater demand for coke as a second requirement. Impetus for larger gas supply eventually came from local corporations though in the early days the coke oven managers had to work hard to demonstrate the advantages of coke oven gas for town use. Blackwell coking plant, also in Derbyshire, was in a dilemma in 1936 when it saw the opportunity to increase the sale of gas to the local community but it did not have sufficient small coal to increase production or it lacked sufficient coke sales. Whatever the reason the demand for gas increased in relation to other products. The problem was solved by installing a producer gas plant so that ovens could be underfired with producer gas and a corresponding amount of rich gas liberated for towns use. This was the first coking plant attached to a colliery to underfire the battery with producer gas and it is a good example of the entrepreneurial approach to success.

Other plants took an interest in solid smokeless fuel production rather than compete for the blast furnace coke market, but the only plant built specifically for this purpose was Nunnery Handsworth in 1929. It was also the first plant built by Woodall Duckham and Co. following diversification from building gas retorts. The only change needed from a conventional coking plant was to build narrow ovens only 14 inches wide, but it was a big change in terms of capital



expenditure in relation to throughput. The principle had merit but competitors evidently preferred other parameters to control smokeless fuel quality; there is reason to believe that in reality very little was done to control the quality of domestic and industrial coke. Nunnery Colliery Company and Thorncliffe Coal Distillation Company were the only two firms who advertised their important products, 'Nunnery Nuts' and 'Izal' respectively on their coke oven chimneys facing the main railway. More usually coking companies advertised themselves on the sides of their rail wagons - a natural follow-on to the parent collieries who traditionally advertised on their wagons.

Barrow Barnsley and South Yorkshire Chemical Works entered the domestic fuel market but unlike Nunnery Handsworth they persevered for longer, perhaps because they were not nationalised and they were competing with the N.C.B. for a static coke market. Both plants survived long after Nunnery Handsworth closed and it is important to realise their destiny was controlled by the N.C.B. who were monopoly coal suppliers, and B.S.C. who were monopoly users of blast furnace coke. The end came when a shrinking coke market meant that if these plants had not closed equivalent coking capacity within the N.C.B. would disappear.

#### Diffusion of Ideas.

In view of the fact that the coking industry is highly specialised it is worthwhile examining its attitude towards science and technology in order to see whether it was insular or progressive. Although the industry is unique from

several points of view it has always been highly competitive yet there has been close liaison with other plants and gas works. Close inspection shows that the coking industry differs in detail from the gas industry even though it has been convenient to draw general similarities because some of the equipment was common to both industries. As a result the industry has been ready to take advantage of progress in science and technology whenever possible. There are many examples of the progressiveness of the industry in the first half of the present century and it is sufficient to outline three contrasting situations by way of illustration.

At the turn of the nineteenth century beehive ovens had been developed as far as they could along well known lines. If the industry was to progress it had to change course with the result that slot-type ovens were introduced. This was not a cosmetic alteration but a fundamental change of such magnitude that some applications of science and technology had to be looked at again to meet the changed circumstances - methods of heating the ovens are mentioned by way of illustration. The coking industry has never been involved with thermodynamics but it has always had a high regard for basic heat transfer.

Advent of slot type ovens set the scene for the introduction of by-product ovens when the demand for by-products was appreciated. The use of by-products from the carbonisation industries demanded liaison between producer and user as well as co-operation within the industry and with contractors. The basic step of changing from waste-heat ovens to by-product recovery had far reaching implications for the coking industry.



Fundamental principles of absorption and distillation were introduced into the industry for the first time and the need for a knowledge of chemical engineering gained momentum. These phenomena were well known in other industries but they were a new experience for contractors and coke oven managers alike. Their introduction came gradually for technical reasons. Responsibility for the transfer of contemporary ideas in science and engineering into the industry happened as a result of close liaison between coke oven managers and the contractors to the mutual benefit of both. Chapter VIII describing education in the industry shows the enthusiasm of coke oven managers and others towards self-improvement. Other changes followed naturally as the industry matured.

The coking industry has always sought to use the latest techniques and materials. An outstanding example of the latter was the introduction of silica for oven chamber construction instead of firebrick. Of course furnace designers were trying hard to improve materials of construction so that better throughput would result but any analogy between a coke oven and a steel furnace is misleading for one important reason - the former has a reducing atmosphere and the latter atmosphere is one of oxidation. Nevertheless advocacy of the use of silica in coke ovens attracted the attention of research workers outside the industry. (93)

Coke ovens progressed early in the century on the only form of power available - steam. Steam was used exclusively for driving pumps and propelling machinery so there was great emphasis on mechanical engineering.

For a long time the industry had been bedevilled by problems associated with the presence of finely divided tar droplets in coke oven gas even though methods of separation had been improved. The trouble was that tar removal relied on mechanical methods which were simply not good enough.

The coal industry was quick to see the advantages of electrical power and early in the century most collieries of any significance generated electricity so the use of electricity for power and for lighting spread simultaneously to the coke ovens. It was not long before electrostatic precipitation of tar fog replaced mechanical methods and achieved efficiencies of 99.99%. (94)

Coke oven managers were keen to learn from others but their particular specialism only enabled them to benefit in general ways from advances in science and technology. They were concerned about the lack of transfer of ideas within the industry early in the century and the outcome was the formation of their own technical association (95) in 1916. This provided a focal point for the presentation of technical papers specifically related to the industry and a meeting place for the free exchange of ideas. The similarities and differences between the plants described earlier show close liaison within the industry as well as a generous attitude towards innovation in the first half of the twentieth century.



### The Modern Industry.

By the end of World War II the coking industry, like the rest of British industry was in poor condition; plants were small, old, and worn out and the colliery companies hadn't the money to reshape the mines let alone their coking plants. The only realistic solution was Nationalisation of the Coal Industry in 1947 so that rationalisation and modernisation could follow. Those coking plants owned by colliery companies were required to vest in the National Coal Board with the result that most, though not all the coking industry was nationalised. The N.C.B. examined the disposition of the coking industry and decided to re-structure it so that it could compete favourably with foreign competition in reducing costs of coke production. In Yorkshire three coking plants out of an initial complement of eighteen were rebuilt and modernised with the result that Manvers became the largest coking plant in Europe. The plants were organised into Divisions corresponding with the mining divisions with a certain amount of autonomy. The policy of the North Eastern Division, which controlled plants in Yorkshire was to minimise capital expenditure, even at the expense of increasing revenue later. The result was that each of the three plants was a mixture of ancient and new equipment and this caused operating difficulties which in some instances were insurmountable and probably contributed to the demise of two plants.

In contrast the East Midlands Division replaced six old plants by one new one and the result was a large coke and chemical plant on a green field site. Perhaps the policy

was dictated by the fact that none of the existing sites were capable of re-development and enlargement although there is an idea that there was a deliberate policy only to build a wholly new plant.

Post war development placed strong emphasis on size as a means of reducing the relative proportion of labour cost but, like early pioneers the modern industry had little idea how far it should go. Unlike early pioneers there was less restriction on size because of colliery output.

Early post war experience suggested that some plants were too large and that the optimum size was probably about 1,500 tons of coal throughput per day.

The modern industry had to face problems which never arose earlier in the century. There had been a long standing acceptance of atmospheric pollution which later became a toleration and finally refusal to accept. The old adage 'where there's muck there's money' was no longer good enough. For a while the coking industry paid lip service to demands by the public but as public resentment mounted the industry was forced to raise standards. It was perhaps inevitable that public opinion against atmospheric pollution would mount because the pollution was so outstanding and because it caused damage. Soon afterwards there was an awakening to the flagrant misuse of rivers by industry and the coking industry was no exception though its contribution to pollution was less dramatic. Initially there was a feeling that quality control of effluent needed to be tightened and later some realisation that effluent treatment and disposal must be regarded as an integral part of the process of coke



production and by-product recovery. For the first time in the history of the industry capital expenditure and revenue for effluent treatment had to be budgeted for and manpower allocated to the effluent plant. The cost of effluent disposal had traditionally been negligible but it had now become a charge on the saleable products.

## REFERENCES AND NOTES

1. Smithywood coking plant is exceptional insofar as it was the first plant to have two batteries of ovens rebuilt early in 1950 but no other major alterations were carried out, and therefore it is included in the previous section.
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4. C. Dinsdale and E.A. Curtis. Producer Gas for Heating Coke Ovens, Transactions of the Coke Oven Managers' Association, 1937, p.133
5. Documents contained in the archives of the Clay Cross Company.
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7. A Hundred Years of Enterprise, 1837-1937, Centenary of the Clay Cross Company.
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9. R. Stephenson, Proc. Inst. Civil Eng., 1855-6, Vol. XV, p.126.
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11. Personal knowledge of Mr. R.F. Childs, Land and Minerals Director of the Clay Cross Company.
12. Plan of the works dated 6th May 1887 in the archives of the Clay Cross Company.
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14. W.B.M. Jackson, Iron and Coal Trades Review, June 1914, p.2107.
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16. Also spelt Jerry's.
17. Grassmoor Coke Oven, Coal Carbonisation, supplement to Colliery Engineering, July 1936, p.129.
18. Glasshoughton coking plant, described later in the chapter, was the first to use silica bricks for oven construction, Further reference is made in chapter IV.
19. Coal Carbonisation, October 1935, p.98
20. New Coke Oven Installation at Holmewood Colliery, Iron and Coal Trades Review, November 20th 1936, p.885.
21. Iron and Coal Trades Review, 2nd April 1937, p.613.
22. I.T.V. Calendar, September 19th 1976.



23. Personal knowledge of C.J. Vickers, former Works Engineer.
24. Personal knowledge of C.J. Vickers, former Works Engineer.
25. Barnsley District Coking Company Ltd., Report to the Directors, September 1967 in author's possession.
26. Assistance in a similar vein is shown between another private company the South Yorkshire Coking Company Limited and another nationalised industry, B.S.C. for similar reasons under the heading describing that company elsewhere in this chapter.
27. The South Yorkshire Advertiser, 31st October 1975.
28. Undated publication by the Semet-Solvay and Piette Coke Oven Company Limited, 155 Norfolk Street, Sheffield.
29. There were strong fears that as a result of the termination of the coke contract with resultant loss of the price advantage, the plant would become uneconomical and would have to close. Feeling at the prospect of closure ran high and much local publicity was in effect a well orchestrated attempt to persuade B.S.C. to agree to an alternative contract which would benefit them and enable the plant to continue in operation.
30. Personal knowledge of R.D. Barrow, late Coking Plant Manager.
31. The Gas World, Coking and By-Product Section, 6th April 1929, p.41-45.
32. The author was involved in producing a new reactive smokeless fuel on a full scale experimental basis in the late 1950s. Further details are given in chapter VIII.
33. 18 inch wide ovens have remained to date and the capacity has been increased by altering the length and the height.
34. The section describing Smithywood Coking Plant shows a similar method of advertising. Only two coking plants chose to publicise themselves in this way.
35. Reproduced from Twenty Years of Coke Oven Construction 1926-1946, The Woodall-Duckham Vertical Retort and Oven Construction Company (1920) Limited, 1947.
36. Reproduced by permission of the N.C.B. Records Office at Mansfield.
37. Personal knowledge of Miss A. Murfitt, former secretary to the coke oven manager.
38. The first was at Nunnery Handsworth, Sheffield.
39. It was unusual for Simon Carves gas producers to be built at a Woodall Duckham coking plant.
40. Smithywood Gas Producer Plant Guarantee Test, 9th December 1953, C.W.D. Ref. R/4/10/1, copy No. 22 in author's possession.
41. Letter from Mr. J. Lunn, Works Manager dated 18th April 1980 in author's possession.
42. The Gas World, Coking Section, July 2nd 1938, p.75.

43. See the section describing compensation for nationalisation in chapter VII.
44. Financial compensation following nationalisation is referred to in chapter VII.
45. E. Morgan, formerly coke oven manager.
46. Compare Glasshoughton Coking Plant described later in the chapter.
47. Compare Rotherham Main Coking Plant described in chapter VI.
48. Reproduced from Twenty Years of Coke Oven Construction 1926-1946, The Woodall-Duckham Vertical Retort and Oven Construction Company (1920) Limited, 1947.
49. Rope haulage is mentioned in the section describing Glasshoughton Coking Plant.
50. Undated booklet produced by Simon Carves Limited to mark the visit of the Coke Oven Managers' Association on September 25th, 1930.
51. See chapter VIII describing Simon Carves Ltd.
52. W. Staniforth, Preheating at the Brookhouse Coking Plant, Transactions of the Coke Oven Managers' Association 1974, p.210.
53. Centralised Carbonising Plants, Coke and Gas, June 1947, p.163.
54. The Gas World, 27th October 1951.
55. The N.C.B. started a series of colliery closures in order to improve profitability and to match output with demand. Also the characteristics of some traditional coking coal seams were changing. Coal blending for the production of foundry coke saved the life of coking plants in the Durham area.
56. New Simon-Carves Coke Oven Installation at Manvers Main Colliery, Iron and Coal Trades Review, March 17th 1934, p.442.
57. D.C. Freshwater, I.I.T.R.I. Conference on Particle Technology, Chicago, Illinois, 1975.
58. The Murton Coking Plant, Coke and Gas, 1959, p.350.
59. Reproduced by permission of the N.C.B. Records Office at Mansfield.
60. This is the only known coking plant which had a British Rail level crossing manned by coke oven labour during the day on exactly the same style as British Rail manned level crossings. In keeping with British Rail policy the crossing was provided with automatic barriers at a later date.
61. Barnsley and District Coking Plant described earlier in the chapter was a similar conglomerate although the scale was smaller.
62. Anticipation of the recommendations of the Report of the Tribunal appointed to enquire into the disaster at Aberfan on October 21st 1966. H.M.S.O.



63. In view of the total lack of sophisticated fire fighting facilities at the old rectification plants it is surprising that there haven't been several disasters.
64. The precedent of having a coke oven battery chimney off-set relative to the battery had already been set by Rotherham Main. The reasons for this are given in chapter VI describing this plant.
65. Personal knowledge of R.W. Burnett, former Works Manager.
66. The Rotherham Star, 12th December 1980.
67. Instrumentation at the smaller plants was very simple and any maintenance was left to a willing shift foreman or an enthusiastic fitter. This was never fully satisfactory but it was tolerable in the days when coking plants were unsophisticated.
68. Compiled by the author and checked by J. Lunn, former shift manager in 1957.
69. Compiled by the author, information checked by J. Lunn, Deputy Works Manager in 1978.
70. The Avenue Carbonisation and Chemical Plant, Coke and Gas November 1956, p.424.
71. Gas World, Coking and By-Product Section, 6th April 1929, p.41-45.
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- 72a. M.R. Meades and G.E.C. Randell, Smokeless Charging, Transactions of the Coke Oven Managers' Association 1962, p.346-7
73. W.H. Wilcockson, Sections of Strata of the Coal Measures of Yorkshire, Third Edition, Wakefield, 1950.
74. The Electrical Review, June 15th 1934.
75. The Coking Plant of the Yorkshire Coking and Chemical Company Ltd., Colliery Guardian, March 1st 1935, p.381-4.
76. This subject is dealt with in an overall context in chapter IV describing the early coking industry.
77. Hard coke is important for use in a blast furnace but it is detrimental for domestic purposes because increase in coke hardness is associated with a decrease in reactivity.
78. Compiled from Pamphlet No.21, Koppers' Coke Oven Co.Ltd. Sheffield, p.7.
79. Graphs compiled from statistics belonging to the Yorkshire Coking and Chemical Company Ltd. in author's possession.
80. If the size of the two Avenue batteries each with 53 ovens is the optimum, the choice of size of Glasshoughton was unfortunate.

81. Metal stitching was carried out by specialist contractors who drilled serrated slots in both parts of the casting and bridged the gap by inserting a strip of metal the same size as the slot. The process was expensive for what it was because it was charged in relation to the value of the equipment being repaired.
82. E. Morgan, N.C. Brewer et.al. 'Coke Oven Wall Repairs', Transactions of the Coke Oven Managers' Association, 1973, p.80-100.
83. Reproduced from M.J. Fox and G.D. King, Industrial Steam, Album number 2, Shepperton, Surrey, 1976, p.65.
84. A.J. Booth, Industrial Steam, Truro, 1976, p.74-75.
85. In the East Midlands Division this does not appear to have been the case, see description of the Avenue Plant.
86. Reproduced from M.J. Fox and G.D. King, Industrial Steam, Album number 2, Shepperton, Surrey, 1976, p.65.
87. Anticipation of the recommendations of the Report of the Tribunal appointed to enquire into the disaster at Aberfan on 21st October 1966. H.M.S.O. Undated.
88. S.G. Dawes, former Plant Manager.
89. South Yorkshire Chemical Company, finally owned by the National Carbonising Company Ltd. and independent of the N.C.B. was the only other plant in Yorkshire to have a coal washery.
90. Out of a list of some ten contractors, albeit many of them small ones, only Simon Carves, Woodall Duckham & Co.Ltd. and Gibbon Bros. have survived.
91. The industry has always been quick to respond to changes in technology. Compare for example chapter VIII describing Simon Carves to see how the use of electrostatic precipitation spread.
92. The section describing the Coke Oven Managers' Association in chapter VIII and chapter VI describing Rotherham Main Coking Plant give details showing how ideas diffused and knowledge spread.
93. Professor J.W. Cobb at Sheffield University in 1915.
94. In 1824 M. Hohlfield, a mathematics teacher at Leipzig first described the precipitation of smoke particles by electricity. The first commercially successful process was demonstrated by F.G. Cottrell in 1906 and developed at the University of California. The earliest applications were to smelting and sulphuric acid industries. Use in the coking industry and for cleaning the ventilating air in crushing and grinding mills soon followed.
95. The Coke Oven Managers' Association is discussed in more detail in chapter VIII.



## CHAPTER VI

### THE DEVELOPMENT OF BRINSWORTH AND CANKLOW

#### Introduction

The development of Brinsworth and Canklow is inextricably linked with the development of local industry and this is bound up with the growth of coal mining and related activities in the area.

The story of Rotherham Main Coking Plant is essentially involved and it is impossible to do it justice in one chapter. It is however endeavoured to demonstrate that the plant was typical of most others in many ways though it was characterised by a few notable exceptions. The effect of the presence of John Brown and Company in the locality can best be seen in context by reference to J. Bullock, Bowers Row. There are many similarities in the environmental conditions of Brinsworth and Canklow and the Castleford Area of the former West Riding described in the light of Bullock's mining background. The sections describing amenities, diet and clothing give the kind of picture which could be applied equally well to many districts. No better evidence for the social history of Brinsworth and Canklow being typical need be sought beyond G.D.H.Cole & R.Postgate, The Common People, who have undertaken a similar investigation but unlike the present author they have examined a more restricted area of study.

It is inevitable that the story of a highly specialised industry over a period of sixty years must be revealed in sections because of the diverse subject matter. Notwithstanding this it should be appreciated that many sections are inter-related and some have a complex relationship with several other sections.

The similarities of Rotherham Main Coking Plant with others and the stark differences can only be appreciated by looking at the overall contribution of individual aspects of the plant as well as the general coking industry in South Yorkshire and North Derbyshire.

#### The Coking Industry of South Yorkshire and North Derbyshire.

The manufacture of coke has been an important industry in South Yorkshire for many years, principally because most of the coal seams north of the River Don are suitable for carbonisation. Until 1899 coal was chiefly carbonised in beehive ovens, and, except in a few isolated instances, by-product recovery from coke ovens was not attempted. A notable exception was the successful recovery of by-products from coal carbonised in beehive ovens by Newton Chambers and Company at the Thorncliffe Coal and Iron Works. The firm had recovered ammonium sulphate and illuminating and lubricating oils from coal carbonised in patent beehive ovens and was already well known for the manufacture of "Izal" from the products of the distillation of tar oils by the time the ovens were replaced in 1929.

Beehive ovens were developed in South Yorkshire to supply coke for crucible steel manufacture and, in 1846, about 100,000 tons of hard coke were used in Sheffield for this purpose. (1) Furthermore, soft coke was produced for forge work by raking a thin layer of coal in a shallow beehive oven. After the development of railways it became practicable to sell coke, and beehive ovens were found at many of the collieries.

The iron industry of South Yorkshire and North Derbyshire was based on the use of coal-measure ironstone until about 1860



when it was replaced by Northamptonshire Jurassic ores with some Lincolnshire ores added in 1875. (2) In 1855 the main ironworks in Derbyshire were located at Renishaw, Staveley, Clay Cross, Alfreton, Wingerworth, Codner Park, Butterley Hall and Stanton. Similarly in 1842 the ironworks in South Yorkshire were located at Holmes, Thorncliffe, Elsecar, Milton and Parkgate. There was a furnace at Sheffield Park but it was not in blast, though several furnaces were in operation near Leeds.

Chapeltown near Sheffield has particular historical importance. The Earls of Shrewsbury at Sheffield Castle had a charcoal blast furnace here before 1600 and in 1795 Newton Chambers built their first coke fired blast furnace. The Marquis of Rockingham tried to distil tar from coal in advance of the 9th Earl of Dundonald, probably in the same area. (3) The first battery of Coppée ovens were built at Chapeltown in 1872. (4) Jamieson produced an improved form of beehive recovery oven in 1883 and a battery of this type was built at Chapeltown about 1885. Izal disinfectant was made from the emulsified tar fractions which were produced in these ovens. The ovens were modified and a battery of 'Newton Chambers' by-product ovens was erected in the U.S.A. in 1895. The coke was removed from the oven mechanically by a shovelling machine invented by T. Smith at the Chapeltown works. After a short while the recovery of by-products was abandoned and the ovens were operated like ordinary beehive ovens. (5)

The manufacture of coke in the modern retort or closed oven, with by-product recovery in South Yorkshire practically dates from 1900 when the first battery of 35 ovens was started at the Wharnccliffe Silkstone Collieries by Messrs. Simon-Carves. The ovens built in 1899 were 32ft 10in. long, 7ft 6 in. high and 22 in. wide. From then on, considerable progress was made

in South Yorkshire and North Derbyshire. The turn of the century saw Simon-Carves building ovens at New Monckton, Barrow, and Robin Hood Collieries and in 1902 they built the first battery of ovens at Rotherham Main. (6) The development of the industry in this period is interesting because it not only indicates rapid growth, but also shows improvements and modifications in oven construction, which closely followed one another as manufacturers and oven constructors gained experience of the conditions necessary for successful coking plant operation. In the early design, a single set of flues heated two ovens, so the oven wall was built sufficiently thick to support the superstructure. Later ovens had a dividing wall and double sets of flues were used with thinner walls. The recuperator was abandoned because a fire grate below the oven sole was no longer needed, the gas was introduced first at the top flue but the air conduit from the recuperator up the buttress could not be maintained in a gas tight condition.

1904 witnessed the rapid adoption of the by-product recovery oven in Yorkshire and Derbyshire and more batteries were built at Rotherham Main, Tinsley Park, and in 1906, at Dalton Main, Wharncliffe Woodmoor, Mitchell Main and Dinnington, see figure 1. In 1902 the first Otto ovens were built for the Yorkshire Iron and Coal Company at Tingley and two years later, a battery of Koppers regenerative ovens were built at Barnsley Main.

Why did the by-product oven develop in Yorkshire and Derbyshire? The deciding factor was the demand for coke which was in turn controlled almost entirely by the demand for iron, the production of which increased by 50% in Northamptonshire, Lincolnshire, South Yorkshire and Derbyshire during the first



FIGURE 1

The Extent of By-Product Recovery 1910. (8)

Contractor	Yorkshire		Derbyshire	
	No. of Batteries	No. of Ovens	No. of Batteries	No. of Ovens
Simon-Carvès	20 (a)	729(a)	-	-
Simplex	1	44	2	150
Semet-Solvey	3	92	-	-
Koppers	8 (b)	317(b)	-	-
Huessener	1	30	2	100
Mackey-Seymour	1	32	-	-
Otto Hilgenstock	5 (c)	325(c)	1	60
Coppée	-	-	2 (d)	117 (d)

(a) Includes 4 batteries under construction comprising 94 ovens

(b) : 2 : : : : 65 :

(c) : 2 : : : : 100 :

(d) : 1 : : : : 50 :

decade of the 20th century. Another important factor was the increased quantity of small coal available, and in Yorkshire, production increased by 50% between 1899 and 1911. The final contributory factor was the improved financial results which came from the improved by-product oven.

The extent of the coking industry in Yorkshire and Derbyshire can be judged by the quantity of coke manufactured at coke ovens in 1909. (7)

United Kingdom	10,240,093 tons
Durham	5,335,790 tons
Yorkshire	2,684,102 tons
Derbyshire	234,825 tons

With the exception of Durham, Yorkshire was the largest coke producing county in Britain. Figure 1 shows the extent of by-product recovery in Yorkshire and Derbyshire and the number, and type of oven are shown in figure 2. An outstanding feature of this figure is that although Derbyshire had a vigorous coking industry at the start of the 20th century, Yorkshire had almost ten times as many ovens. One explanation for this is the rapid growth of the iron and steel industry in South Yorkshire which was not matched by a similar growth in Derbyshire.

Coke was made for a long time by the hearth process and in beehive ovens in Derbyshire. George Stephenson built 52 ovens in two rows, 9ft long and 6ft wide at Clay Cross in 1840 and this was the start of the Clay Cross Company. In 1904 8 Simplex ovens were built in pairs, also at Clay Cross, and were 33ft long, 6ft 9in. high and 24, 26, 28 and 30 in. wide, to determine whether the coal was suitable for carbonisation.



FIGURE 2

Distribution of Types of Oven 1910. (11)

Type of Oven	Yorkshire	Derbyshire
Beehive	3802	302
Simon-Carvès	709	-
Semet-Solvay	125	-
Coppée	50	67
Koppers	72	36
Otto Hilgenstock	325	60
Simplex	44	150
Huessener	25	134
Collins	45	-
Mackey-Seymour	32	-
Others	74	-
Total	5303	649

This demonstrates an early awareness of the risks associated with carbonising unsuitable coals and the serious attempt to overcome the problem. The narrowest oven was found to give the best coke but experiments with hand compressing the charge showed that still better coke could be made and 34 coke-charged ovens, each 21½in wide came into operation in 1905. A further 16 ovens were added in 1907. The charge, containing 12 - 15% moisture was carbonised in 36 hours. These ovens had horizontal flues with a division wall in the middle of the length of each wall so that one set of three horizontal flues were common to two ovens. (9) A battery of 50 Otto ovens was built at Grassmoor in 1905 and in 1907 the Simplex oven was introduced at the Staveley works. (10)

#### Social Background.

In order to appreciate the growth of the community it is necessary to examine the way economic history influenced events. Although there were still wide gaps between the economic condition of different sections of the community, the fifty years preceding World War I had brought remarkable improvements for wage earners in general. In spite of all the manifestations of discontent between 1911 and 1914 it is unlikely that there had ever been a time when, in material terms, things had been so favourable for the population. (12)

Simultaneously with this period of advancement was one in which the existence of widespread poverty, to an extent not hitherto generally realised, was precisely documented and forced upon the attention of the public. Also, there were suspicions that even though there was a general improvement in standards, the problems of the very poor were unaltered. This is illustrated



by Charles Booth's survey of living conditions in London between 1887 and 1892. (13) The conclusions of the survey were startling and were based on a most comprehensive and objective measurement of poverty.

Seebohm Rowntree carried out an even more detailed survey of York in 1899 while the results of Booth's revelations were still in people's minds. Rowntree concluded that 9.91% of the population of York were living in what he called primary poverty and he estimated that there were a further 17.93% of the population who were in fact living in poverty because some of their earnings were absorbed by other expenditure. (14)

The background information on general aspects of the early coking industry in South Yorkshire and North East Derbyshire has been included, together with a short section on the social background, in order to set the scene for a closer look at two adjacent villages in the industrialised area of South Yorkshire.

#### Growth of the Community

The coal industry of South Yorkshire gradually became concentrated in the district of Rotherham and within five years of the turn of the century it was prophesied that Rotherham would become one of the most important towns in the country from a mining point of view. In the event Rotherham failed to rise to this prediction although, in keeping with other towns in Yorkshire and elsewhere, its status was enhanced by the presence of a large number of collieries in the area. (15) In many respects Canklow, located on the River Rother and at the southern edge of the town, typified the changes taking place during its transition from a small peaceful hamlet in the early 1890s to

the headquarters of a large colliery enterprise. As a consequence of the colliery, the population increased rapidly and the few old stone houses were supplemented by several dozen modern and more convenient houses at the turn of the century.

The boundary between the civic parishes of Brinsworth and Canklow is difficult to identify but it is understood by many older residents that Canklow comprises an area to the north of East Bawtry Road near to the railway line and also the land east of the railway. The majority of the land to the west of the railway is included in the parish of Brinsworth. It has not been possible to obtain records of the parish boundaries and the above conclusion has been arrived at after obtaining the comments and opinions of numerous inhabitants of the district. The parish of Brinsworth included the hamlet of Templeborough at one time. (16) Figure 3 shows the location of the main centres of activity in 1911. (17) By this date the parish of Brinsworth comprised about half a dozen farms and two housing developments built a few years earlier to accommodate the influx of workers to the colliery and the engine shed belonging to the Midland Railway Company at Canklow. A list of residents of Brinsworth is given in figure 4. Prior to the establishment of these two labour intensive industries, Brinsworth relied extensively on agriculture to support the small population of 208 in 1811, 225 in 1821, 226 in 1851, 1,679 in 1891 (18) and 2,421 in 1921. (19) Brinsworth, Catcliffe, Treeton and Orgreave were formed into separate parishes in 1903. (20)

Before the colliery shafts were sunk, the only sign of industrialisation on a large scale was the presence of the



FIGURE 3

Ordnance Survey Map of Brinsworth 1911



FIGURE 4

Residents of Brinsworth 1901. (23)

Name	Address	Occupation
Fred Barber	Brinsworth Grange	Farmer
Isaac Barber	Manor House	Farmer
William Batty	Howarth Grange	Farmer
Frank Brown	Hall	Farmer
Joseph Brown	Hill Top Farm	Farmer
Abraham Ibbotson	-	Farmer
Arthur Ibbotson	-	Farmer
Frank Jaques	Poplar Farm	Farmer
Joseph Shepherd	-	Farmer
Charles Johnson	Brinsworth Bar	Cowkeeper
Nelson Lee Smith	Thornbank Nursery	Nurseryman and market gardner
George Saville	Howarth Hall	Farmer and horse dealer
James Sonior	65 Atlas Street	Grocer
Joseph Slater	Whitehill Farm	Bailiff
James Tingle	87 Atlas Street	Shopkeeper
Henry Wake	Atlas Hotel	Victualler and Farmer
Thomas Stubbs	Whitehill Farm	Colliery Manager



railway which linked Rotherham with London in 1840. Initially the line was single track but it was duplicated later. (21) The railway shed was built soon after the colliery, early in the 20th century.

What were the attractions of Canklow for John Brown and Company and the Midland Railway Company which subsequently amalgamated to form the London, Midland and Scottish Railway Company? The main feature of interest to the railway company was the proximity of Brinsworth and Canklow to the developing town of Rotherham, which necessitated extensive railway sidings to meet the growth of rail-borne coal from the numerous collieries in the area as well as the increased output from the iron and steel works. (22) Quite naturally, John Brown & Co. supplied coal to the Canklow engine shed. Canklow was one of the first villages in the county to be lit by gas and water and <sup>supply</sup> sewage <sup>disposal systems</sup> had been brought to the district by the end of the 19th century. Further details of these developments are given later in the chapter. The engine shed could have been built further south at Treeton or at other hamlets along the line but they did not have any of these amenities, so necessary to attract good employees. It was also convenient to have the shed near to the large siding in Rotherham and the siding belonging to John Brown & Co. The land on the south of the large siding was already owned by the colliery and the Midland Railway Company bought the next piece of suitable land.

Canklow had quite different attractions for the colliery which preceeded railway development in the district. The existence of the railway as a means of transporting goods was important to

the colliery which needed to distribute large quantities of coal to markets too far away to be served by the relatively poor roads and equally poor road vehicles. Roads were primitive and the main form of transport was horse-drawn although internal combustion engine vehicles were gaining popularity. By this time the railway was well developed for moving bulky materials and undoubtedly it grew because of the increase in coal mining activities which in turn stimulated other industries. The maximum coal output ever achieved in Britain was 287 million tons in 1913. (24)

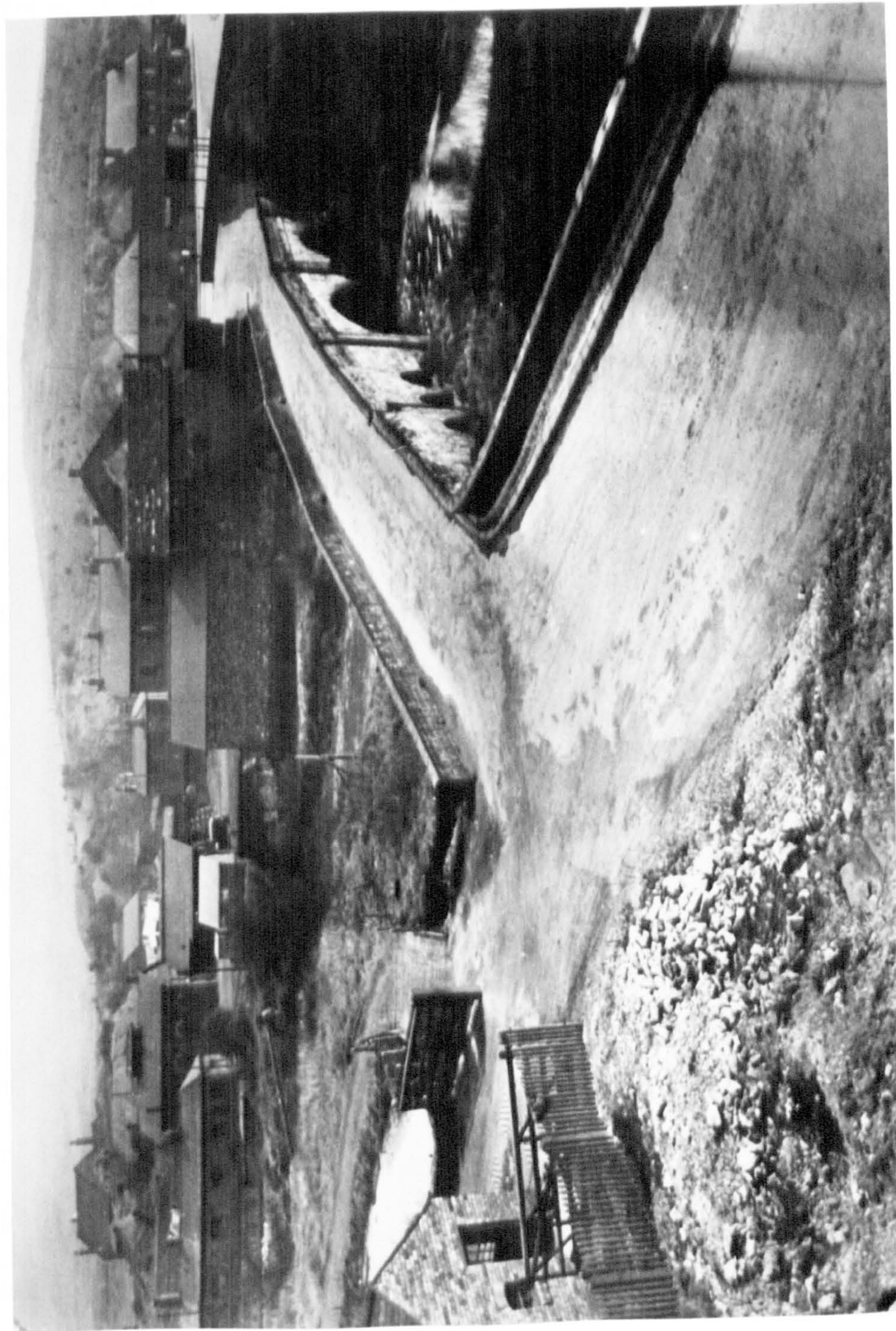
What were the main features of growth in the area?

John Brown and Co. were already well established in ship building at Clydeside, they had steel works in Sheffield and owned several collieries. The company had already established Aldwarke Main and Carr House Collieries, and the Atlas works in Sheffield, and started to establish a colliery at Canklow in 1890. (25) Up to this time Canklow had been a country district and the only indication of a trading world beyond was the presence of the Midland Railway passing through and the historic flour mill which was partly destroyed by fire in 1888. (26) The stone building nearest the stone bridge shown in figure 5<sup>was</sup> rebuilt and made suitable for offices and a fitting shop when it was acquired by John Brown and Co. Ltd. (27) It is believed the undershot mill wheel was transported about a quarter of a mile south east to another mill in Canklow Meadows, situated at a location having the local name 'Hell Hole'. (28) The author confirms that the remains of an old building in this locality which could easily have been a mill exists today.



FIGURE 5

Canklow Old Bridge and Road from the  
Railway Bridge, Facing East. (32)





Like other colliery companies John Brown & Co. had to build accommodation and develop social facilities in order to attract and retain the large labour force into the area. (29) The growth which followed the establishment of the colliery is quite typical of the growth of the mining villages in South Yorkshire. Figure 3 shows three areas of land used for developing colliery housing. The land immediately to the west of the colliery comprised two rows of terraced houses and a National School provided by the company for 145 children. (30) The Rotherham and District Co-operative Society Ltd. had purpose-built butchery and grocery shops built at the same time. This particular street was named Atlas Street, after one of the Company Directors. (31) Figure 6 shows these houses in the foreground in relation to the colliery and the road. The property remained unchanged in fabric until it was demolished early in the 1970s, long after the colliery and the coke ovens had been closed. Figure 7 shows a closer view of similar houses taken from the coke oven battery. Contrary to this figure which was taken just before the property was demolished, the houses were quite cheerful and much in demand. Similar developments took place on other land to the south of the colliery and two streets of houses became known as Ellis Street and Duncan Street, also after directors of the Company. Ellis Street was never fully developed by the colliery company, presumably because they were able to attract sufficient labour and enough land was sold to the London Midland Railway Company for them to build two blocks of houses. The 'railway houses' as they were known, were built later and to a better standard, and reflect the progress made in the style of terraced property. It is known that they were not



FIGURE 6

Canklow and Rotherham Main Colliery 1937. (32)

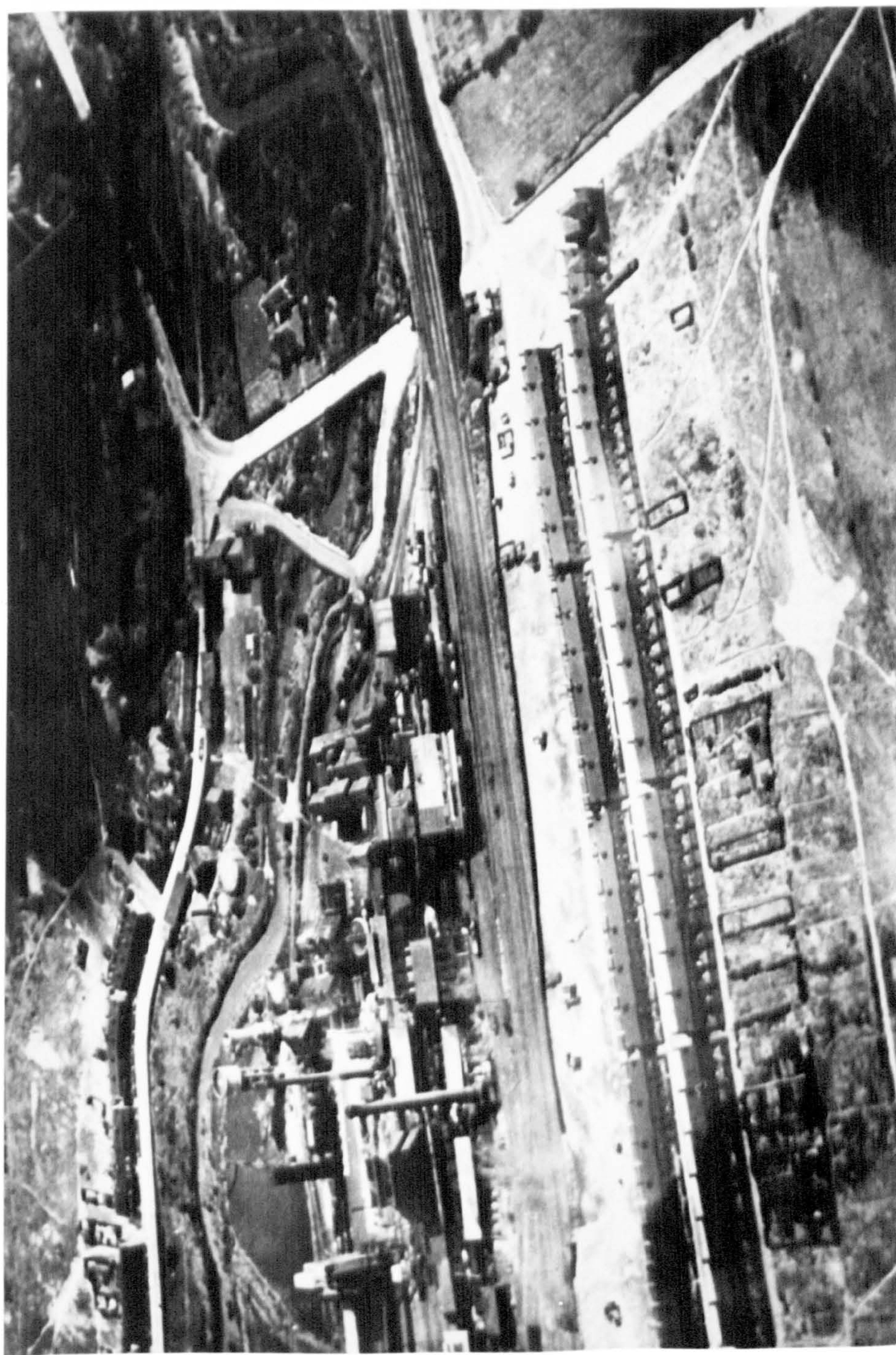




FIGURE 7

Water Tower and Methodist Church July 1949. (36)





equipped with gas lighting in 1914 but no doubt it came soon afterwards as the system of gas mains progressed throughout Brinsworth and Canklow and then Catcliffe. (34)

John Brown and Company leased 18 houses, numbered 1 - 18 at Canklow Terrace (now nos. 43 - 47 West Bawtry Road) from the Duke of Norfolk for a period of 99 years from 29th September 1893; they were known locally as 'Deputy Row' and they can be seen in the upper right-hand corner of figure 6. It is worthy of note that Canklow Wood, shown in the background had been laid bare by the time figure 7 was taken in 1949 and indicates the means taken to obtain domestic fuel when times were hard. Immediately before 29th September, the rent was £68.10.0. but thereafter it was reduced to £62. 10.0. (34) These houses, being relatively close to the coking plant were equipped with gas lighting by 1914.

All the colliery houses were lit by oil lamps in the early days and it was not until about 1911 that they were replaced by gas lighting. (35) Examination of figure 6 shows that each block of houses in Atlas Street comprised 12 houses and there were four or five blocks per row. The houses built in Duncan Street and Ellis Street were identical. Each block was built so that they were bounded by a brick wall which formed an integral part of the end houses in each block and also an integral part of the toilet and coal place for each house. (37) The brick buildings comprising the toilet and coal store were built as far from each house as possible, whereas the corresponding buildings in the newer railway houses were adjacent to each dwelling. The reason for the change in approach to sanitation is that when the colliery houses were built a sewage system was not constructed and earth

closets had to be used; a regular feature was the emptying of the 'middings' into a horse drawn cart each night-time. (38) By the time the railway houses were built both sewage and water mains were laid and this enabled the outbuildings to be more conveniently sited adjacent to the houses. Evidently it was still not thought to be advisable to incorporate the toilet inside each house, although a lack of space may have been partly responsible. It is not until the first private development took place in Brinsworth about 1929 that toilets and bathrooms were included as a composite part of the buildings. Some 90 houses lit by gas and with running hot water supplied from a back boiler were built in what became known as Bonet Lane as a venture into a better type of property. They contrasted markedly with the houses built by the colliery some 30 years earlier and equipped with 'Yorkshire Ranges'. These were open fires with an iron water tank at one side which had a drain tap for providing hot water. Bathing was primitive and consisted in carrying water from the tank and pouring it into a zinc bath in front of the open fire. Because of the manual work involved in preparing the bath and emptying it afterwards, members of the family used the same water and bathing was infrequent. Traditionally children bathed first and father bathed last - perhaps there was more emphasis on thrift than hygiene.

The white lines shown in figure 6 were well used paths across open land and the irregular-shaped white area was the local sports ground which enabled football and cricket to be played. Gambling took place in the more secluded area between the railway and the houses; the principal game was pitch and toss. Another important feature was the allotments which were in effect



an extension of the small gardens. The allotments were rigorously cultivated and though they were quite open, they were not subject to theft or damage. Many of the tenants kept pigeons on part of their allotment and this form of sport or relaxation was in sharp contrast to the demands of employment at the coking plant and the colliery.

As the area developed and the flow of road traffic increased the twisting road over the hump-back bridge across the Rother was by-passed with a steel girder bridge built in 1928 at a cost of £12,000, (39) and shown in figure 8 and 15. It is a good example of overdesign, perhaps because of a lack of confidence in engineering calculations and the imprecision in metallurgical processes. The bridge was built at a time when motor vehicles were in their infancy and horse drawn transport was commonplace and yet it is still in service more than half a century later carrying juggernauts having a gross weight of some fifty tonnes. It is obvious that little attention was paid to reducing the cost of construction by reducing the factor of safety, so that ironically this bridge and many other civil engineering structures built in the 1920s have proved to be tremendous assets some fifty years after they were built. Canklow had become the terminus for trams from Rotherham and straightening and widening the road between the terminus and the railway bridge brought it up to the standard of the rest of the road to Tinsley and then to Sheffield. This feature is shown clearly in figure 6.

The last social amenity to be constructed as part of the development of the area because of the arrival of the colliery was the Miners' Welfare Hall which was opened on 16th April 1927. (40)



FIGURE 8.

Canklow Bridge from the Colliery Landsale 4th July 1958. (36)





and shown in the top right hand corner of figure 6. It rapidly became a focal centre for the community with the main feature being dances held on Saturday nights. It was also a convenient place to hold wedding reception- for local people when catering was carried out on a quite informal basis. One such wedding reception was that of Mr. and Mrs. H. Shaw in 1939. The building was constructed on the site of the mill dam and almost certainly it was on land belonging to the colliery. (41)

St. George's ecclesiastical parish included Brinsworth, Catcliffe, Canklow and Orgreave, all in the Rotherham Deanery. (43) The first church to be built in Brinsworth was St. Andrews in 1885, (44) followed by a temporary steel framed building clad with corrugated sheets which became St. Faiths in 1895.

A pictorial view of St. Andrews is presented in figure 9.

Local enquiries suggest the view was taken about 1952. The tythe barn shown to the right was far older than the church. The barn contained a hammer head roof structure worthy of preservation as the only one of its type in the district but at the time it was dismantled in the 1950s there was much less interest in archaeological preservation. Early in the present century the church was in a run down condition because of insufficient support from a sparse population. Mrs. M. Hallatt had much to do with the survival of the church in the first part of the century and Mr. G. Marsden provided impetus for its survival later on. St. Andrew's and St. George's were sufficient to meet the needs of their respective farming and farming/mining communities until the advent of Rotherham Main Colliery brought about a changed situation.



FIGURE 9

St. Andrews Church. (42)





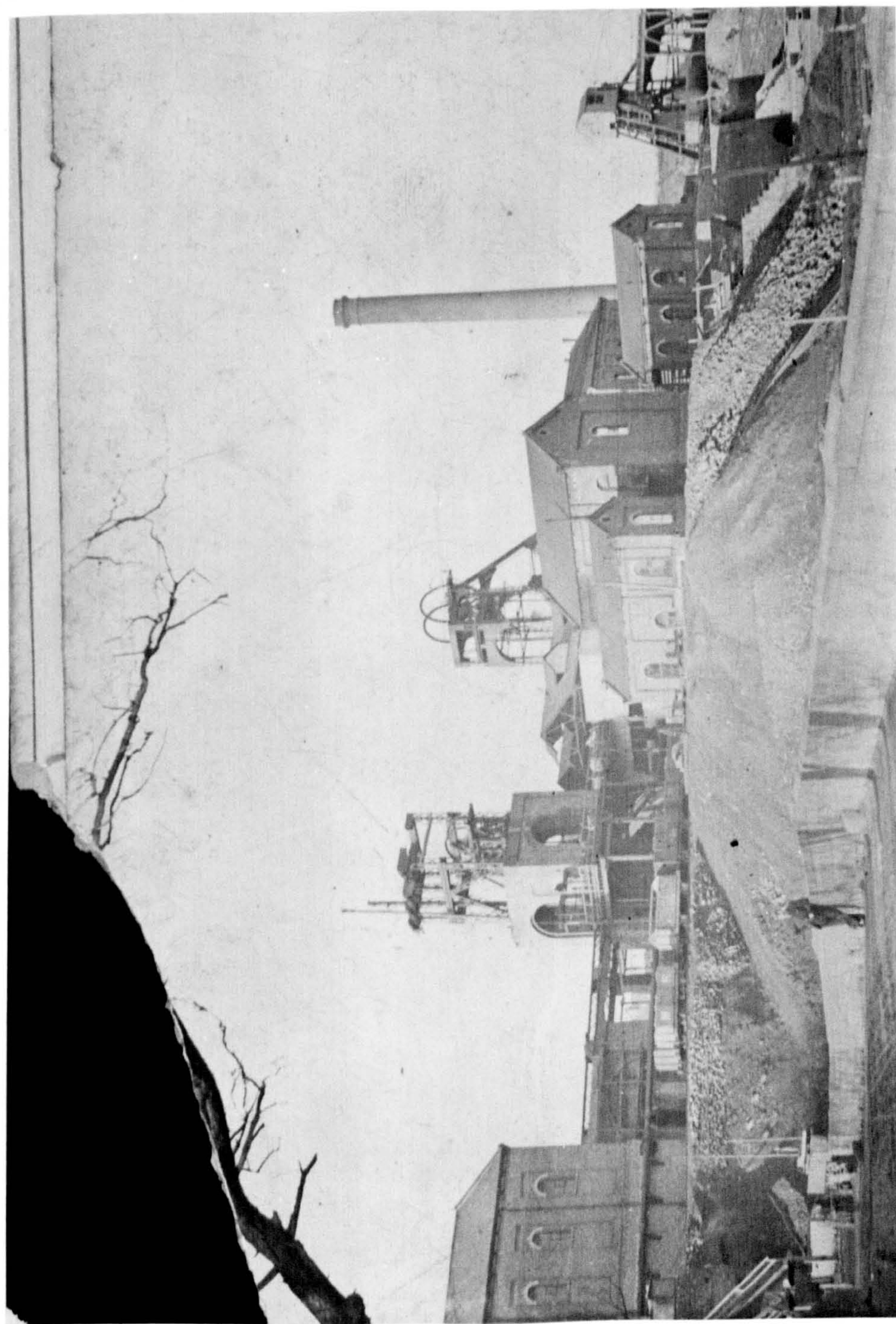
The first colliery shaft was sunk at Canklow at the end of the 19th century, (figure 10) and John Brown and Company were anxious to cater for as many needs as possible for the new community. Perhaps in the light of experience gained in shipbuilding, in steelworks and with their other collieries, but also with the knowledge that competitors were operating, or were about to operate in the district, John Brown and Co. were generous towards the village. A lack of good roads and poor transport at the turn of the century meant that people were reluctant to live more than a mile or two from their place of employment and so, in one sense, the collieries were not strictly competing for the same labour market, but in another they were competing to attract new labour into the area. This must have influenced the attitude of the company towards good public relations.

Creation of the colliery brought a new importance to the district. John Brown and Co. built a new school at the top end of Atlas Street because the existing school on West Bawtry Road, shown in figure 3, was inadequate for the enlarged population. The school was an iron structure transferred from Middle Lane, Rotherham and opened in November 1901 on its new site. (45) This was in turn replaced by an infant and junior school for 300 and 600 children respectively, built by the West Riding County Council in 1907. (47) Children were permitted to leave school at 14 years of age but they could leave at 13 years of age provided their attendance was adequate. The number of children in the infant and junior sections are highly significant because it would normally be expected that children entering the infant school would progress to the junior school, so the capacity of each ought to be similar. The fact that the junior school was twice



FIGURE 10

An Early View of the Colliery. (46)





as large shows that the W.R.C.C. anticipated a large influx of older children into the district. (48) . The temporary school erected by John Brown and Co. Ltd. was transferred to Thurcroft, also within the boundary of the W.R.C.C. to meet the increased population when that colliery was opened in 1909. (49)

Thomas Bradley, an Oxford graduate, was the first headmaster and he believed in academic studies to the almost total exclusion of non vocational activities. His efforts were rewarded in 1909 when Samuel Edward Carson, at the age of 10 years, became the first boy from that school to obtain a West Riding County Council scholarship to attend the prestigious Rotherham Grammar School. He voluntarily joined the Air Force at the outbreak of World War I, became a pilot and was killed over France on 18th July 1918 at 20 years of age. The Grammar School had existed from 1547 and it was well established as a fee paying school for children of upper class parents. (50) The academic standard was high because the school was the only one of its kind for several miles and competition for places was fierce. Rotherham, like many other similar districts also had a Mechanics' Institute for providing education of a different type. (51)

Another boy, Cyril Lumb, also from Canklow, had preceded Edward Carson but he had been financed by a C.W.S. scholarship which was by then a well established means of support. Demand for places at the Grammar School by parents who were willing to pay for the education of their children was increasing. As a result Woodhouse Grammar School was built in 1909 (52) outside the Rotherham Rural Deanery but accessible by people from Brinsworth, Canklow, and neighbouring districts. It too was for fee paying pupils in the early days but it never acquired

the prestige of Rotherham Grammar School, mainly because it did not have such an early start. Introduction of state support brought about a decline in the number of fee paying pupils so competition for places depended increasing<sup>ly</sup> on academic ability. As a result Woodhouse Grammar School was able to establish itself as a contributor of candidates for Oxford, Cambridge, London and other universities. By 1913 the national approach to all forms of education, but especially primary education started to change. Collateral financial aid, especially for new enterprises was forthcoming in ever increasing amounts from American foundations for example Andrew Carnegie, the American steel magnate, up to 1913 had given local education authorities some £1.77 million and promised £0.175 million with which to establish public libraries.

#### Amenities

The growth of coal mining and iron and steel industries in South Yorkshire encouraged several small towns to expand rapidly in the late nineteenth century and Rotherham<sup>was</sup> typical of the general trend. The advent of the internal combustion powered vehicle encouraged commuting within a radius of a few miles of the town centre and progress with electric traction enabled Rotherham and Sheffield to develop an extensive tramway system; Canklow became one of the termini for trams. Later the town combined the advantages of electric traction and rubber tyred vehicles to operate a trolley bus system - although it did not directly affect the employees of John Brown and Company Limited. Other towns which operated trolley buses include Bradford and Bournemouth. Although this method of transport never became universally popular, Rotherham retained trolley buses long after they had ceased working elsewhere.



Growth in the use of electricity brought many other benefits, including mass entertainment at cinemas and a theatre. (53) Rotherham Main Colliery was well placed for easy public transport into town whereas the workforce at adjacent collieries at Treeton and Orgreave had to walk two or three miles to the terminus at Canklow. Notwithstanding the relatively easy access to Rotherham many employees of John Brown and Company sought social recreation in the Miners' Welfare and the church hall, (54) and the Atlas Hotel and physical recreation on the company sports ground. Geographically the focus for employment and leisure activities were almost co-incident. The sports facilities provided by the company included cricket, tennis and bowls, and participation was open to staff and workmen alike. The sports mentioned are generally regarded as *pastimes* for the middle class but at Rotherham Main support by the workforce was essential for them to remain viable. Employees had the advantage of several types of recreation facility at or near to their place of work as well as a variety of public entertainment in Rotherham.

### Politics

In 1865 the South Division of the West Riding of Yorkshire consisted of Rotherham, Barnsley, Doncaster, Wath, Dewsbury, Huddersfield, Holmfirth, Penistone and Thorne. Feelings about the election on that date were high and riots occurred in Rotherham; as a result the Riot Act was read from a window in the Crown Hotel and afterwards at the cattle market. (55) The Hussars, who had already arrived from Sheffield were ordered to clear the streets. The soldiers met with fierce opposition because the roughs firmly believed that employment of soldiers during an election was illegal and they resisted with courage seldom displayed by an English mob.

The local outcome of the Election was that two Liberal Members were elected to Parliament.

The 1868 Election was much more peaceful and the Liberals again succeeded in retaining both seats but only by a narrow majority.

The General Election of 1874 brought success for the Conservatives at the expense of the Liberals so that Disraeli succeeded Gladstone as Prime Minister. At a meeting of publicans and beersellers in Rotherham it was decided to vote for both Conservative candidates and they were successfully elected to Parliament. (56)

At all previous elections the state of the poll could be ascertained at any time by paying a visit to one of the committee rooms but the Ballot Act of 1874 stopped the practice so the result of a General Election was not known until it was declared at Wakefield the following day. This reduced some of the unlawful behaviour which had become part of the election scene in the district.

Nevertheless rioting again took place at the General Election of 1880. The two political parties in Rotherham changed their headquarters because the publicans had become tired of sustaining damage to drinking glasses and to the fabric because of fighting. The Conservatives adopted the Ship Hotel and the Liberals used the Crown Hotel. As the riot developed the police, some of whom were imported from country villages and were unacquainted with such crowds, lost control of themselves so many innocent people were struck and some prominent citizens were mauled.



At the end of the poll in the election of 1885, when the new Parliamentary Division of Rotherham returned its first Member, trouble again broke out and the inspector of the Bradford police - who were imported to assist the local force, requested permission to charge and take in custody the councillor who was causing the trouble. Only forbearance by the Mayor saved the irresponsible councillor from the indignity of arrest.

Although the political colour of the district changed as the number of collieries increased the fierce determination of the population was already well established and the strong tradition of militancy continued throughout most of the early part of the next century. It was against this background of staunchness that John Brown and Co.Ltd. along with many other colliery owners set about creating new villages which hitherto existed in little more than name alone.

The politics of the area in the later part of the nineteenth century have been described only to show that militancy has never been far from people's minds. Dormant feelings of this type should be borne in mind when considering the attitude of John Brown and Company towards its employees during the formative years.

#### Diet

It has been estimated that about half the British population was too poor to afford an adequate all-round diet and nearly one third suffered from serious dietetic deficiencies even as late as 1936. Poverty, in the sense of actual malnutrition, had probably diminished since 1929 in view of the lower price of food

but it is none the less a fact that, even outside the depressed areas from 20 to 30 per cent of the working class were still living in 1939 below the Rowntree minimum.

Actually, in the inter-war years imports, and especially imported food stuffs were usually cheap in relation to other goods. They became very cheap during the years of world crisis after 1929 when food producers found themselves with vast stocks which they had to sell off at any price. (57) That was why, during those years the standard of living in Great Britain - except for the two millions or so who were unemployed and the millions more who were on short time - actually rose instead of falling. Wholesale food prices came tumbling down, and retail prices had to come down after them - though not so far. Real wages, for workers in full employment, rose by 10 per cent or more between 1929 and 1933 although they fell slightly thereafter as prices rose again with partial world economic recovery, and remained fairly stable up to the outbreak of World War II.

What effect did the foregoing have on the population of Brinsworth and Canklow early in the century? Figure 6 shows that the gardens associated with the colliery houses were small so it was common for the tenants to rent one or more allotments in order to approach self sufficiency with respect to vegetables. (58) The houses shown in the part of figure 6, known locally as 'deputy row' had much larger gardens and therefore the need for allotments was less - though not eliminated. There were several reasons for growing vegetables and perhaps the most important was that it provided a major saving of expenditure so what little money



there was could be used for other purposes. Families tended to be large and food was an important part of the household budget. In general when times were particularly hard and unemployment was high, growing vegetables provided one means of survival although this did not apply to tenants in the houses belonging to John Brown and Co. as loss of jobs meant loss of tenancy. Another reason for home grown vegetables was the importance attached to fresh vegetables in regard to taste and quality and this was the only way of fulfilling the need.

Other important features have emerged from a consideration of the diet of families of coking plant employees. Several aspects predominate, not the least of which was the fact that all meals were designed to provide bulk, the idea being that a feeling of satisfaction after a meal was an indication of energy replenishment. Another attitude believed it prudent to eat heartily before leaving home especially for work because it sustained vitality. This attitude tended to conflict with low family income and it became practice at lunch time for poor families to serve 'Yorkshire Pudding' as a first course with gravy, sugar or syrup in order to partially satisfy the appetite. The intention was that by this means less of the expensive joint of meat would be required with the main course. Potatoes were also served generously for the same reason. In case either or both these courses were insufficient the 'pudding' was also bulky, frequently composed of rice, sago, tapioca flavoured with jam or sponge, also flavoured with jam.

The expression 'feed the worker' was often used in a light hearted manner but the underlying implication was serious. (59) It is clear that in times of strikes or unemployment the philosophy was to sustain the wage earner at the expense of other members of

the family so that he could go to work when conditions allowed and earn money to sustain the family. Undoubtedly this contributed to the wage earner being recognised as head of the household.

The analogy between eating food to provide energy and stoking a boiler with coal to raise steam was widespread and based on limited understanding of biology and anatomy. The common view stated that the larger the meal the greater the energy output. The idea that eating plenty of 'fatty' food such as bacon and fried bread on cold days increased body resistance to cold penetration supports the analogy. A side effect was that of using fried bread to provide an economical means of using up bacon fat which would otherwise be wasted.

### Clothing

Although the following comments are based on the experience of coke oven workers and their families it is probable that they were equally applicable to railway workers and colliery employees, in fact they may be regarded as typical of many districts. It is known that in houses built by John Brown and Company in Duncan Street and Atlas Street as well as those known as 'deputy row' shown in figures 3 and 6, water for washing was obtained from a 'copper'. The copper simply consisted of a hemispherical vessel about four feet in diameter made from iron, (60) fitted with a drain tap and built into a brick setting which led to an independent chimney in the kitchen where it was separate from the dining room; in other cases it was built into the corner of a combined dining room and kitchen. On wash day, usually each Monday, the housewife rose earlier than usual to fill the copper with water and then light a coal fire under it. It took several hours to heat the water before the clothes could be placed in the copper and washed



by hand. A dolly agitated the clothes and a rubbing board assisted removal of particularly troublesome dirt. Finally the clothes were squeezed dry in a hand operated wringing machine, often known as a 'mangle' before being hung outside to dry, and ironing with a gas heated iron completed the process. Clearly washing clothes was laborious and demanded a great deal of time and energy.

Clothes were designed to minimise the demands of wash day with the result that dark colours predominated because they did not show the dirt. (61) Figures 23, 24 and 25 provide supporting evidence of this fact. Failure to reduce the labour content of the process focussed attention on modifications to the clothes. (62) Short cut measures were taken so that cleanliness became more apparent than real. Detachable shirt collars were used so that the shirt could be worn several days with a clean collar each day. Also, loose fronts made of matching material were tied round the wearer on special occasions so as to present an illusion of cleanliness. Thrift played a part in the use of these cosmetic measures because the treatment given to the clothes in the washing process shortened their lives, there developed a tendency to buy strong and well made clothes capable of being handed down to successive members of the family. In general families were large and so it was easy to get 'worth' out of the garments. Nevertheless an alternative method of obtaining value for money without the sometimes distasteful process of 'handing on' developed. Prolonged wear by the first recipient was obtained by initially purchasing too large a size so the garment could be worn until it became too small and worn out. Some clothing was invariably relegated to use at work, see figure 23.

Obsolete clothing wasn't wasted. It was cut into small squares and the squares sown together to form a hearth rug and sometimes a larger rug for most of the living room floor area, the perimeter of the room was covered with linoleum. (63)

The rugs were hard wearing but almost impossible to clean so the fact that dark coloured material was used in their construction was an advantage.

There has been a dramatic change in standards of clothing in recent times; perhaps clothing like many other things received its biggest boost after World War II. The clothing industry has been revolutionised but it couldn't have happened without equally important progress being taken in other sectors. Perhaps the most important being the development of man made fibres and technological advances in colour chemistry - two of several aspects which are closely related to developments in the petrochemical and chemical industries.

#### Benevolence towards the Church

John Brown and Company had a keen interest in the needs of their employees and they were instrumental in starting community life in the district. The foundation stone for a Wesleyan Mission Church was laid in 1894 with the help of money provided by the company, (64) and an elementary school established, see figure 7. The company had also erected a sewage works and brought mains water to the district. The established church inaugurated a scheme for the planting of a sanctuary dedicated to St. George in 1898, the foundation stone was laid on 11th May in the same year and representatives of the company were present. The idea to build a new church was proposed by the vicar and Rural Dean



of Rotherham, (65) and generous assistance was provided by John Brown and Company. They gave the site for one shilling, the burial ground for 28 pence, donated £200 towards the building itself, and provided the red bricks free of charge. The easy flow of inspiration, money and kind, encouraged an ambitious project with an initial seating capacity for a congregation of 412 people. The church was built with temporary side walls forming the nave, so that the width could be increased later. The east end of the nave was enclosed temporarily so that in effect, part of the nave became the chancel. Again the idea was to extend the body of the church to incorporate a more appropriate chancel at a later date. Both the temporary and the permanent sections of the fabric were built with matching bricks throughout. For the official opening the procession, comprising members of the Parish Church and Catcliffe Mission Choirs formed in a private room in the Atlas Hotel, also built by John Brown and Company. (66) The church and the hotel which included extensive stables are built on opposite sides of what became known as Narrow Lane and is now officially designated Brinsworth Lane. Both buildings were constructed with matching bricks. John Brown and Company didn't have a brickworks at Canklow but it is conceivable that they had one or more at their other collieries, Aldwarke and Thrybergh. At least one competitor in the district had a brickworks and it seems unlikely that this company would enter the same market for another waste product-clay. (67) Prior to the Atlas Hotel, the only other hotels in the area were the Horse and Groom in Bonet Lane, Brinsworth which existed in 1812 and perhaps existed in the 16th century, (68) and the Sitwell Arms, built at Whiston in 1812. (69) The Canklow Hotel, the last to be built for half a century, was

situated mid-way between the Atlas Hotel and Rotherham. It received its licence from the Cross Daggers Hotel in High Street, Rotherham, after some initial difficulty. Twelve applications were made before 1st April, 1909. Removal of the licence from the Cross Daggers Hotel was refused after being granted two months earlier on 4th February 1909, but finally it was granted on 7th April 1910,(70) The original scheme allowed for part of the hotel to be isolated from the section requiring a licence so that it would essentially be a coffee tavern. There was to be a meeting and reading room so that workmen could borrow library books. In the event only the part of the building requiring permission of the magistrates came into being, but recent inspection shows that it had sufficient rooms for all the social facilities to have been developed.

John Brown and Company were by no means unique in building a public house in the locality of the mine. It is known for instance that Cortonwood Collieries Co.Ltd., sold to Messrs. J.Smith's Tadcaster Brewery Company Ltd., the "Brampton Bulls Head Inn" for £13,000 on 25th May 1927. (71)

The church authorities realised they were very ambitious and relied heavily on sheer determination to be successful not only with this church, but elsewhere in the parish. Their great hope was that the commercial and the religious lives of the district would grow together. As well as providing a new church at Brinsworth, it was expected that a new ecclesiastical parish would be formed out of Orgreave, Catcliffe and Canklow, though this expectation failed to materialise. The total financial contributions for St. George's church amounted to £1,000 and did not allow for the inclusion of a parish room in the initial scheme. The parish room, known locally as the church hall, was built in



the same red brick on another site at the end of the colliery houses in Duncan Street some years later. Presumably the site and the bricks were provided by John Brown and Company but the building was very modest in comparison to the hopes and aspirations for St. George's church. (72) Perhaps this indicates a slackening of tempo and a greater awareness by the church authorities that their ambitions were not going to be easily achieved.

John Brown and Company built the vicarage at a cost of £1,500 (73) and provided coke free of charge for the church and the vicarage. The organ and furniture were provided by public subscription. (74) John Brown and Company were not the only company to help the local church and an adjacent competitor provided similar help. The ceremonial cutting of the top soil for the start of a more permanent church on the same site was carried out on 9th June 1909. (75) The external walls of the building were faced with random rubble from Orgreave Colliery and all the stone for the church walls was provided by Rothervale Colliery Company Limited. A coal fired low pressure gravity feed boiler was to be provided for heating and lighting would eventually be by gas. (76) It is evident that the use of town's gas had not yet reached Catcliffe although its arrival was anticipated in a few years time. When St. Mary's church was completed in 1910 the former St. Faith's church served as a parish room and it too was lit by gas. It continued in this capacity until the 1950s when it was replaced by a brick building designed as a focal point for the parish social activities. The former church was fitted with gas lighting at about the time when St. Mary's was so equipped but unlike St. Mary's the gas lighting was never replaced in turn with electric light and power. Several staff of John Brown and Company were enthusiastic church

members and they not only encouraged and maybe initiated official benevolence towards the church, they provided unofficial help towards items of maintenance. (77) Many deeds of this type were carried out at St. George's, St. Mary's and to a much lesser extent, St. Andrew's, solely because one or two company officials at the coke ovens actively supported the church. The custom and practice of providing assistance was so well established by the time the Coal Industry was nationalised in 1947, that in spite of a directive to the contrary, practical assistance continued, though on a reduced scale. The fact that such a tradition continued without hesitation into the 1950s when workpeople in general were questioning long established standards and attitudes is a tribute to the outstanding loyalty of the labour force at the coking plant. (78)

Was this company, together with other colliery companies justified in such benevolence when they failed to provide adequate washing facilities and a canteen until another half century had passed? Such an omission made it unavoidable for miners to travel to and from work in their pit clothes when buses became available, and ~~to have~~ to sit next to members of the travelling public. Shouldn't society have forced a change in hygiene when the colliery companies had failed to do so after spending money on other social facilities? The answer to the question is involved and it is beyond the scope of this thesis.

#### Town's Water Supply

In 1896 the Rotherham Waterworks Committee recommended that the water mains should be extended to the borough boundary at Canklow. (79) One member of the committee claimed the subject



had been considered on several occasions and had always been refused because of insufficient rateable value. The circumstances which now made the scheme feasible was the fact that land was to be laid out for building purposes at a very nominal cost and the ground rent was fixed at two and a half pence per yard, for 99 years. At least one member of the committee expected the whole of the land to be built upon and so bring considerable revenue into the town.

At that time the inhabitants of Canklow, both inside and outside the borough, used wells to supply water. In order to overcome this problem, the Corporation encouraged building operations on Canklow Road because it was known that John Brown and Co.Ltd. would shortly be employing about 3,000 men at the colliery. Already there was a nucleus of employees engaged at the colliery so there was proof of the intentions of the Company. The Committee had some concern for the fact that if people went outside the borough to build, they should have all the advantages of subsidised water for their benefit. The line was taken that if they built there, they knew what the terms would be for those benefits. Another view was that the water mains should be laid when the property had been erected but this was over-ruled by the view that people should be encouraged to build on the outskirts of the borough. The Committee had in mind the fact that if gas and water were taken to Canklow they would have a lever to bring the colliery within the borough boundary. The gasworks owned by the colliery supplied gas to Canklow and then to Brinsworth. The precise date when this happened is unknown although it is recorded that Rotherham Main Gasworks governor, meter, purifier beds and retort house chimneys were built in 1893. (80)

Early in the next century, probably after the modern ovens were built, crude gas was supplied to Rotherham Corporation for purification and re-distribution.

An approximate indication of the cost of laying the water main to Canklow is about £230 and at 4% interest would yield £10 per year. It was envisaged that the property already there would pay  $2\frac{1}{2}\%$  and the anticipation was that more property would be erected in a short space of time. The question which had to be considered was whether the six houses at Canklow and one public house without a licence (81) justified laying the main. Encouragement for the scheme came in the knowledge that the old Dusty Miller public house at the Rotherham end of Canklow Road had been converted into three cottages and there had been fifty applications for them.

#### A Mains Sewage System

John Brown and Company were responsible for transforming Canklow from a rural area into a busy industrial centre. In the 1890s large numbers of houses were built for employees of the company in Canklow and the adjacent village of Brinsworth and this focussed attention on other needs of the population. The spiritual and educational needs of the young and the old had received attention by <sup>the</sup> building of a Wesleyan Chapel and the starting of an elementary day school. The Church of England too had in hand a scheme for a mission church.

By 1897 about 1000 men were employed at the colliery and many of them lived at Canklow. The time was appropriate for something to be done about sanitation and already the Rivers Board had drawn attention to the pollution of the stream running through the district. John Brown were well aware of the need for



improved sanitation and they decided to build a sewage works. A Rotherham man was entrusted with the design and erection of the plant because he had experience of sewage plants. The scheme, inclusive of the land, cost £2,200 and was capable of dealing with the sewage from a population of 4,000 people. Canklow sewage works was officially opened on Monday 25th July 1897. (82)

#### The first Closure of the Colliery 1928.

By the 1920s the thriving colliery had enabled the almost uninhabited villages of Brinsworth and Canklow to develop into communities which, in common with other mining communities, were almost entirely dependent on the coal industry for survival. The unanswered question is had they become too dependent? The fact that John Brown and Company had to issue notices to all employees terminating their employment with effect from Wednesday 12th September 1928 was a major concern although it must have been anticipated for some time. (83) It was a well known fact that geological conditions at the colliery were such that it could only prosper when the coal trade was in a normal condition. The depression in the industry made it impossible to continue and it was only after working at a serious financial loss for some time and giving the matter much careful thought that the directors decided to suspend coal mining.

Closure of the mine meant that 2,000 - 3,000 men and boys were affected and brought stagnation to the whole district. In the early days Rotherham Main was regarded as a prosperous colliery but natural difficulties, together with a depressed market for coal, forced the directors to continue running a non-paying concern in competition with their other collieries or to cease operations at Canklow. It was inevitable that the

directors chose the latter course, even though it meant that the population of Canklow and Brinsworth would have to suffer so that some relief was likely to be felt at the other collieries in the district and the continued losses at Rotherham Main obviated.

At the time of cessation of coal mining it was impossible to say how long the pit would remain at a standstill because the duration depended largely on the coal industry as a whole. An assurance was given so that if there was an improved demand for coal in the near future it could be taken for granted that work would be resumed. As far as possible the pit was placed on a care and maintenance basis so that when the promised industrial revival materialised it could be re-opened, though at the time such an event did not seem imminent.

Canklow and Brinsworth looked like being placed in desperate situations. Most of the people who resided in the districts obtained their livelihood from the colliery and it was difficult to see what could be done for them when unemployment was so rife. There was scarcely a household in the immediate neighbourhood of the colliery which was not affected and quite a number in Rotherham and district were also affected. Tradesmen found themselves in a dilemma the likes of which had never been experienced before.

The effect of the feared calamity, which followed quickly after a serious stoppage at Maltby Main, had a serious effect on Rotherham because a total of 6,000 men on unemployment pay inevitably affected business in the town. There was a new awareness in the district that a colliery which started in 1890 and an up to date coking plant which supplied gas to Rotherham



Corporation could not provide total security of employment.

In the event the closure of the colliery lasted only a *few* <sup>to</sup> *days* and ~~re~~-opened in September 1928. The inhabitants of the district had been made aware of the fact that they were too dependent on the prosperity of the coal mining industry.

As time went by there was a small amount of diversification, not for its own sake, but as a result of prosperity brought about by coal mining.

#### A New Coking Plant, 1929,

Lord Aberconway announced an important development at Rotherham Main at the 1927 Annual General Meeting of the shareholders of John Brown and Company and the local press duly reported the speech under the heading 'Industrial Progress'. (84)

A statement was made to the effect that a contract had been awarded to Simon-Carves Ltd. for the erection of a new coking plant to replace two existing batteries of 30 and 35 waste heat ovens which were built in 1902 and 1904 respectively, and had worked continuously ever since.

Figure 11 is typical of early stamp charged ovens.

The new battery of ovens shown in figure 12 was built on the site of the first ovens shown in the right hand side of figure 11.

When Simon-Carves were awarded the contract to build 28 regenerative ovens and a new by-product plant at Rotherham Main the contracting industry was highly competitive. Four quotations were received with prices ranging from £155,428 to £190,932 and though the specifications differed in detail they were in general comparable. (85) The contract necessitated siting the new battery so that another battery of 28 ovens could



FIGURE 11

The first battery of Coke Ovens, 1902. (90)

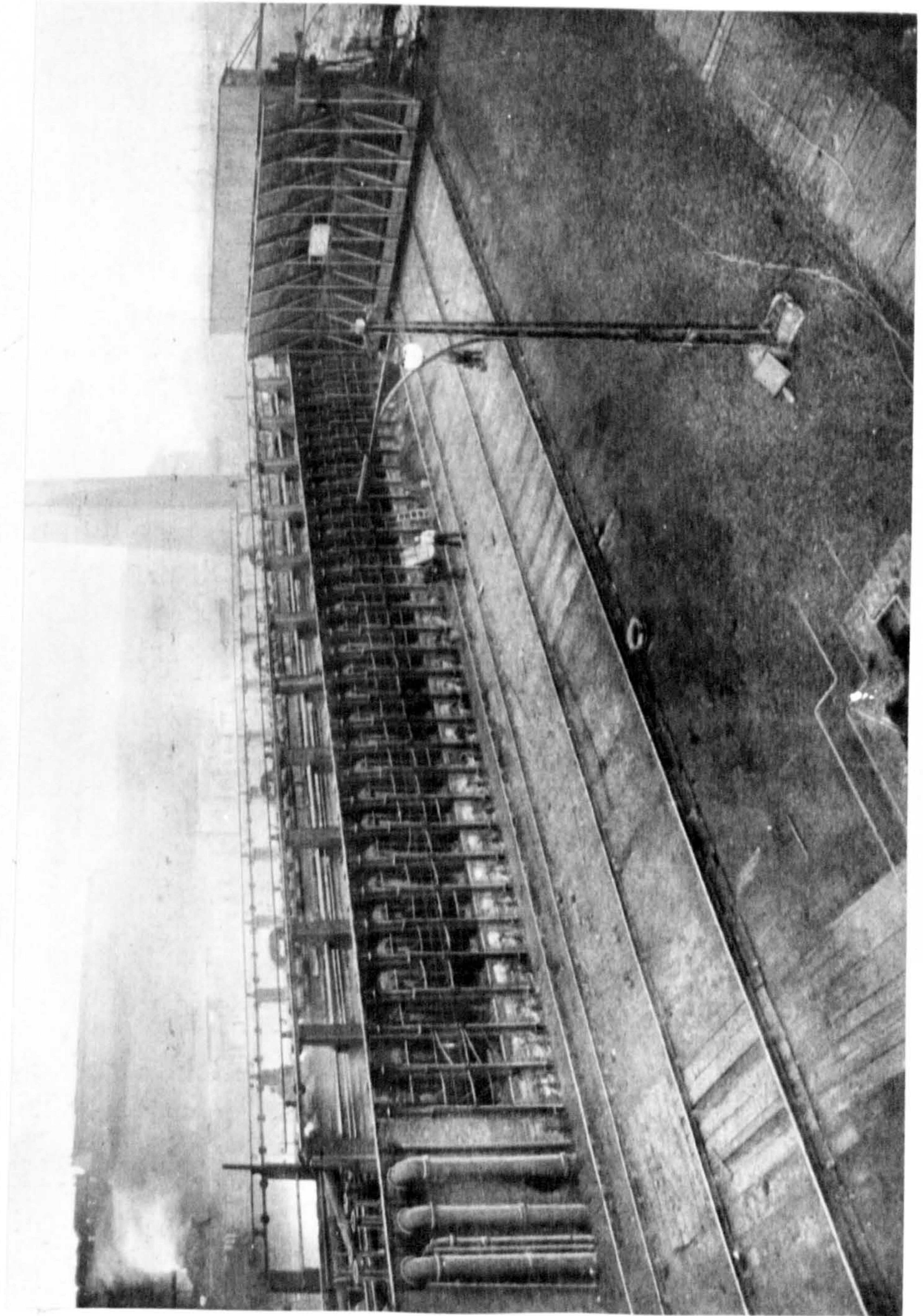
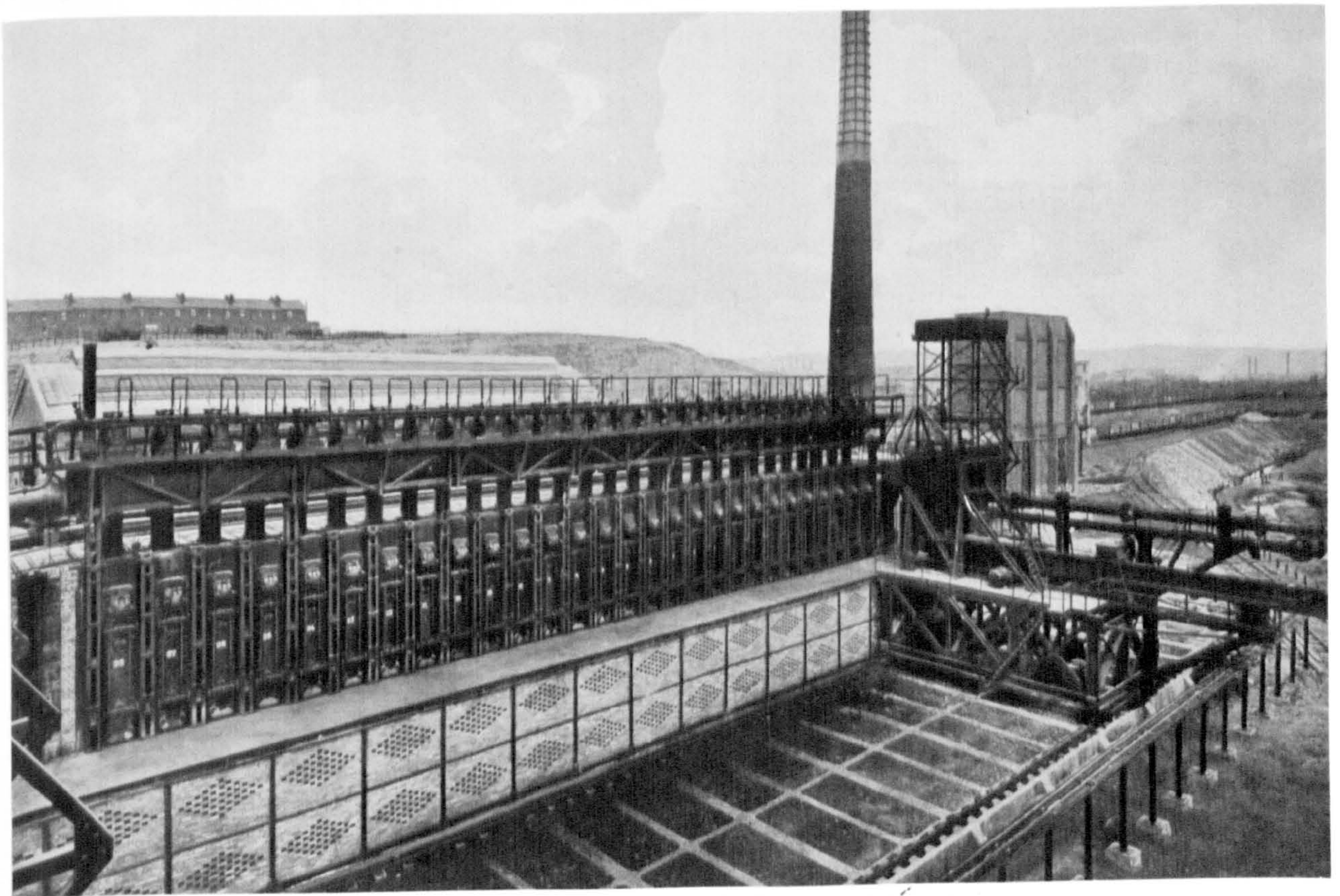




FIGURE 12.

The New Battery of Ovens soon after  
Commissioning. (91)





be added later if it became necessary. In the event the extra ovens were never built. Chapter V describing a selection of coking plants built about this time shows that provision for expansion in this way was typical.

The new plant was a major advancement and this was illustrated in the press reference. The battery would comprise 28 underjet ovens capable of carbonising 3,000 tons of coal per week. Because the old batteries were stamp charged, Lord Aberconway was justified in claiming that the new battery would be equipped with the most modern machinery for charging coal into the ovens and for discharging and subsequent handling of the coke. The author believes both figures 7 and 11 were taken from the top of one of the gas coolers. The reinforced concrete service bunker was to have a capacity of 1,000 tons of coal and included coal elevating and crushing plant. (86) Mention was made of the larry car for charging the ovens and the combined ram and levelling machine were to be electrically driven - in contrast to the steam driven equipment on the existing waste heat batteries. Typical of plants built at this time, Rotherham Main was to have an electrically driven coke car, a coke quenching station, an inclined reinforced concrete wharf and a rubber conveyor leading to the coke screening plant. (87) The screening plant was designed to separate the large coke from the undersize, it incorporated a breaking plant (88) and secondary screening plant for producing coke for domestic, central heating, (89) and producer purposes. The system was designed to minimise operating costs and produce graded coke as economically as possible so that profitability could be increased and the coke market expanded. In effect accountants were beginning to make more impact on industry.



Advantages of the 'underjet' system were pointed out, including the simplicity and certainly of the method of gas distribution for the heating of ovens so uniformity and intensity of heating was expected to be ensured.

This is an acknowledgment that earlier heating systems were unsatisfactory in several respects and it shows an awareness of the importance of uniformly high flue temperatures in respect of plant throughput and coke quality. There was enthusiasm for minimising underfiring gas consumption so that maximum gas was available for town use - lighting, heating, gas engines, steel smelting etc. It was also recognised that this was the cheapest source of hydrogen which was becoming more important as a starting point for synthetic ammonia and alcohol. (92)

The contract included re-designing and replacing the existing by-product plant so that all the whole coking plant would be as up to date as possible. The style of the rebuild and modernisation was quite typical of the period and it should be contrasted with the way Glasshoughton Coking Plant was re-built after nationalisation. Chapter V describing selected coking plants gives more details on this subject.

It isn't surprising that Lord Aberconway was keen to give maximum publicity to the plant because it is believed the Directors had entered into an arrangement whereby they owned 52% of the coking plant and John Brown and Co. hoped to own the other 48%. (93)

Much animosity was created because the coking plant received free water, steam and shunting services from the colliery and most certainly this contributed to the financial success of the coking plant and was to some extent in contrast with the coal mining activity. The coking plant's dependence on the colliery for services is shown by the fact that when John Brown and Co.

were claiming compensation for Nationalisation the amount of land credited to the coke ovens was only 10 acres whereas 160 acres were credited to the colliery. (94) The 10 acres merely designated the area covered by the coke oven battery, screening plant, by-product plant and some land adjacent to the coke oven offices; it did not take into account the extensive sidings used exclusively for full and empty coke wagons and later for stocking foreign coal after the colliery closed. The coal stocking ground is shown in figure 18.

Consistent with other coking plants built in this period it is believed that Simon-Carves financed part of the venture and in return took all the profits from the by-product plant until they had recouped sufficient reward for their capital outlay. In typical manner John Brown and Co. suffered in the early stages because of a lack of capital and this was their way of circumventing the problem.

The situation whereby so many services for the coking plant were provided free of charge was quite typical of the early twentieth century coking industry and was reasonable provided it is considered in the context that coke ovens came into being to convert otherwise waste coking slack into a saleable product.

Colliery and coke oven operations are quite distinct in every respect; the former are labour intensive while the latter are capital intensive and the management skills are so different that traditionally they have always been looked upon as two quite separate but complementary entities. Coking plants form a large part of an integrated scheme to mine and sell coal, but the complex art of coke production and by-product recovery isn't



relevant to the process of mining so it is easy to see how two different cultures developed side by side. However, it is not easy to see how transfer charges with respect to coal should be made in isolation to the rest of the materials and services needed to operate a coking plant.

It was not until twenty years after nationalisation of the coal industry that relationships between collieries and coke ovens were re-examined and transfer charges between the units applied to enable independent appraisal of the financial situation of each unit on a monthly basis. (95) The question why, as late as 1948 onwards, so much more importance should be attached to internal transfer charges on items which had traditionally been excluded needs consideration. There isn't a simple answer but circumstances over twenty or more years changed considerably as a natural evolution accelerated by World War II. A much greater awareness of profitability in relation to capital investment brought about attention to financial detail which had hitherto passed unquestioned. The passage of time alone brought a change in attitude but, if this wasn't sufficient Nationalisation of the Coal Industry generated an awakening of public awareness to a vast industry which was neither efficient nor financially sound. In effect the N.C.B. was accountable to the nation and the nation always hoped it might be subsidised. Such hope was far removed from reality and sharpened the awareness of unprofitable activities. The early complexities, which started when the new plant was built, were transformed as time went by but they were not eliminated.

## Deployment of Labour 1928-30

As a prelude to this section it is important to realise there had been tremendous industrial effort called forth by World War I and a short lived boom afterwards. At the end of 1922 the shipping industry suffered from surplus capacity because wartime losses in merchant ships had been more than replaced and with the volume of world trade falling there were too many ships for the number of cargoes available. More significant still Britain's share in the world's tonnage of merchant ships fell. With more and more countries turning to oil and electricity instead of coal as sources of power and fuel the scene was set for the depression of Britain's staple industries during the interwar period.

Many businessmen expected the postwar boom to last several years. (97) In fact its collapse in 1920 heralded two decades of depression, broken by brief periods of partial recovery. Economic activity picked up again by 1922 and the recovery lasted, with some sharp interruptions until 1929.

Several years of economic uncertainty prior to the building of the new battery of ovens and by-product plant caused John Brown and Co. Ltd. to undertake some of the less stringent tasks with their own labour. This was readily accepted by the labour force as a means of retaining employment in the transition period between the closure of the old plant and the start up of the new.

Unemployment in Sheffield, Rotherham, Barnsley and Doncaster between 1927 and 1937 was decidedly higher than in the leading towns of West Yorkshire. Unemployment at Barnsley was particularly serious, rising to between 45 per cent and 60 per cent between 1932 and 1935. Unemployment in Sheffield and Rotherham was also



serious but appears to have been cyclical. In the boom of 1929 Sheffield was still recovering from the dislocation which followed World War I and unemployment was about 5 per cent above the national average. (98)

The last battery on the old plant was stopped in September 1927 and the new battery was not started up until May 1929. (99) Rotherham Main had been fortunate in that if any damage to the old ovens had been sustained as a result of the General Strike they were not retained in service long enough afterwards for it to have any appreciable effect.

It is worthwhile to examine in some detail the deployment of labour by John Brown and Co.Ltd. during the rebuild. The company was very cost conscious and after the old plant was closed down groups of men worked for sub-contractors on the new plant or were themselves sub-contractors paid by John Brown and Co. One illustration is the fact that the Stafford Reinforcement Company had the contract to build the water tower and the cooling tower. (100) They had insufficient expertise to do the job so they borrowed Albert Pateman from the colliery to supervise the contract. Albert Clarke, joiner at the coking plant at the time, continued to be paid by John Brown and Co. while he installed and later removed the shuttering for the water tower and the cooling tower.

Similarly figure 24 shows a paved yard in front of the exhaust house, this work had been carried out by Jim Miller the coking plant bricklayer during the interim period. (101)

Other contract work was undertaken by L. Jarvis and Co. who charged 1/3d per cubic yard for erecting new benzole plant

foundations which were then completed by Simon Carves Ltd. There are several examples of S. Fretwell doing work under contract. (102) In one instance Fretwell charged  $1\frac{1}{3}d$ <sup>1 day</sup> for excavating the foundations for the coke car track and the coke quenching station, this work was likewise finished by the main contractor. These two jobs were completed very quickly between 12th and 30th October 1928 because Fretwell paid his men 10 shillings per day and a bonus of half a crown per week. He worked  $15\frac{1}{4}$  shifts and his men worked 56 shifts to remove some 530 cubic yards of material. Fretwell paid himself £1 per shift.

There is evidence to show how these contracts were meticulously supervised because of the precise records kept by the coke oven manager regarding time, conditions and quantities. As an illustration Fretwell and Co. excavated a retaining wall at  $1\frac{1}{6}d$  per cubic yard between 22nd November 1928 and 2nd February 1929. On this occasion the ratio of working supervision to workmen was almost 1 : 1. Fretwell worked  $41\frac{11}{16}$  shifts while his men worked  $64\frac{7}{16}$  shifts to remove  $590\frac{1}{2}$  cubic yards of material. Fretwell's wage at  $18\frac{1}{16}d$  was approximately double that of his labourers at 9 shillings. (103) The contract was initially cheaper than other contracts but allowances amounting to  $8\frac{5}{8}$  shifts at 12 shillings per shift were claimed for drawing timber and using it to support an overhanging bank during the excavations.

Other allowances of  $12\frac{1}{2}$  shifts at  $7\frac{1}{6}d$  per shift were incurred for wheeling and loading up rubbish. Also, 147 cubic yards were paid for at double rate on account of the depth and the average cost of the excavation became  $2\frac{1}{3}d$  per cu.yard.



There is evidence of a struggle between the plant manager and the contractor to obtain a bargain; it is unlikely that the former overlooked the possibility of allowances and it is reasonable to assume he negotiated an initial low price though the final cost was rather high.

A good working relationship developed between the coke oven manager and the contract labour. The manager was not generous but he was probably fair because there is evidence that on one occasion at least he deliberately overpaid Fretwell and Co. to compensate for an earlier contract which was poorly paid. Judging by the fact that all costs were converted into shifts, measured to the nearest 30 minutes it is evident that no contingencies were allowed officially by John Brown and Co. It is assumed that in reality the company realised that variable circumstances had to be met by extra payments and conversion to shifts was the best way of doing this without attracting the attention of auditors. (104)

Evidently there were several groups of men doing contract work because L.N. Brewer, who was the Manager's Assistant from 1917 to 1930, was made clerk of works for the erection of the new plant between 1928 and 1930. This experience was two-fold; he gained valuable knowledge in handling men, and detailed knowledge of the plant layout and equipment. Such experience was invaluable when he became Senior Operating Foreman after the new plant was started up. (105)

#### Features of the Site

The colliery shafts were sunk in 1890 - 1893 (106) in between the Midland Railway and the river Rother adjacent to the intersection of West Bawtry road, East Bawtry road and Canklow road. The

contract for the first 18ft diameter shaft was let to Francis Coulson on 15th June 1891 for £10. 12. 6. per yard. (107)

The cost should be noted in conjunction with similar charges elsewhere in the district:-

Aldwarke Colliery	7th July 1877	£12. per yard
Warren House	22nd June 1893	£9. 10. 0. per yard
Carr House	23rd December 1889	£9. per yard

It is understandable that the Aldwarke shaft should be relatively expensive because deep shafts were still growing in popularity and there was a shortage of expertise in this type of operation. Increase in specialist skills associated with sinking shafts, and a better use of mechanical machinery such as steam driven hoists, enabled the price to stabilize so that after 1890 or thereabouts there was a tendency for prices to vary more closely with changes in the cost of living and local conditions.

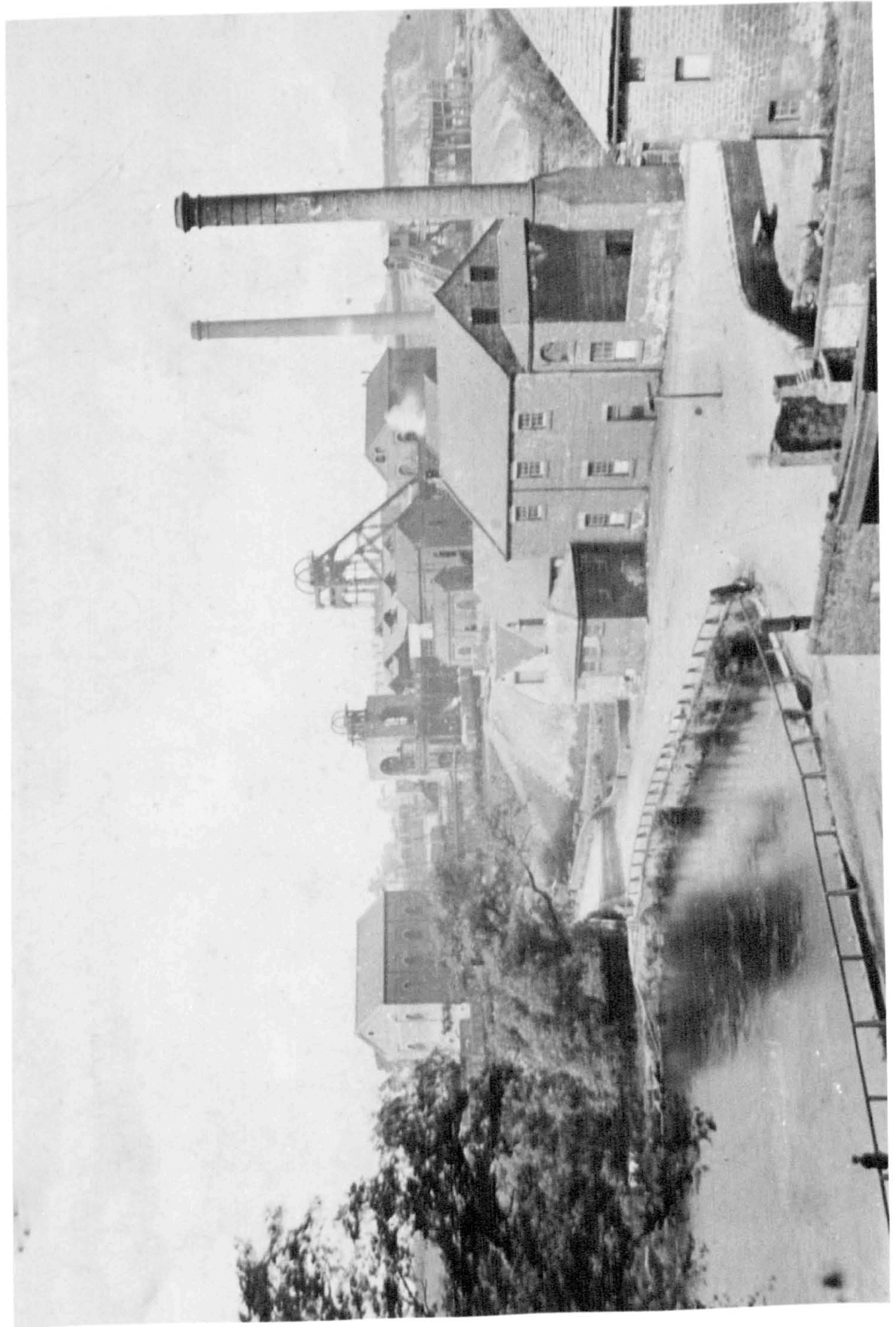
The colliery boilers were built in 1896.(108) They were a typical set of 12 hand fired Lancashire boilers served by the parallel sided chimney nearest to the railway track shown in figure 14. The author has identified a section of brick wall as the only remaining evidence of the existence of the boiler plant, or indeed, anything of the entire complex apart from a few courses of brickwork for the upcast and downcast shafts.

Figure 10 and 13 were taken soon after the colliery was built and probably before the first batteries of coke ovens were constructed. The colliery offices were prestigiously located at the intersection of Canklow road, West Bawtry road and East Bawtry road. (109) An aerial view of the installation shown in figure 6 indicates the restrictions of site which had



FIGURE 13

The Industrial Complex at Canklow. (110)





to be endured in order to gain a valuable location for the offices, the restrictions are confirmed in figure 14.

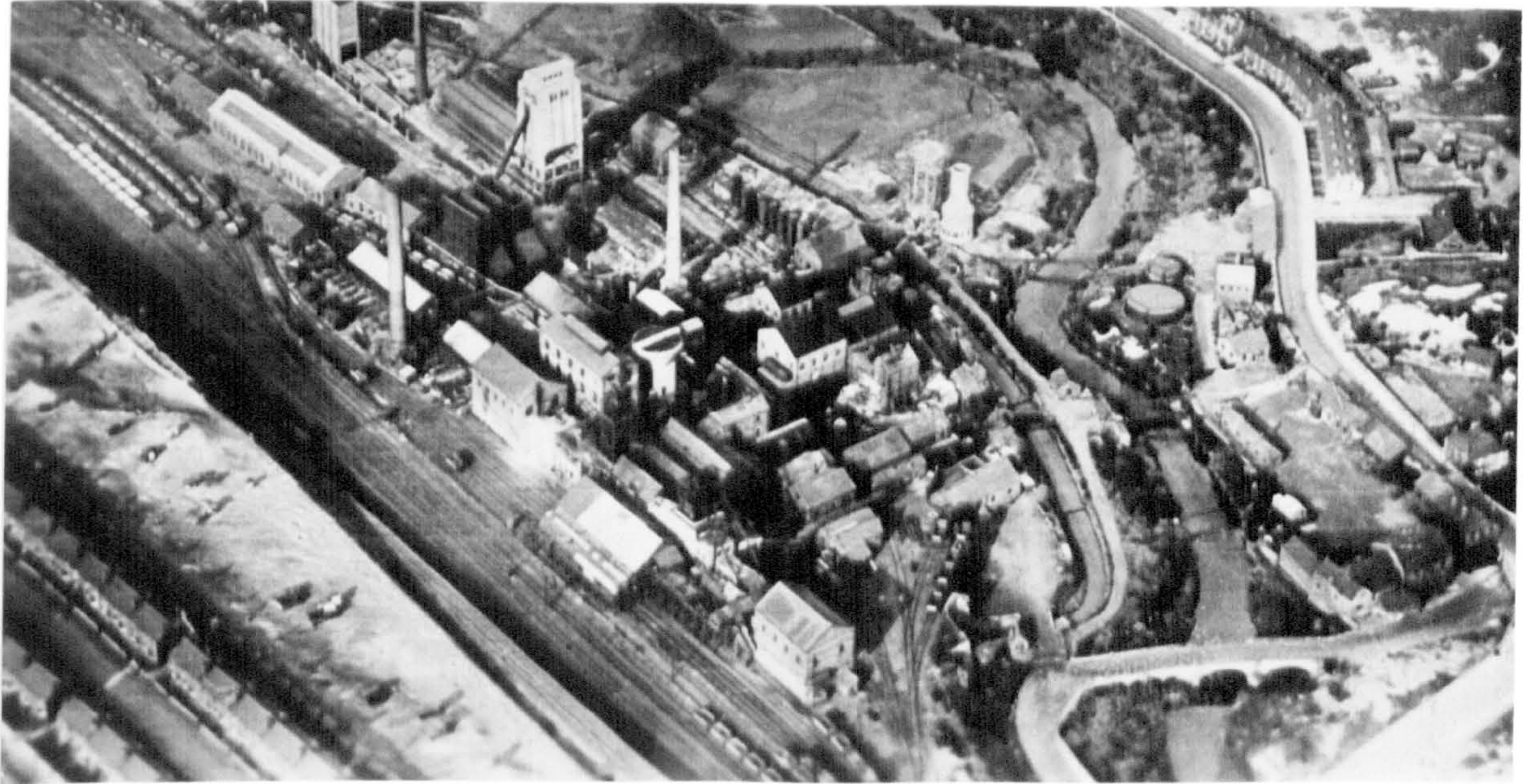
Figure 11 shows a battery of 35 waste heat ovens and the combined stamp charging machine and ram, *soon after start up in May 1902.* These items are mentioned in respect of other plants described in chapter V, but figure 11 is the only known illustration of them at this plant. In 1904 a second battery of waste heat ovens were built. A wooden bunker stored the coking coal for the horizontal flue ovens which required one man continually adjusting the volumes of combustion gas and air, (111) such was the primitive nature of the process at this stage. The discharged coke was quenched on an open bench by one man standing at each end. Typical of all early coking plants the only by-products recovered at Rotherham Main were tar and ammonia. (112) Characteristic of the period though perhaps untypical of the coking industry, the figure shows a square cross section coke oven chimney while figure 13 shows that the colliery, which pre-dates the coking plant had circular cross section chimneys. At this stage there was some doubt about the best type of chimney and the typical circular chimney did not become popular until later on.

It is worthwhile to consider why the method of stamp charging already mentioned was used. The coal charge was compressed in a combined ram and stamping machine because it was believed that increasing the density of the coke would make it less reactive to carbon dioxide, a disadvantage which Sir Lowthian Bell considered to apply to by-product oven coke but which Sir Bernhard Samuelson, himself a Fellow of the Royal Society, called a prejudice on the part of Sir Lowthian Bell. (113)



FIGURE 14

Modern View of the Industrial Complex  
at Canklow. (127)





The important question is - did compressing the coal charge before carbonisation give rise to increased density of the resultant coke? From purely empirical considerations it is surprising that the principle wasn't questioned earlier. In the event stamp charging remained the only method of charging the ovens until it was superseded by the mechanically more efficient method of top charging.

Figure 13 shows an early view of what later became Canklow terminus for tramcars and then buses from Rotherham. (114) The mill pond shown in the figure was supplied with water from a stream which came from Whiston and another which joined it in Canklow Meadows, see figure 3. Water from the dam powered a water wheel across the road. The single storey stone building (115) shown in figure 5 formed part of the mill destroyed by fire in 1888. Thereafter it was relegated to grinding beans for pit ponies. (116) The slightly taller building immediately behind it was also part of the mill but the large two storey stone building next to the mill was built much later, presumably as part of the colliery premises - it is known to have been used as a colliery stores and a fitting shop when the colliery became operational. This figure must have been taken before 1902 because it does not show the existence of the first coking plant.

Rotherham Main Gasworks governor, meter, retort house and purifier beds were built in 1894 and by 1896 the colliery company provided gas to light Canklow and Brinsworth. (117) The smaller of the two gasholders shown in figures 6 and 14 with a capacity of 10,000 cu.ft. was used for balancing supply and demand. The larger holder, with a capacity of 30,000 cu.ft. was built between 1896 and 1901. The retort house is visible immediately



behind the gas holders in figure 6 and a front elevation is shown in figure 7; it housed two banks of seven retorts and one bank of five retorts which corresponded with three windows in the end of the building which are visible in outline today.(118)

The small size of the building meant that it must have been very congested with so much plant inside. The limited louvre type roof ventilators suggest that working conditions were hot and dirty - standards which went unquestioned because they were considered an integral part of the process of gas manufacture. (119)

Figures 7 and 14 show how the gas producer plant in the background was situated between Canklow road and the river Rother, even though they were taken many years after it closed down. Four men operated the plant on days only with one man on each of the three shifts when making gas. (120) The colliery company had its own fitting shop specifically for supplying gas lights and gas fittings to Brinsworth.

During the national coal strike of 1912 the coke oven workers, unlike the miners, were not in dispute but they were locked out. All men were prevented from working at the gas works until it was realised there was no gas available for Brinsworth and Canklow, whereupon the gas retorts were re-lit. The only repercussion was caused by someone throwing a brick through the retort house window but notwithstanding this isolated incident the residents were quite happy to have gas available for lighting and cooking.

Between 1910 and 1912 the supply of gas was extended from Rotherham to Catcliffe and then to Treeton during 1918. (121) Rotherham Corporation requested that Rotherham Main should supply gas to Catcliffe and Treeton because of a temporary breakdown

in supplies of gas from Rawmarsh gas works. (122)

There is strong local evidence to indicate that Rotherham Main Gas Works were the first to supply gas to a Corporation. It is known that early in the twentieth century a correspondent wrote to one of the trade journals claiming that his company was the first to achieve the distinction but the coke oven manager, A.C. Middleton, successfully convinced the correspondent, through the medium of the press, that this honour rightly belonged to Rotherham Main.

In August 1920 an electrically driven compressor was installed at the coking plant to supply nearly 400,000 cu.ft. of gas per day and in April 1922 two compressors were operated in parallel to deliver 700,000 to 800,000 cu.ft. gas per day. There is evidence of a change in the need for gas which the coking plant was well able to meet. Figure 8 is a reminder that street lighting by street lamps had been increased in height and a modern lamp fitted.

The author has found a picture showing some mechanical plant in an untitled and undated book and he positively identifies it as being the interior of the exhauster house at Rotherham Main. The photograph is reproduced in figure 16 and comparison with figure 24 is striking. It is evident that by the time figure 24 was taken in 1930 the exhauster house doors had been renewed. Figure 16 must have been taken before 1920 because it does not show the electrically driven gas compressors already mentioned. A very important feature of this exhauster house, which was typical of the period, was the common line shaft driven by a vertical steam pump shown in the right hand side of the figure. Was there



total disregard for safety or an unawareness of the risk of igniting a gas leak from the belt drive? Whatever the answer the best means available had been applied to the problem.

In July 1927 number two coke oven battery was shut down and dismantled so that a modern battery having 50 per cent more throughput than both existing waste heat batteries could be built. Only one battery was left working from July 1927 to 1928 and the supply of gas to Rotherham was reduced to 250,000 cu.ft. per day. In September 1928 number one coke oven battery was stopped and the supply of gas to Rotherham suspended until the new ovens were started on 7th May 1930. (123) Figure 12 was taken soon afterwards. In the meantime a supply of gas for use in Brinsworth and Canklow was obtained from Rotherham Corporation and this continued for many years afterwards. Typical of the industry as a whole, the new battery supplied unpurified gas to Rotherham Corporation for purification and distribution. The company opted to mine coal and produce coke and by-products rather than become involved in a limited way in the distribution of gas. During the last two days of heating the new ovens Rotherham Corporation supplied an additional 145,000 cu.ft. of gas for underfiring the battery. (124)

Was there an element of trial and error in respect of some of the new equipment associated with the new ovens? A new rotary booster having a capacity of 100,000 cu.ft./hour was started up on 8th October 1931 and a new vertical steam driven compressor rated at 150,000 cu.ft./hour was started up on 18th May 1938. The answer to the question which was prompted by the late installation of the rotary booster and the compressor probably lies in the fact that money was in short supply, management was by tradition thrifty, and so capital investment

for replacing old and obsolete equipment was delayed as long as possible. By adopting this attitude towards replacement of equipment there was time for the pattern of demand for gas to establish itself and facility for teething troubles on the new plant to be ironed out. The fact that an electrostatic tar precipitator was brought into service in 1936 is supporting evidence for change brought about by advance in technology and a change in demand.

Figures 10, 13 and 17 show a feature which is most unusual, if not unique in coal mining. They show headgear pulley wheels which served the Swallow Wood seam and also the extension to the headgear so that two more pulley wheels could be added at right angles to the first pair of wheels. The additional pulley wheels served the Barnsley Bed coal seam. The net result was that a single 18ft. diameter shaft served two independent sets of cages, each with their own winding engine and serving one seam. The shaft was equipped with two 3 deck cages with a total of 6 tubs per cage for the 350 yard deep Barnsley Bed and two 2 deck cages with four tubs per cage for the Swallow Wood seam which was 80 yards deeper. The more distant headgear shown in figures 10 and 13 and seen as the downcast shaft in figure 17 served the 608 yard deep Parkgate seam. In an emergency, a 'Klondyke chair' was coupled underneath the Swallow Wood cage so that men from the Parkgate seam could be raised to the Barnsley Bed level and then transferred. (125) The company were prepared to innovate at the colliery when it was advantageous to do so and it is reasonable to presume they would do likewise at the coking plant if necessary.

Figure 17 shows the colliery taken from outside the coke oven offices. The author believes the view was taken about 1945



FIGURE 15

General View towards Canklow Road 4th July 1958. (128)





FIGURE 16

Interior of the Exhauster House (129)

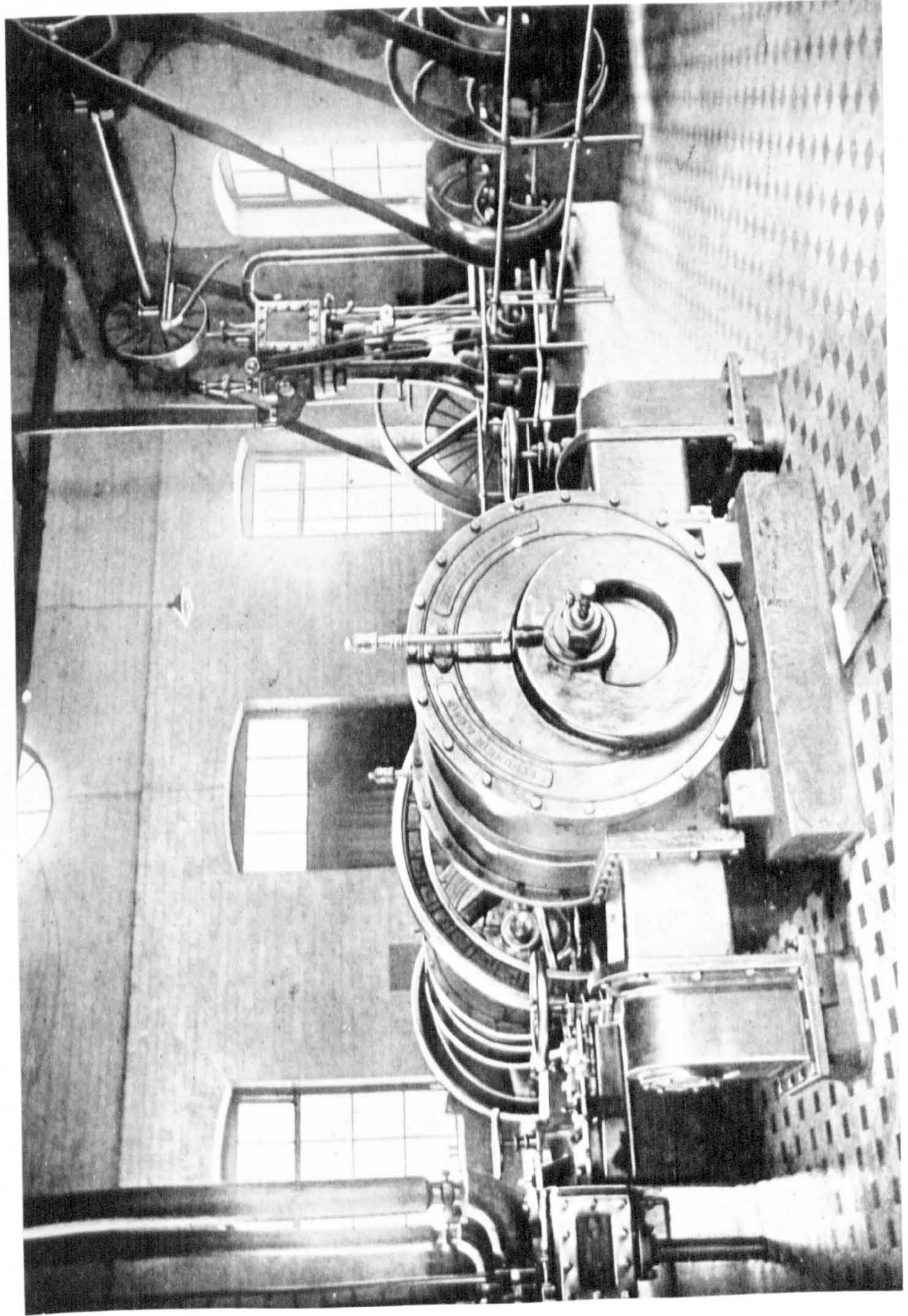
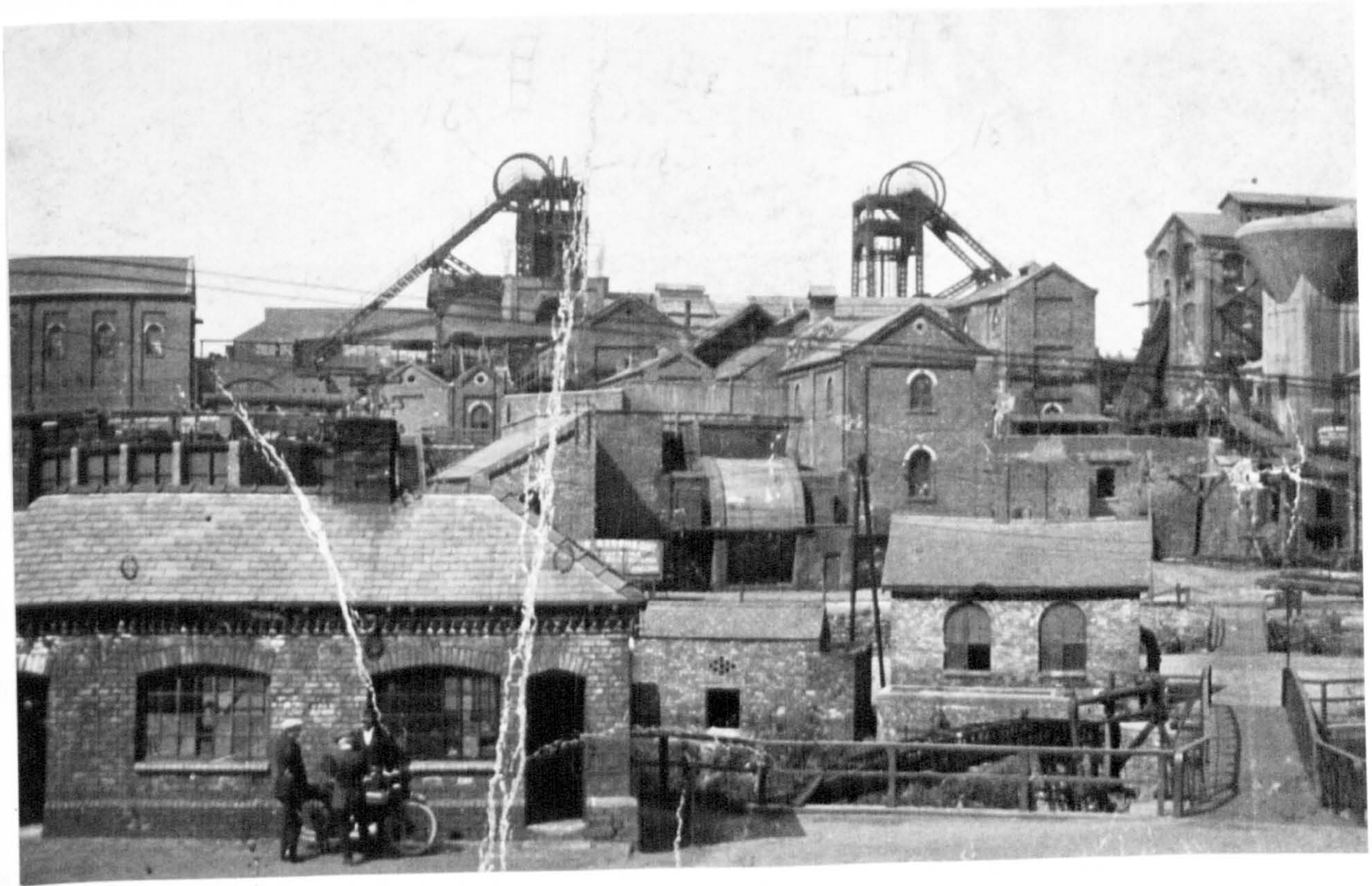




FIGURE 17

The Colliery as seen from  
the Colliery Yard. (130)





although it remained unchanged from the development of the colliery early this century until it was closed in 1954. In the foreground are two foot bridges, the first spans the river Rother and the second spans the Ickles goyt, part of which can be seen in figure 5. The totally artificial goyt was built with the sole object of delivering water to the Ickles mill in the late nineteenth century. It was supplied with water from the river above the Ickles weir. (126)

Figure 14 is outstanding because it gives the impression of a large undertaking built compactly on a difficult site and figure 15 shows abnormal conditions through which the colliery and the coke ovens operated. One item worthy of mention and not referred to elsewhere is the landsale, the entrance to which is shown in figure 5 and whose four bunkers are clearly visible on the left of figure 17 with two internal rail wagons standing over them. Other items are the concrete cyclone for the washery in the right hand side of the figure and the circular concrete structure covering the fan blades in the centre of the figure.

Figure 18 shows the extensive sidings with the spires of Rotherham churches and the concrete cooling tower of the power station in the background. In the foreground can be seen one of the typical B.R. locomotives and an assortment of rolling stock comprising wooden wagons with white diagonal lines signifying restriction to internal use, and small steel wagons used only between the colliery and the tip. There are three tar tanks in the sidings, located between the coking plant and the river. (131)

Figure 19 is a view towards the opposite side of the colliery and shows one of three shunting locomotives going towards the colliery tip. The shunting engine is quite typical of industrial engines, the main feature being the short wheel base.



John Brown and Co. extended the railway bridge which crossed the road to the right but off the figure so that the track ran adjacent to the main lines. The private track was demolished after the coking plant closed down but the structure of the bridge shows evidence of where the track crossed the road. In an area to the left of the locomotive the author has found a few lengths of track which have escaped demolition.

The gas control room under the bunker as seen at night is shown in figure 20. In the distance can be seen the wagon tippler which was typical of many installations. All rail wagons had end opening doors and were raised at one or the other end of the tippler according to which end of the wagon the hinged door was situated. Later wagons were capable of being tipped at either end.

Figure 21 has been included because it shows the exceptionally clean lines of the quenching tower and overhead water tank as well as the coke wharf and coke car track as well as the coke guide itself almost thirty years after the plant was started up. (132) In this respect it is outstanding.

An overall view of the coking plant and the colliery, as seen by the residents of Atlas street is given in figure 22 and is the converse of figure 11. Examination of an enlarged version of this figure reveals a land mine crater in Canklow wood at a location above and to the left of the concrete coke hopper shown towards the left of the figure. (133) In the foreground can be seen the new 20 tons capacity steel hopper wagons used for transporting coke. Many of the small wooden wagons were purchased from British Rail for internal use. This colliery, like many



FIGURE 18

View of the Railway Sidings looking towards  
Rotherham. (134)





FIGURE 19

Shunting Operation in the Direction of  
the Colliery Tip, 3rd July, 1958. (135)





Part of the Battery of Ovens at Night Time (136)

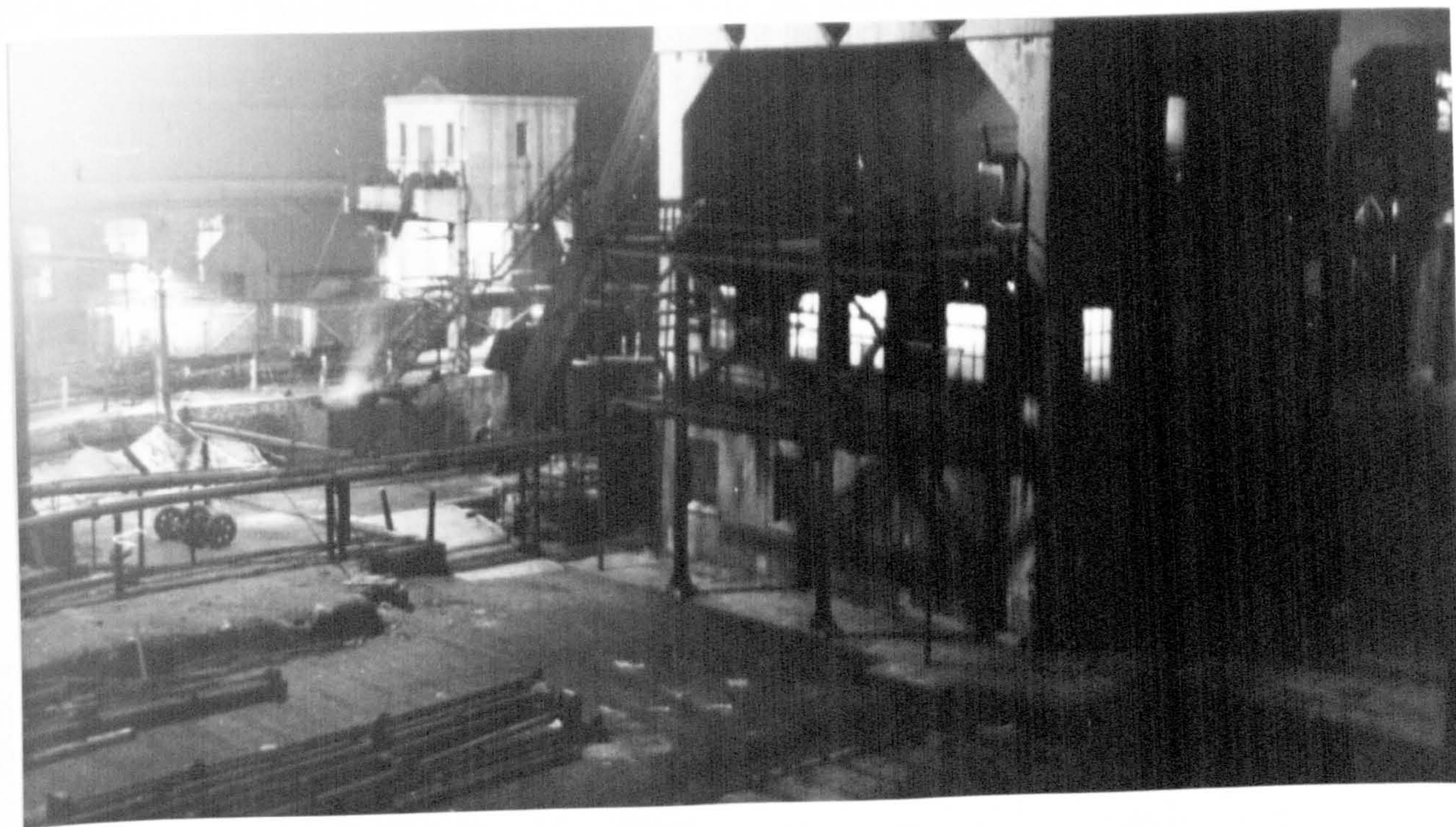




FIGURE 21

Quenching Station and Coke Wharf 22nd September 1957  
(137)





FIGURE 22

Rotherham Main Coking Plant 1950 (138)





others, had a small wagon repair shop and the purchase of large quantities of second hand rail wagons was a simple solution to the ever increasing problem of wagon maintenance. Also in the foreground and to the right of the figure can be seen the colliery locomotive shed built onto the end of the fitting shop in typical manner.

#### The Foreman's Office

The foreman's office is specifically mentioned because it indicates a traditional method of economy which has continued until the latest generation of coke oven rebuilds in the 1950s. Simon Carves constructed a small brick site cabin near the old battery of waste heat ovens when they started building the new ovens. A wooden 'lean to' structure was built on the front and provided 'clocking in' and 'clocking out' facilities. Another 'lean to' on one side contained a series of wash basins supplied with running cold water and a further 'lean to' on the opposite side contained a bathroom but this was only used infrequently. Yet another 'lean to' on the rear of the building provided a small store for shovels, picks and a wheel barrow so that the foreman could keep a check on these vulnerable items. Why was this method of obtaining a foreman's office adopted and was it the best method? The building was located conveniently in the middle of the plant and with three 'lean to' structures in regular use became the focal point - the foreman was well placed to know detailed information which might otherwise not be so readily available.

Superficially the colliery company acquired the building free of charge but in reality it must have been included in the contract price. It could be argued that it would have been

better to include a new foreman's office and other facilities as part of the contract on the understanding that the contractors could use the facility while on site. The fact that the contractor's site cabin would have to be paid for in any case supports the argument that a purpose designed building would have many advantages. Nevertheless, in retrospect the brick building, with three wooden framed 'lean to' structures and a brick built extension at the back withstood the test of time and survived more than 30 years until the plant was closed. Perhaps acquiring the office in this way happened because in the 1920s money was short and false economy though it was, the coke oven manager could be seen to be working to a tight budget.

It is worthy of note that in the 1950s numerous wooden site huts were used by Woodall Duckham and by Simon Carves when they built Avenue and Manvers respectively and in both cases the huts were taken over by the N.C.B. when the contracts were completed. Since, in these instances, the site huts were portable it is reasonable to assume that some financial arrangement for their transfer was made or they would have been removed by the contractor.

#### Coke Oven Chimney

The coke oven chimney for the new battery of ovens illustrates problems which can beset an industry and are characteristic of pioneering. Regenerative ovens were still in their infancy and the chimney for the new battery was constructed to a standard more appropriate to waste heat ovens characterised by high waste gas temperatures. The temperature of the waste gases at the base of the new chimney would only be about 350°C, (139) so



condensation of water vapour probably occurred higher up and formed sulphurous and sulphuric acids which attacked the brickwork. Whatever the technical details the chimney had to be strengthened with steel rings three times and then reduced in height. (140)

It is known that in 1934 and 1937 the chimney was repaired and strengthening repairs which are presumed to mean the fitting of steel rings were carried out in 1942. In 1944 it was reduced in height by 10ft. because it was unsafe and demolished later in the same year. (141) The steel rings can be clearly seen in figure 12 which was taken early in the life of the new plant. (142)

In 1944 a new chimney 185ft. high, 6ft. internal diameter and lined with  $4\frac{1}{2}$  in. thick firebricks for the first 60ft. was built by Tattersalls for £3,155 and guaranteed for 10 years. Because the chimney was built a safe distance from the old one a new flue had to be constructed at a cost of £1,500. (143) The dimensions of the chimney are given because it was quite typical in size and appearance, although records do not indicate whether the upper part was built with acid resisting bricks. (144) This omission is highly significant because soon after the guarantee expired W.E. Harrison and Company, a firm of steeplejacks in Sheffield, removed about 30ft. of the top brickwork following one of their inspections, because it was unsound. As time went by the chimney was lowered twice more until there was only just sufficient draught to operate the coke oven battery. (145) As a safeguard against falling brickwork the area at the base of the chimney was fenced off and the chimney lasted without any further shortening until the plant was closed down on 24th November 1962. (146) This is the only plant where a serious failure of

the battery chimney is known and it is worth considering why it should happen at Rotherham Main. Tattersalls were a well established firm of chimney builders and it is unlikely they would have used faulty materials or poor workmanship in the construction of a chimney. Furthermore, they had additional incentive to give value because of the premature failure of the first chimney. One factor which would encourage condensation in the upper part of the chimney and cause deterioration was the excellent condition of the coke oven battery which had virtually no flue leakage. It is ironic that, had the battery been in poor condition the exit flue gases would have been hotter and less likely to condense in the upper part of the chimney. It is an unproven possibility that there is a positive correlation between this battery having two new chimneys each lasting about 15 years, when a coke oven chimney should last the life of a battery, and the chimney base temperature being the lowest in the North Eastern Divisional Carbonisation Department of the N.C.B. (147)

#### The Coking Plant Office

During the life of the waste heat ovens the manager's office was incorporated in the plant laboratory building which itself formed the pedestal of a tar storage tank - in consequence the walls of the laboratory were three feet thick. Most of the clerical work was carried out by the colliery on behalf of the coking plant and so only offices for the manager and his assistant were needed.

The office facilities were re-examined when the new ovens were built; the outcome was a separate office block built on the only suitable land available on the other side of the river,



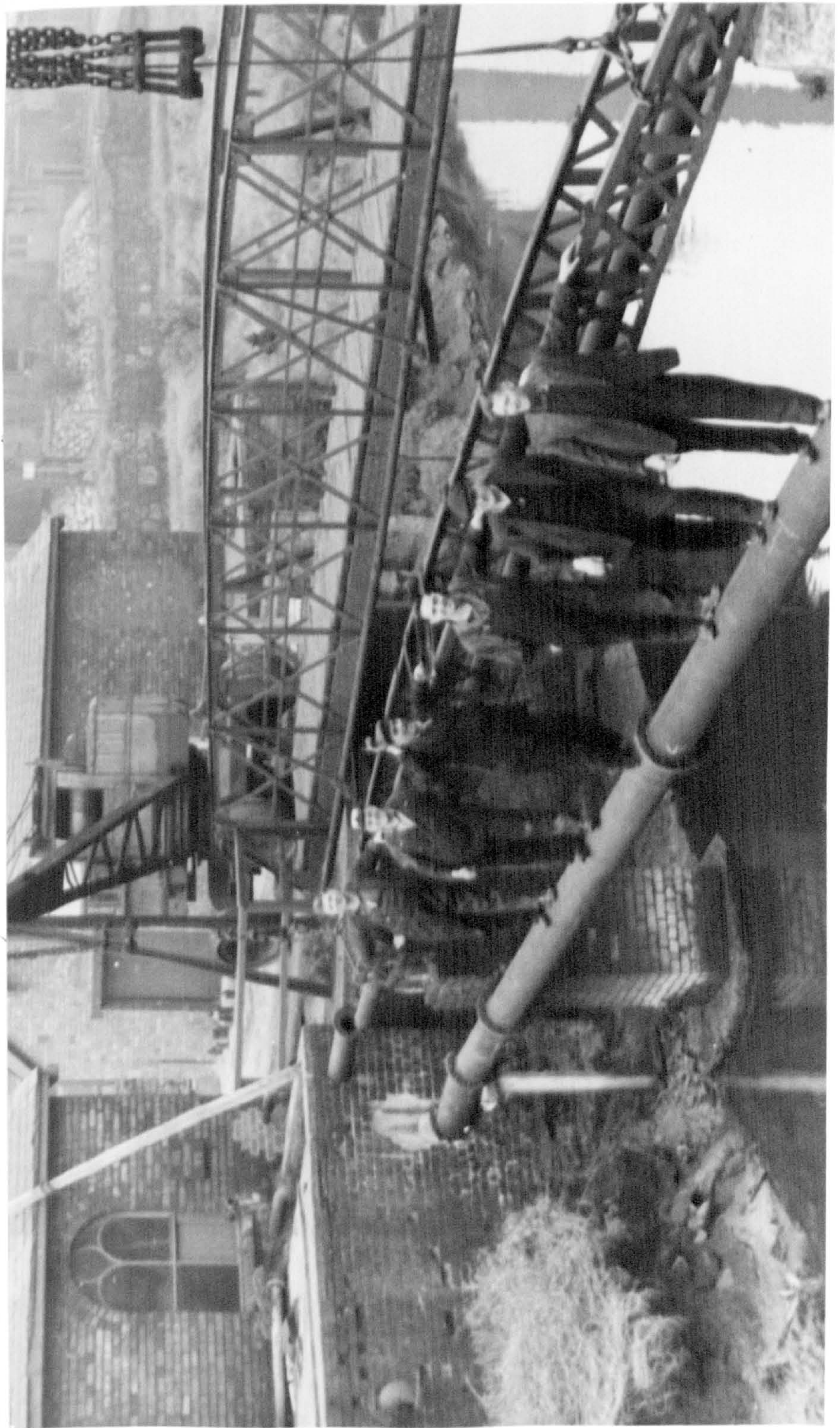
near to the gas holders and designed specifically for the coking plant needs. See figures 6 and 14. There was evidently a realisation that the needs of the coking plant could best be served by increasing authority. The foot bridge linking the plant and the offices on either side of the river Rother is shown in figure 23. (148) The former manager's office was altered to allow for an increase in laboratory facilities because there was increasing awareness of the importance of analytical control of the coking process, especially as the market for by-products was gaining importance. The art of coke making was gradually becoming more science based. The long standing lack of sophistication was being rectified as a result of improved scientific knowledge. The new single storey office building included the manager's office with a communicating door to the general office, an engineer's office, an office for the assistant manager and a small waiting room for visitors. All the offices were equipped with fireplaces though gas fires were installed throughout at an early date. One other small room became a secondary stores, mostly for small miscellaneous electrical items. This store should never have come into being but the room was too small for an office and perhaps more significantly, it was an attempt to secure specialist items which would not be stocked with enthusiasm in the main colliery stores. This is a clear indication that greater autonomy from the colliery was being encouraged.

Typical of many offices in the 1920s and 30s the general office was equipped with tall desks and matching stools not unlike those of 'Charles Dickens' period. The top of each desk, which sloped towards the writer, could be raised to facilitate storage



FIGURE 23

A new Gas Main, 23rd October 1957. (150)





of ledgers etc. By the 1950s this type of office equipment had generally been replaced with a more modern type but the original furniture in the general office at Rotherham Main continued in use, presumably by choice of the clerks, until the plant closed in 1962.

The engineer's office was equipped with similar tall furniture and also a drawing board. In practice the engineer had to produce drawings and supervise the engineering activities on the plant. The office was large, perhaps because of its dual function, but also because there may have been the possibility of engaging a draughtsman in the early days. (149)

The use of tall desks and stools was typical of the period and presumably it was considered to be ideal at the time. The continued use of the equipment on a voluntary basis long after styles had changed shows that it had merit forty years later.

The manager's office, in contrast had a relatively low desk and a swivel chair - perhaps these were more recently acquired, and a bookcase and two cupboards. The wooden fire surround was built diagonally across one corner of the office and is in evidence today though the offices were sold to a haulage contractor several years ago. The manager was the only person to have a desk light as well as normal room lighting.

Quite typically all the offices and the corridor were fitted out with heavy brown linoleum but there was a door mat at the entrance to the building and another at the entrance to the manager's office. Each office was capable of being heated by an open fire although gas fires were fitted throughout at

an early date. The only items provided by the colliery after the new battery was built were a stores facility and time keeping and wages distribution facilities. Evidence of confidentiality in respect of staff salaries is shown by the fact that the wage of the coke oven manager was not classified along with those of the assistant manager, engineer, chemists and clerk. (151)

Like other similar offices an additional toilet had to be provided during World War II when a female typist was engaged to replace staff who were called upon to undertake national service. Another feature was that the manager's office was prudently located so that he could see much of the plant and the access to it across the footbridge from the office windows.

Finally, the advent of nationalisation and the passage of time required every coke oven manager to have a small safe fixed in his office. When the plant closed the safe became redundant at a time when the church commissioners were requiring that every church vestry should also be equipped with a safe, hence the safe at Rotherham Main Coking Plant was purchased by the church authorities at a nominal charge and installed in the vestry of Catcliffe church. (152)

#### Features in Elevation

Figure 23 reveals several important features, some of which are typical of any industrial scene in the late 1950s, while others are peculiar to Rotherham Main. The fact that the coking plant required a footbridge across a river was unique, though it didn't cause any hardship as far as access and plant control were concerned.



Other features shown in the background are the sample preparation room and laboratory. Also in the background is the railway track, initially used for loading salt, tar and benzole into rail wagons or rail tanks. By the late 1950s most salt and benzole was despatched by road and only tar was transported in rail tanks to Y.T.D. (153) Also in the background but nearer the camera can be seen part of the retaining bank for the Ickles goyt shown in figure 5. The stone bank was necessary in order to construct the single track railway on this congested part of the plant.

Two 'Jones' cranes were used in the pipe renewal project and one of them is clearly visible in the figure. They were quite typical of cranes used for loading and unloading rail wagons with coal on the coal stocking site and for stocking and reclaiming coke. For a long time the plant had depended on one crane for all its lifting duties but closure of Waleswood coking plant provided an opportunity for a similar but older crane to be transferred to Rotherham Main.

Cranes of the type shown were intended for light hoisting duties. Although often fitted with a grab they were never intended to work on such arduous duties for long hours associated with stocking and reclaiming coal and coke. The fact that both cranes frequently travelled across rail tracks and over rough terrain and carried out endless grab duties is tribute indeed to reliability and robustness despite their slight appearance.

Last, and perhaps most important, figure 23 shows typical clothing worn by maintenance men in the 1950s. Ordinary heavy boots designed for durability were purchased by each fitter -

safety footwear came into use later. Each man also bought and maintained his own overalls. Generally old suit jackets were worn as additional protection against inclement weather, caps were worn by some of the men for the same reason. When handling hot equipment it was standard practice for an operator or a fitter to remove his cap and use it to provide thermal insulation between the equipment and his hand. All clothing was dark and durable, though it was never designed to end its life in service in the coking industry.

Personal hygiene and safety figured low on the list of priorities and only accidents were investigated in any detail. It was not until a few years later that safety clothing became accepted as essential equipment, although barrier creams and skin cleansers were gaining popularity.

#### Wartime Conditions

Rotherham Main, like many other coking plants, had a toluene plant built onto the end of the rectification plant at the outbreak of World War II and most of the toluene was sold as a feedstock for T.N.T. production. (154) Within 12 months of the start up of this plant Bernard Bellamy was released from general work and given Ministry of Supply Work at the toluene plant so that he became exempt from National Service. (155) As a precaution against invasion by the German army the toluene and motor spirit tanks were individually coupled by a 3in. diameter pipe to the tar storage so that if need be they could be quickly filled with tar by gravity feed and the contents spoilt.

In typical manner a large shed was built over the coke oven battery to prevent glare at night-time and make landmarks



more difficult to identify by the German Luftwaffe during World War II. It is difficult to assess the effectiveness of this shed and the question of whether the objective could have been achieved much more easily by simpler means needs considering. Rotherham Main was by far the best kept plant and discipline was high. Oven door leakage was non-existent, neither was there any leakage from the chargehole lids or ascension pipes. Under such circumstances it would have been a simple matter to temporarily close one or maybe two ascension pipe lids in the event of an air-raid over Rotherham and Sheffield so that all visible light was eliminated. In any case such precautions had to be carried out as a matter of routine after each air raid warning even though the anti-glare shed was constructed. Presumably the shed was built because of Government directive which would be general and all embracing. (156) The structure made conditions on the battery top very bad indeed and they would not have been tolerated except as a war-time emergency. It is interesting to note that despite constraints on the battery top the ovens were maintained to the traditional high standard throughout the war. (157)

The advent of World War II meant that all non-essential workers of suitable age were enlisted into the armed forces. Two of the clerks were no exception and they had to be replaced by employing one female typist/telephone operator. This caused much comment and necessitated another toilet facility being built onto the end of the coking plant office block. Hitherto clerical duties had been the sole domain of boys and men, presumably on the grounds that they might wish to transfer to jobs on the plant later on. (158)

Wartime conditions brought greater incentive for management to maximise yields, if any was needed. One novel way of improving the amount of gas for sale was the installation of a movable slide on the gas main prior to the exhauster. This device, known as Brewer's producer, was adjusted to allow the ingress of dilution air into the main so that gas of contractual calorific value was sold to Rotherham Corporation. The gas contract stipulated volumetric analysis as well as calorific value; one of the constituents so controlled was oxygen content. Rotherham Corporation were at a loss to understand why the oxygen content of the gas from this plant was higher than the gas from other plants but the phenomenon went on for so long that it became accepted even though it was not understood. Although the technique of gas dilution was good for business in the short term it aided corrosion of the mild steel mains in the long term. The detrimental effect was conveniently ignored.

An aftermath of wartime conditions was the tightening of measuring standards in the coking industry. As an example the volume and temperature and the former was in turn influenced by atmospheric pressure. Every coking plant had a mercury in glass barometer, usually located in the laboratory, and one duty of a chemist was to take spot checks of atmospheric pressure at set times throughout normal office hours. The results were given to a clerk the next day for inclusion in a calculation to determine the volume of gas sold. Similar circumstances were adopted at Rotherham Corporation Gas Works and a clerk there calculated the volume of gas received. The actual volume on which payment was made was then agreed by telephone and often resulted in compromise. The weak link was atmospheric pressure



because it was only checked during daytime though gas was sold continuously. The problem was overcome by installation of a barograph so that the average atmospheric pressure over the preceding twenty four hours could be more accurately determined. (159)

#### Closure of the Colliery 1954.

Early in the 1950s the colliery had increasing problems underground and after some 60 years of virtual continuous working it became more economical to mine the coal from other pits. The colliery closed at the end of April 1954 (160) and the remaining 290 employees were transferred to other collieries. By this date some 8 coking plants in Yorkshire and a smaller number in Derbyshire had been closed. (161) Bearing in mind the reason for the existence of early coking plants and technological progress in the electricity generating industry the surplus coking coal could easily be used as power station fuel, although this is shown later to be wasteful. In sharp contrast Rotherham Main Colliery was the first colliery to be closed before the associated coking plant and a different set of financial constraints became essential. It is a tribute to all past and present members of the coking plant that it ran successfully until 1962 without the financial benefit of at least some local coking coal and colliery services. The plant had to assume full responsibility for the shunting services and related maintenance and two 0-4-0 saddle tank locomotives No. 7 and 14 were taken over. (162) Because of a shortfall in steam raising capacity the plant took over two of the colliery Lancashire boilers to supplement the supply of steam. Yet another burden was the need to pay increased rates on the extra land from the colliery though it continued to be profitable mainly because high quality blast furnace coke, at a premium price was produced.

### Careers of some Senior Staff

Figures 24 and 25 taken in 1930 mark the retirement of W. Sanders, Senior Operating Foreman, (163) and it is convenient to illustrate the progress of some of the senior staff shown in figure 25 and identified in figure 26.

The career of L.N. Brewer is examined in detail in order to illustrate certain features. His remuneration is given in figure 27 and the indices of weekly wage rates over the same period given in figure 28 for comparison. The retirement of the senior operating foreman brought promotion for L.N. Brewer from the position of Manager's Assistant which he had occupied since leaving school in 1917. (164) Why was the post of senior operating foreman occupied by a person who had not been a shift foreman? In order to answer this question the duties of Manager's Assistant need to be examined. The only occupant spent thirteen years in post and it is evident that as he matured he was given more responsibility. For instance, he was in charge of all the maintenance men for the coke ovens and the by-product plant up to demolition in 1928, and became clerk of works for the erection of the new plant 1928-30. Thereafter he was responsible for all plant operations. At some stage early in his career but after 1930 he supervised the Rotherham Main coal washery and also the Beehive coke ovens at Aldwarke Main colliery - also owned by John Brown and Company and located on the opposite side of Rotherham. Like other staff with ambition he attended Sheffield Central Secondary School and Sheffield University in his spare time and obtained certificates in Chemistry, Mathematics, Machine Drawing and the City and Guilds Certificate in Coke and By-product Manufacture. With



FIGURE 24

The Retirement of W. Sanders 1930. (167)

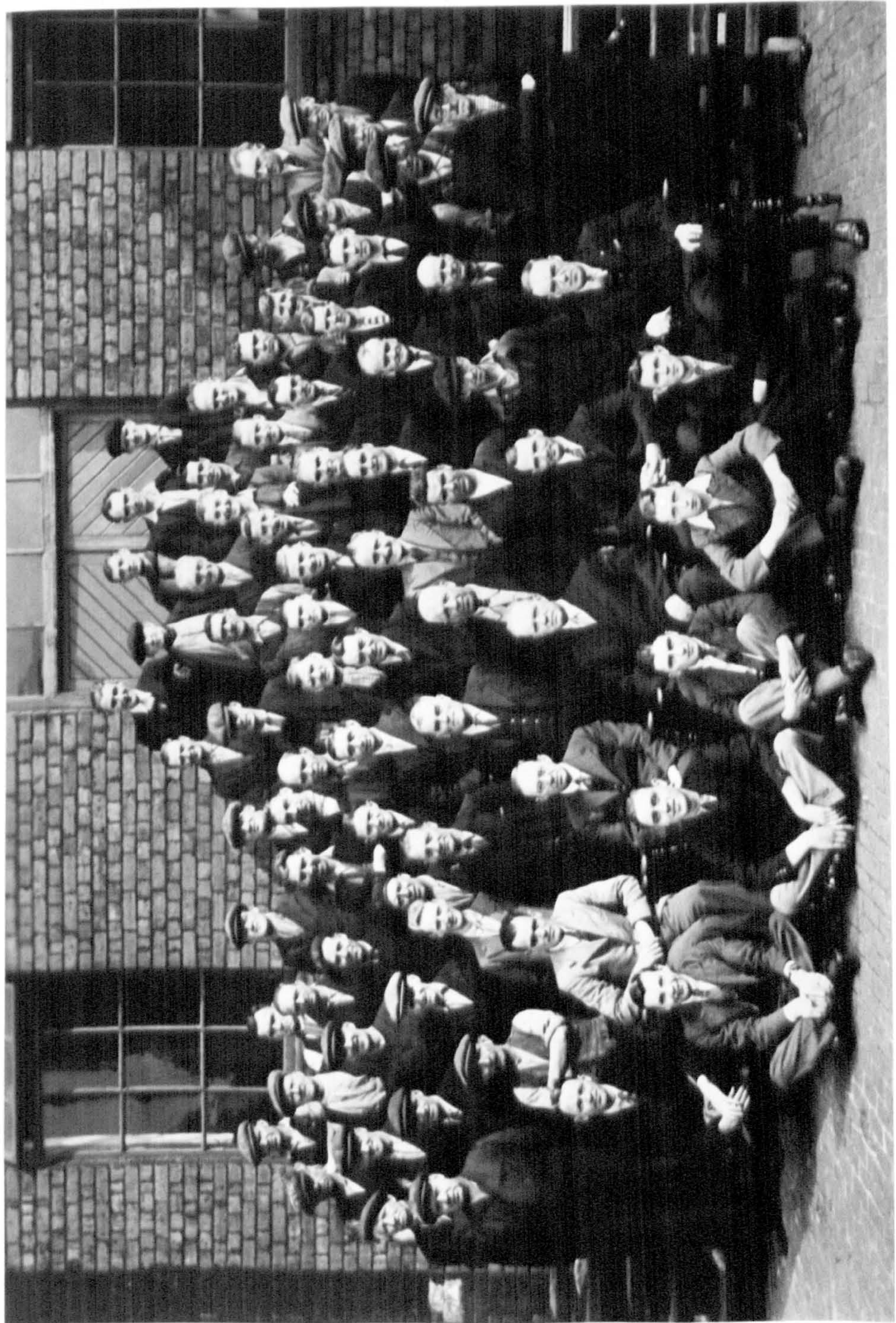
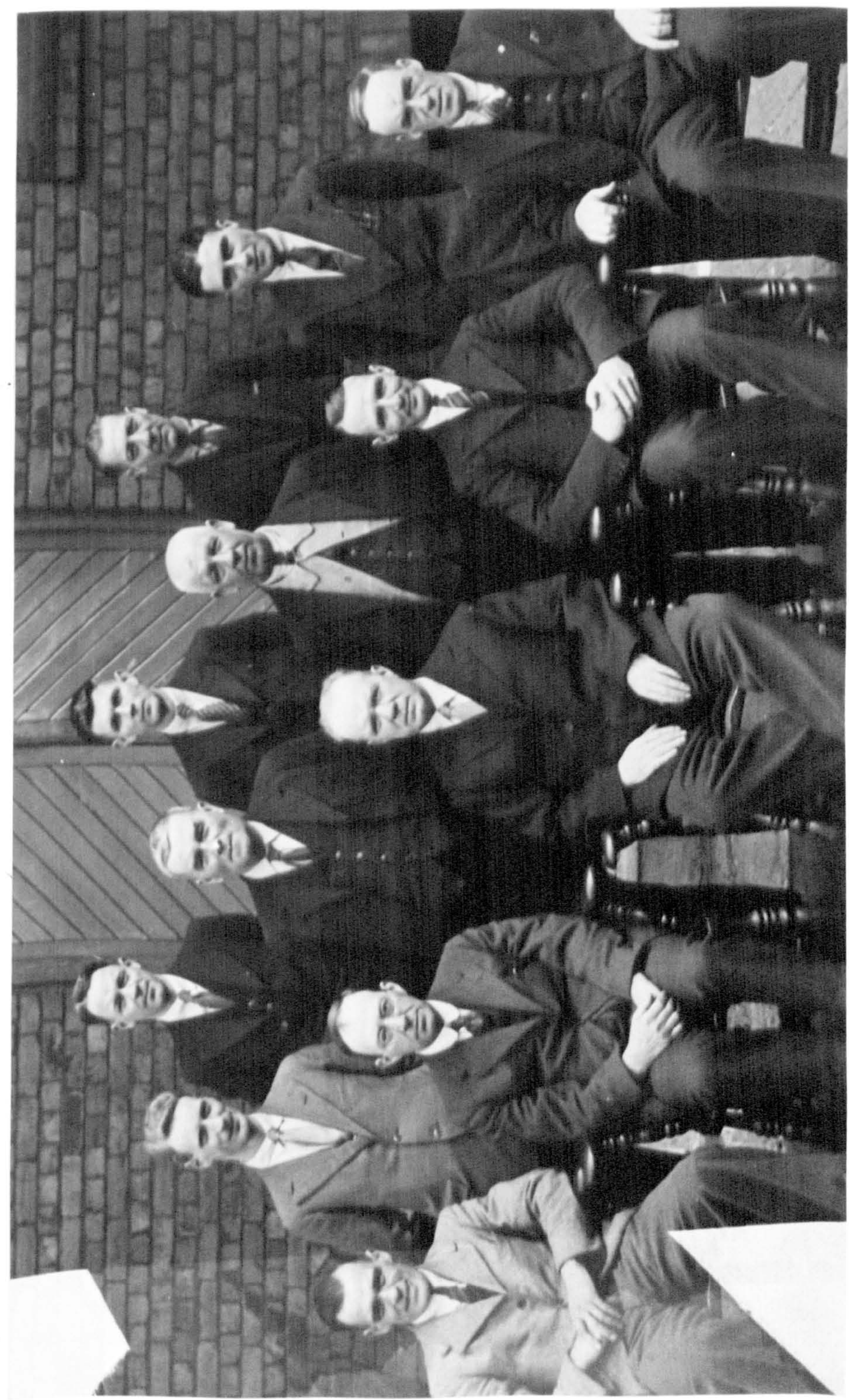




FIGURE 25

Senior Staff at the Coking Plant 1930. (168)





**FIGURE 26**

**Identification of Senior Staff. (169)**

Arthur Foster	Stan. Wilson	Jack Allen
Leslie Atkinson	George Stephenson	Edgar Winterbottom
		Ernest Brown
Jack Arrowsmith	Alfred Charles Middleton	Bill Sanders
		Leslie Noel Brewer
		Jim Morris

such a record it would have been inappropriate to offer him the post of shift foreman. Undoubtedly his appointment as Senior Operating Foreman was influenced by his academic achievements in conjunction with personal qualities, he was appointed Assistant Manager in 1936. A.C. Middleton retired in 1945 and he was succeeded by G.J. Greenfield.

The appointment of G.J. Greenfield is worthy of comment because it marks a brief departure from the traditional method of internal promotion. Greenfield had a background knowledge of the coking industry and a university degree. There is some doubt about whether his academic qualification influenced this appointment or whether he arrived because of influential friends. It soon became clear that his impracticable approach to plant problems was not beneficial to the plant and some of his ideas were even dangerous. Within a few months G.J. Greenfield was dismissed and the appointment of L.N. Brewer as his successor in 1945 restored the traditional hierarchy. If circumstances in the industry had been different there would have been little chance of further promotion; however, the advent of Nationalisation of the Coal Industry brought about a completely new tier structure which had to be filled by people within the industry. (165)

Early in Nationalisation when petrol rationing was still in existence L.N. Brewer was given added responsibility for managing Cortonwood Coking Plant (166) but when Groups were established he relinquished dual responsibility and became Group A Carbonisation Manager with responsibility for Nunnery Sheffield, Nunnery Handsworth, Rotherham Main, Smithywood and Dinnington Coking Plants. E.T. Parry became Coke Oven Manager at Rotherham Main and G.W. Chambers became Manager at Cortonwood when the respective



plants at Waleswood and Mitchell Main closed coincidentally with the transfer of L.N. Brewer to the Group A headquarters. Although L.N. Brewer did not have an Assistant Manager when he succeeded Greenfield at Rotherham Main, the closure of Mitchell Main produced a surplus Assistant Manager and so G. Crow was transferred to Rotherham Main on a short term basis until the Assistant Manager at Cortonwood, M.V. Wilks retired. G. Crow was transferred to Cortonwood and the Assistant Manager post at Rotherham Main remained vacant.

As part of the evolution of the Carbonisation Department two senior posts were created at Divisional level. One was a Divisional Chief Carbonisation Officer (Operations) and the other was Divisional Chief Carbonisation Officer (Planning). These were filled internally by two of the three Group Managers, L.N. Brewer became responsible for Operations and H.M. Kenyon moved from Group C in the Wakefield area to become responsible for Planning. The respective vacancies were filled by Coke Oven Managers within their own groups, namely E.T. Parry and C.C. Morris. Parry's vacancy at Rotherham Main was filled by promoting G. Crow from Assistant Manager at Cortonwood, and leaving the latter post unfilled. Crow retired on ill health grounds, thereby enabling Jim Avery, a former Assistant Manager of the little known Nunnery Sheffield Coking Plant to assume overall responsibility for Rotherham Main. He was paid at Assistant Manager rate for several years and it was not until close to retirement that he was officially appointed Manager - the unanswered question is - were the N.C.B. obtaining supervision cheaply or were they being kind to an Assistant Manager whose original plant had closed so that he was left without a job?

A few months before Avery retired from Rotherham Main E. Morgan, who had already been transferred from Denaby Main Gas Works when that plant closed was still Manager at the closed down Dinnington Coking Plant. It was reasonable for him to succeed Avery at Rotherham Main until it closed. Thereafter he moved to Smithywood Coking Plant as Assistant Manager without loss of salary until the vacancy for a Manager at Glasshoughton Coking Plant occurred.

Simultaneously with all these moves at plant level were changes in the structure of the entire system. In 1963 Coal Products Division was formed as a result of the decreasing number of plants and the former North Eastern Division and the East Midlands Carbonisation Department amalgamated. For the first time in the history of the industry there were two people for each post in the region and both the Director of the North Eastern Division and the General Manager of the East Midlands Division were anxious to have the new Regional Headquarters in their existing buildings. Whichever Division won the location would also secure the majority of jobs in the new organisation. The North Eastern Division had many more coking plants but the headquarters were located in a former private residence in a high class area of Sheffield and could not easily be extended. In contrast the East Midlands Headquarters were purpose built along with the Avenue Carbonisation Plant in 1958. It was soon obvious that the new headquarters of the combined divisions would have to be located at Avenue. This had a marked influence on subsequent staff changes.



The former East Midlands General Manager retired and the former N.E. Divisional Director, John Bradwell, became General Manager for a few years until retirement. Bradwell was succeeded by A.I. Coleman, who came from Fisons the fertilizer and feedstuffs manufacturers. Coleman remained General Manager for about 4 years and was succeeded by M.R. Meades who had been Manager at Avenue and believed in the former East Midlands hierarchy to the exclusion of all else. Both L.N. Brewer and H.M. Kenyon were transferred to the new headquarters but the former was not given a substantive post because he was due to retire within 12 months. H.M. Kenyon was an obvious choice for Production Manager.

Why did L.N. Brewer appear to have a successful career and would the coking plant at Rotherham Main have derived more benefit from the appointment of a Manager with higher qualifications? It is difficult to give a short embracing answer to a question of this type when it involves continuous employment over more than forty eight years. Success was inevitably bound up with a combination of personal endeavour and good fortune in various proportions, as the following section attempts to portray.

L.N. Brewer was the son of the schoolmaster at Catcliffe and sought employment at the coking plant because it was within reasonable walking distance from home. Buses did not appear in the district until about 1910 and it was later still before the service from Rotherham was extended to Catcliffe and the neighbouring village of Treeton. He was one of a host of people who sought local employment at the earliest opportunity even though he had sufficient ability to be accepted for a place at Woodhouse Grammar School. As a result of this typical attitude industry gained a nucleus of able people in lowly employment

after being denied, or denying themselves, adequate school education. In spite of long hours at work and poor transport some employees improved their education by attending evening classes at the University of Sheffield. (170) Many of the courses there were biased to meet the needs of the surrounding community. (171) People who educated themselves in this way were well qualified by prevailing standards even though they did not have a degree. This attitude towards self improvement was largely responsible for reducing, if not eliminating the 'coke lore' referred to in chapter VI. Certainly they could understand the published work relating to the coking industry. (172) Motivation and initiation were essential qualities of people likely to gain promotion in the 1920s and those who possessed them had the foresight to see that sacrifices made early in life were likely to bring benefits later. Their academic ambition lay somewhere between craft and technician level with a bias towards the latter.

So far the qualities of education and endeavour have been dealt with but a third quality was essential in order to become a Manager. Leadership played an essential component of management but it was not taught. Perhaps at the time it was believed the subject could not be taught though the ideas of management could. As a result people were left to provide their own training for management by various means according to particular circumstances. Potential managers were recognised to some extent by their extramural activities and provided they had the requisite technical ability as well prospects were good. L.N. Brewer was choirmaster at Catoliffe church and Vicar's Warden, he rose to the rank of Inspector in the Special Constabulary during World War II. He served for a while as independent member on the predominantly



labour Council in Brinsworth in succession to A.C. Middleton the first coke oven manager. (173) He was also secretary of the Lawn Tennis Club when he lived at Mill House, Canklow and three colliery officials were associated with bowls, cricket or the Institute. (174)

It is worthwhile to digress briefly to draw attention to the fact that John Brown and Co.Ltd. developed extensive sports facilities under the control of senior staff. The activities were open to all employees although few workmen took advantage of the facilities. In the 1930s tennis, cricket and bowls were regarded as upper class sports and in the main those workmen who participated in them had aspirations for staff positions. In all probability the only reason why workmen with the Company had access to the sports facilities was to supplement the staff contingent and thereby make them feasible. This poses a question the answer to which is beyond the scope of this thesis - were the company attempting to remove long established social barriers or simply ensuring their staff could enjoy a selection of sporting activities in the district?

The remuneration received by L.N. Brewer is shown in figure 27. It shows that he was undoubtedly successful though success of this magnitude was uncommon in the coking industry. Figure 28 is given for purposes of comparison and figure 29 gives an indication of coking plant staff wages. John Brown and Company paid the Manager's Assistant a sum of £200 in 1917-30. (175) A Senior Operating Foreman received a salary of £250 in 1930-6, and the Assistant Manager received £450 per annum in 1936-45. From 1945 until nationalisation the Manager received a gross salary of £900 per annum, comprising a basic salary of £800

FIGURE 27

Remuneration received by L. N. Brewer. (177)

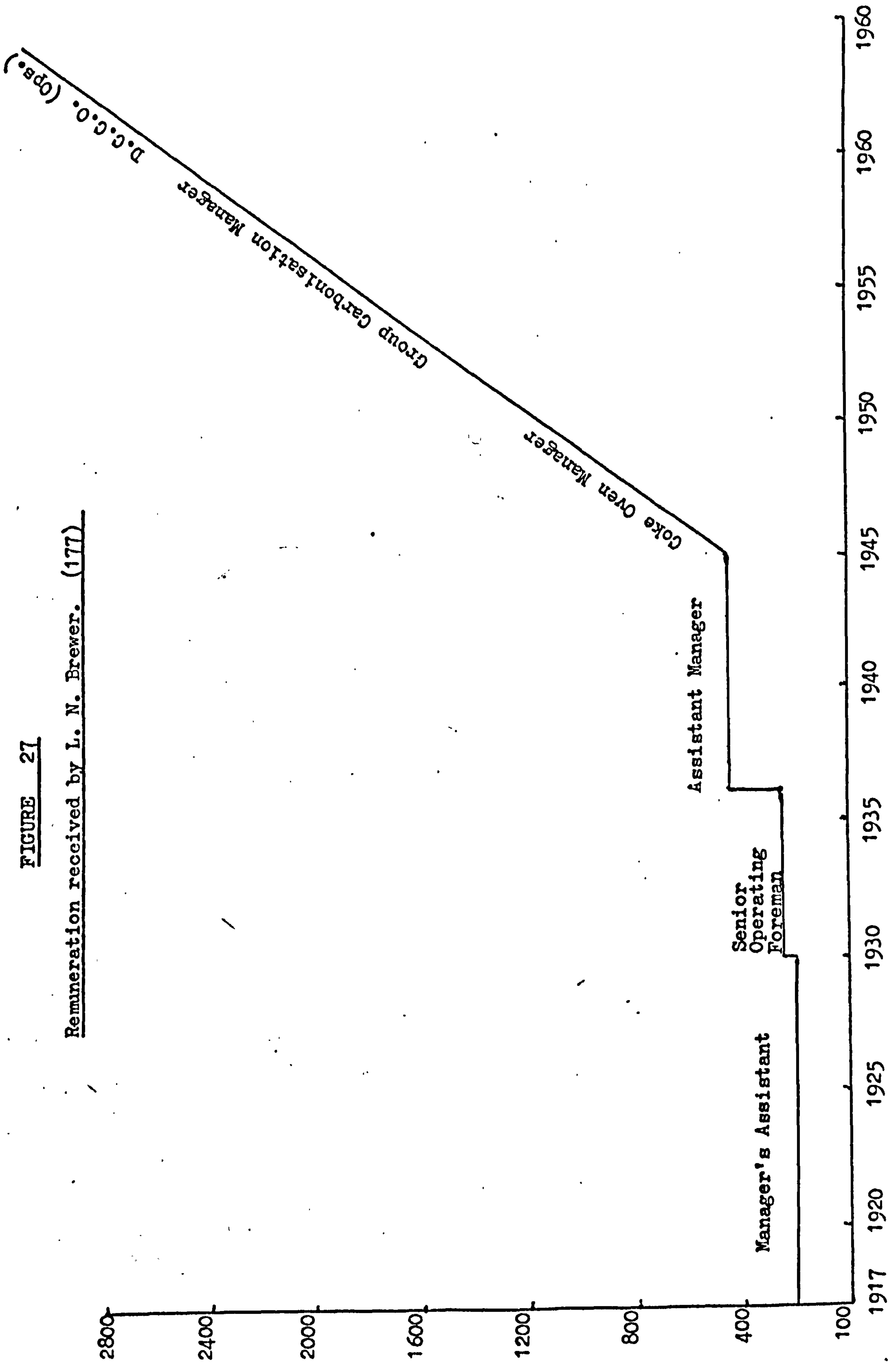




FIGURE 28

Indices of Weekly Wage Rates.

All Manual Workers, all Industries and Services. (178)

(1956 = 100)

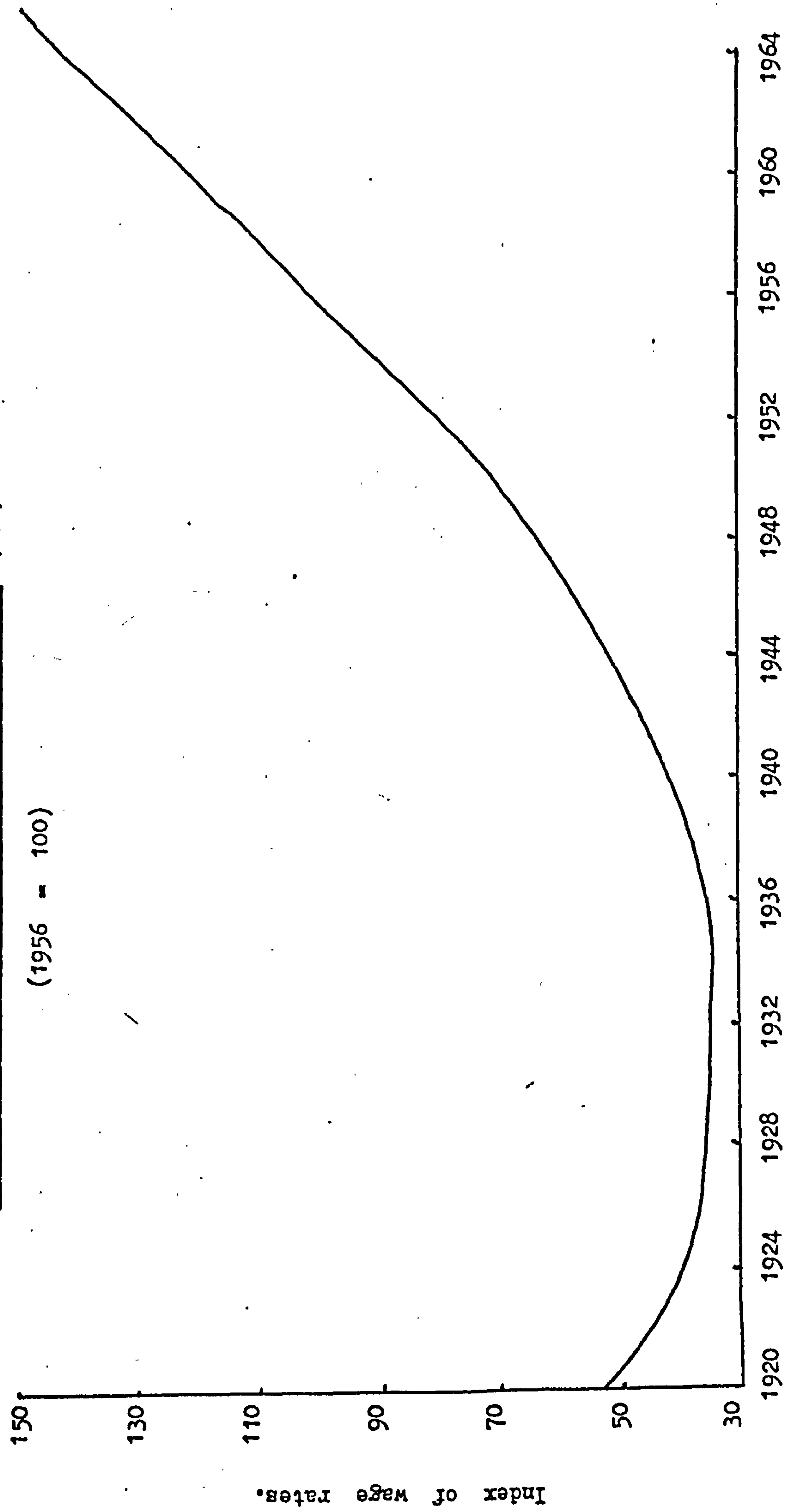


FIGURE 29

Typical Wage Rates (179)

	Gross Wages £. s. d.		
	Week ending 26th Feb. 1941	Week ending 29th Aug. 1945	Week ending 16th Nov. 1946
L.N. Brewer    Coke Oven Manager's Assistant.	8.10.11.	9. 0. 0.	(Manager)
A. Coster       Engineer	6. 2.11.	6. 15. 5.	8. 0. 0.
A.C. Fleming   Chemist	5.16. 9.	5. 14. 3.	5.14. 3.
J.D. Morris     Chemist	5.12. 6.	5. 9. 6.	5.15. 5.
F.S. Wilson     Chemist	3.12. 6.	(War Service)	(War Service)

Total wages for all the colliery and coke oven staff  
amounted to £127. 9. 2. for the week ending  
26th February 1941.



and a bonus of £100 in respect of also being Manager at Cortonwood Coking Plant for about a year. In addition he was entitled to gas until 1945 but thereafter only coal or coke was allowed free of charge.

A gardener was provided even though he did not live in a company house and a lunch allowance was paid. Soon after vesting date the value of emoluments were stated as:-

Fuel	£30 per annum
Gardener	£50 : :
Lunch allowances	£26 : :
Coke Oven Managers' Association expenses	£10 : :
Telephone (all calls and rental)	

It is reasonable to assume that emoluments to a similar value were granted to other Coke Oven Managers and that they may be regarded as part of the salary. If the assumption that other companies paid expenses to Managers who were members of the Coke Oven Managers' Association is correct, this would in part account for the financially sound, though numerically small and select, Association described in detail in chapter VIII. After nationalisation all perquisites, except the concessionary fuel and the total cost of the telephone, were withdrawn. The concessionary fuel allowance prior to nationalisation was fairly typical insofar as it provided unlimited coal or coke for the personal use of the manager.

These wages and salaries, when compared with the remuneration for similar responsibilities at the same period, are worthy of further comment. The post of Manager's Assistant was purely clerical and suitable for a young person who had ability and initiative and therefore provided a training ground

for anyone who might eventually be expected to fill a senior position. The salary was nearly as good as that afforded to Civil Service clerical officers and railway clerks, though considerably less than that paid to bank clerks.

Salary paid to a Senior Operating Foreman was as good as that paid to a Civil Service clerical officer but it had been overtaken by salaries paid to clergy. On the other hand the Coke Oven Manager's salary was almost double that received by clergy but it was only two thirds of the salary received by Barristers and Doctors. (176)

There is insufficient positive information available on workmen's wages to make worthwhile comparisons though it is known that differentials existed between labourers, process operators and oven men. It is believed process operators and oven operators received similar rates of pay, the former were traditionally mature and responsible people while the latter were generally much younger and worked in arduous conditions. Similar rates were paid to encourage people to work on the ovens in conditions which were unattractive because of heat, dirt and the elements.

How did other people shown in figures 25 and 26 progress? Arthur Foster's career was unusual. He transferred from the colliery when young and became coking plant engineer - a post he retained until Manvers was rebuilt in 1957. Foster could not be promoted at Rotherham Main so he gained promotion by accepting a similar post at the far larger Manvers Coking Plant. The vacancy so created was never filled.



Ernest Brown started his industrial career as a junior chemist and later became chief chemist at Dalton Main Coking Plant - also owned by John Brown and Co. Eventually he was promoted Assistant Manager and then Manager<sup>and</sup> was able to attract Leslie Atkinson, who had become Chief Chemist at Rotherham Main, to the same post at Dalton. This made way for a young man called Alex Cotton and he remained as Chief Chemist until a few months before the plant closed when he became Chief Chemist at Manvers. The vacancy at Manvers was advertised internally though it was expected that Cotton would fill it because Rotherham Main was due to close. Fred Steer moved from Assistant Manager at Smithywood to Nunnery Handsowrth and then left the N.C.B. to become coke oven manager at the Steel Company of Wales. In the meantime Dalton had closed and Brown and Atkinson were transferred laterally to Nunnery Handsworth Coking Plant for the last few months of its working life. When the plant closed Atkinson returned to Rotherham Main as a chemist for a short while until that closure coincided with his own retirement. Although he was no longer Chief Chemist his salary was retained on a personal basis

#### Flexibility towards management.

The plant had an excellent reputation for being profitable, being in good condition throughout its life, and being non-militant - this was particularly noticeable in the 1950s when other coking plants were becoming militant often in respect of wages. The colliery on the otherhand was quite typical and figure 33 is evidence for its support of at least one demonstration. In order to see whether human weaknesses took advantage of the situation

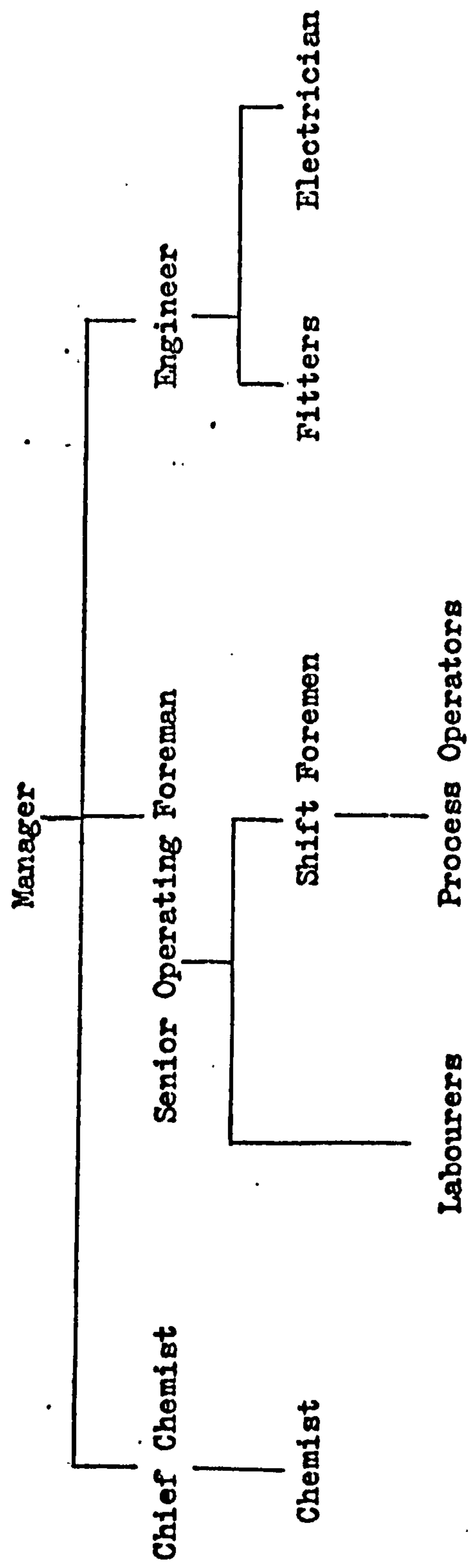
after nationalisation it is worthwhile to re-examine the staff structure from a different point of view. It has already been shown that the post of Senior Operating Foreman was abolished in 1936 though this did not alter the number of foremen. The post of Assistant Manager disappeared after 1945 and that of Plant Engineer went after 1957. Other plants of similar size retained some or all of these positions. On top of this the last person to serve in the capacity of Manager was paid at Assistant Manager rate for most of his time at the plant. It is clear that the senior staff was depleted over a period of several years but this does not present the complete story and the state of other staff grades needs to be considered. In many respects the grading of supervisory staff presents a sad picture in marked contrast to their ability. Absence of a Chief Operating Foreman necessitated Shift Foremen working closely together. Abolition of the Assistant Manager post meant Foremen had less direct contact with management and they were perhaps called on to use more initiative than would otherwise be required. In the main this situation was enjoyed even though concern about it was expressed occasionally. Since the plant never had a Yard Foreman, Shift Foremen were called upon to control the labourers who worked from 8.a.m. until 4 p.m. when they were on the day shift or the afternoon shift. They also carried the normal responsibility for shift labour, production and safety of the plant.

Figures 30, 31 and 32 illustrate the changing pattern of management structure, due in the early days to the settling down period after the new plant was commissioned, (180) but later because of external factors created by nationalisation. It must



FIGURE 30

Line Management in 1930.



**FIGURE 31**

**Line Management in 1950s**

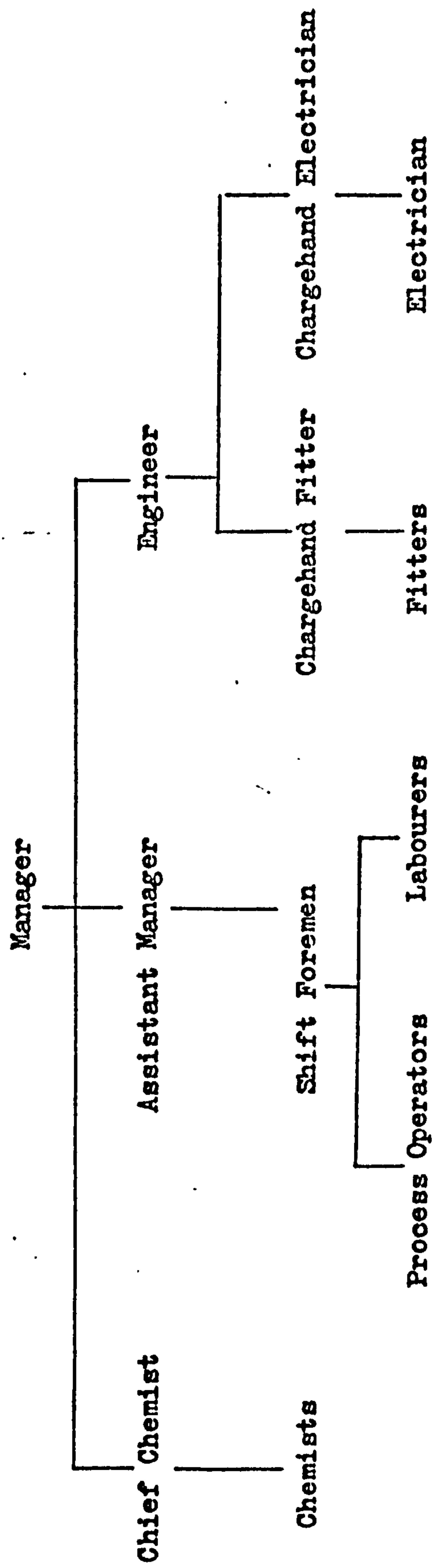
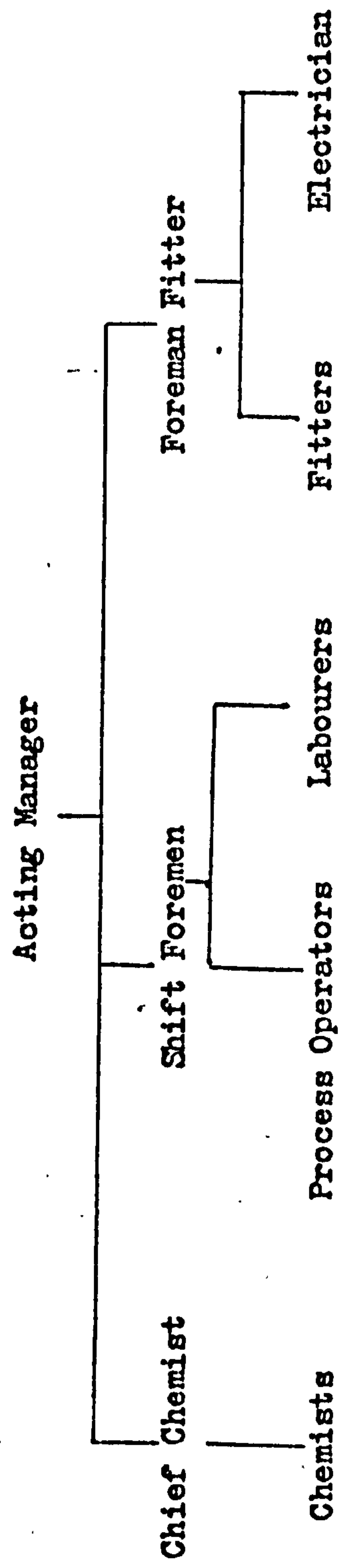




FIGURE 32

Line Management in 1962



be emphasised that all three figures show the official position whereas in practice relationships below that of manager in the 1930s were informal. By the 1950s the manager's position started to become less autocratic so that even the manager had an informal relationship with his sub-ordinates. Did such informality lead to indifference by plant operators? The Manager and the Foremen continued to be regarded with the same authority and long established happy relationships enhanced by family relationships, shown later in the chapter, continued unabated until closure came in 1962.

When the Plant Engineer went to Manvers Coking Plant in 1957 the fitting staff was left in the control of a chargehand, similarly the electricians were controlled by a chargehand but he soon received Foreman status. (181) The chargehand fitter was not appointed to the post of foreman until the plant was nearing the end of its life.

It can be said that Rotherham Main ran well with minimal supervision and this is creditable reflection on the long established labour force which took pride in its workplace.

Did the labour force realise it was receiving special treatment by the N.C.B.? It was aware that the N.C.B. was getting the benefit of supervision cheaply but it was also proud of the fact that at no other plant could the supervision have been so minimal without impairing efficiency and profitability. Nevertheless critical undertones were heard in the 1950s though the peaceful majority carried on in the traditional way.

Company loyalty generated partly by fear of unemployment, partly by inter-relationships and partly by pride in the job lasted until the end of the plant when, on the last day, men were sweeping up in the way they had always done just as though



nothing would change. (182)

### Non-Militancy

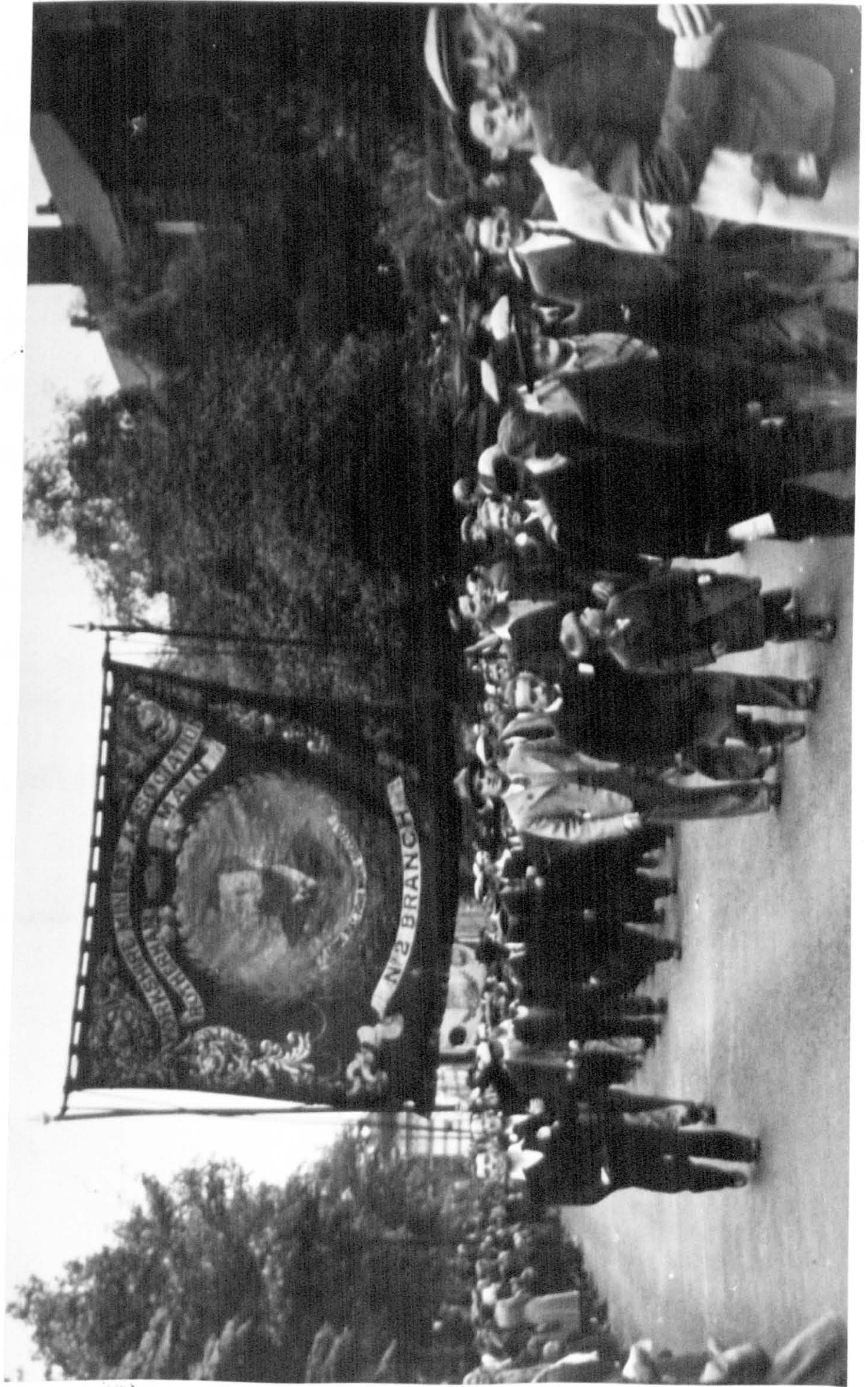
The coking plant had an unrivalled record of non-militancy throughout its life and there was only one strike at the plant apart from the General Strike of 1926; this occurred in the late 1940s and lasted for about a week. Why should the coking plant be unique in this respect? One strong factor was the dictatorial approach of A.C. Middleton in the 1930s and 1940s, another was the general shortage of good jobs and the pride which resulted from having a good job. (183) A third factor was the benefit derived inter-relationships and the mutual respect between Manager and men. There is evidence of at least one deputation which went to see the Manager regarding a discrepancy in wages for a section of men. They had a legitimate grievance and the Manager supported their claim so that it was resolved in the men's favour. (184) All these circumstances contributed towards a happy environment, so much so that when it was agreed by the N.C.B. and the N.U.M. in the 1950s that each plant should have its own consultative committee to solve internal problems and discuss ways of improving throughput, the committee at Rotherham Main was embarrassed because there was very little to discuss. Effective and efficient management, particularly in early years had paid off. This should be contrasted with the colliery which came in the middle of a league of 24 Yorkshire collieries for the number of strikes per 100 faceworkers in 1949-63.

The attitude of the N.U.M. at the colliery was typical (185) of that found at other collieries in the district. Figure 33



FIGURE 33

Miners' Demonstration at Rotherham 1950





shows the Rotherham Main section of the Yorkshire Miners' Association (186) in a procession along Doncaster Gate from the town centre towards Clifton Park. Traditional banners featured intricate embroidery work and the one shown in the figure is quite representative.

#### Humanitarian approach by the N.C.B.

An examination of the careers of some of the people in figure 23 suggests considerable movement of staff, especially in the 1950s when the N.C.B. established its own management structure. Soon afterwards a combination of recession in the coke market, the rebuild at Manvers and the existence of many worn out coking plants brought about an unprecedented series of closures. The N.C.B. moved staff about frequently during this period to avoid redundancy and for the first time in the history of the coking industry early retirements were offered in certain cases and invariably accepted. Frequently senior staff were retained at closed down plants doing work which would normally be done by lower paid staff until a suitable vacancy occurred at an operating plant. Such movements were carried out with skill and generosity on the part of the N.C.B. and their early image of a 'body without a soul' was dispelled. There was little difference between the generosity shown to staff and to workpeople, and in both cases the Board were more generous than they need have been. When a plant was due to close every workman had an interview and he was offered employment within the N.C.B., often at the coking plant or colliery of his choice. Those men who were near to retirement were offered generous retirement payments.

The task of re-locating displaced personnel was relatively easy in the early days and they were invariably re-located at other coking plants. As the number of coking plants decreased the task became more difficult and eventually arrangements had to be made with selected collieries whereby they gave preference to employing people from a coking plant scheduled for closure. In the main coking plant personnel were reluctant to go to a colliery and often preferred to travel further to another coking plant - this is understandable because the special skills acquired in the coking industry are not relevant to coal mining. Only joiners and blacksmiths could transfer easily and this only involved two people out of a displaced workforce of 100 - 150 people.

Rotherham Main was the last plant to close in a long series of closures and it is worthwhile to look at re-location as it affected that plant. Without doubt the quality of the tightly knit labour was of the highest order (187) so it is all the more sad that those people should have had the greatest difficulty in being re-located. The workforce were more reluctant than their predecessors to move but, faced with inevitable unemployment a large proportion endured perhaps the greater hardship and accepted re-location. By this time there was only Manvers and Smithywood coking plants in the district owned by the N.C.B. and for the first time special arrangements had to be made with the British Steel Corporation regarding transfer of some of the Rotherham Main men to their Orgreave coke ovens. Similar arrangements were made with the independent South Yorkshire Coking Plant owned by the National Carbonising Company. The Rotherham Main men were not happy at leaving the N.C.B. and few took up



offers of employment at these two coking plants. For the first time not all the labour force could be absorbed by the local colliery because that had closed several years earlier so most of the men were found jobs at Smithywood or Manvers. This in itself made history because both plants were prevented from setting on employees for several months before the impending closure so the number of vacancies closely matched the number of displaced employees. Such a large number of vacancies meant excessive overtime at the operating plants and this in turn meant increased absenteeism so that by the time Rotherham Main closed management at both plants had been weakened, but it recovered quickly when the new labour arrived. For a while there was inevitably much comparing and contrasting of conditions by the men, and a general proven awareness by the Rotherham Main men that they had worked to higher standards. There are many reasons for these differences, perhaps the main ones were due to differences in size and the element of change, they cannot be accounted for by management alone because they were broadly similar. One benefit of being transferred to Smithywood was the more readily available overtime because of the higher absence rate which ironically was partly produced by a higher proportion of overtime. Eventually integration was completed and a harmonious relationship established. An early difficulty was the need to engage all transferred men as labourers in the first instance, this was particularly hard for many who had spent a large part of their working life to become skilled operators. Eventually the fears of the labour force at both Smithywood and Manvers regarding lost promotion prospects were overcome and the Rotherham Main men found their own level. Most stayed at their re-location until retirement in the late 1970s.

Rotherham Main Foremen were particularly hard hit because at the time of closure they were all near to the age of retirement. They developed deep rooted views about carrying added responsibility for the plant for in former years when supervisory staff were particularly short <sup>work carried on normally</sup> and now some form of retrospective recognition was expected. The N.C.B. disagreed with the view and offered two foremen who refused to take early retirement labouring rate of pay reclaiming coke from stock at Nunnery Handsworth which had already closed down. Apart from the stigma of having to 'clock on' and 'off' they were no worse off regarding pay. With overtime earnings gross pay could be higher than ever without having any responsibility. In the event their view that they had been treated shabbily after giving many years of loyal service and taking on extra responsibility in more recent years remained with them. Perhaps the image about extra responsibility was not quite true because they didn't have any more responsibility than would be expected at any other small plant on the back shifts. Nevertheless it is clear that if the foremen had worked closer to rule a few years before the plant closed the N.C.B. would have been compelled to increase supervision and they did not want that - they enjoyed being in sole charge even if this was more apparent than real. Whatever the course of events the final circumstances of the foremen would not have altered.

The above transfers and promotions show how a highly specialised industry was able to adapt to changed circumstances and fill staff vacancies in the most appropriate manner for the well being of both industry and employees. Perhaps the advent of nationalisation brought about changes in attitude by all



employees. Chapter VII describing Nationalisation of the Coal Industry shows that at the outset, and in sharp contrast to later reality, the industry was accused of indifference towards the staff and workpeople.

Critics will point out that greater regard should have been paid to improving profitability with less attention to image. Perhaps benevolence fostered in marked contrast to the attitude of many former colliery companies came about because of the need to dispel the image of indifference towards employees. Undoubtedly human kindness was expensive but it had the advantage that a short term deficit of management skills was avoided.

#### Inter-Relationships

The personal relationships which existed at the plant are shown in figure 34. About one fifth of the total labour force was related and this illustrates several important features in the first half of the twentieth century; the Bellamy relationship extended over three generations, principally because Edwin Arthur Bellamy's son reached employable age at the end of the last century when John Brown and Co. were beginning to transform the district. When Rotherham Corporation took over responsibility for supplying gas to Brinsworth his son Bernard transferred to the coke oven fitting shop until the new ovens were started up in 1929, whereupon he became coke guide operator. In 1945 Bernard was appointed Shift Foreman and soon afterwards his four sons joined the company. (188) Most other relationships were limited to a span of two generations but it is quite certain that some of them would have extended into a third generation if

the plant hadn't closed on 24th November 1962. (189) What were the reasons for such a high proportion of the labour force being related? The employees were stable and industrial relations were good for relatives to be attracted to the coking plant. This is not to suggest that all employees were perfectly happy but, considering industrial instability in general and a shortage of jobs together with poor transport, they were content to work in an industry which offered security. Equally important, the wages must have been competitive with those paid by other companies within a radius of a few miles. The type of labour needed at the coking plant was different from that required by the colliery though some of the labour force was drawn from the colliery when the new coking plant was commissioned. The plant always had an atmosphere of contentment and efficiency generated by the combined efforts of the first Manager and the workforce. Such an atmosphere was conducive to attracting good labour which in turn favoured efficiency.

The procedure for hiring labour needs some consideration because it played a large part in bringing about the relationships. Unemployment was high for the greater part of the first half of the present century and life was hard. For example unemployment in the steel industry varied between 17% and 57% between 1924 and 1930 (190) and the coking plant was built in a predominantly mining and steel producing area. Even with high unemployment Managers had the task of obtaining good quality labour which would adapt to the specialised needs of the coking industry. If an employee had proved to be satisfactory and approached the Manager regarding employment of a relative the request was generally given favourable consideration. There were undoubtedly many other equally suitable employees who were denied the opportunity



FIGURE 34

Relationships. (191)

E.A. Bellamy	Gasworks foreman
Son B. Bellamy	Coke oven shift foreman
Sons Ken Bellamy	Fitter
Dereck Bellamy	Fitter
Wilf. Bellamy	Fitter
Geoff. Bellamy	Fitter's mate
Brother in law Ernest Brooke	Crane driver
William Sanders	Senior foreman
Sons Billy Sanders	Ram driver
Fred Sanders	Coke car driver
Harry Sanders	Apprentice bricklayer
Brothers Teddy Cousins	Fitter
Sid. Cousins	Welder
Jos. Cousins	Coal Bunker Attendant
Tommy Hague	Rectification Plant Attendant.
Son Roy Hague	Fitter
Brother in law Jim Hartley	Shift Foreman
Related by marriage Albert Clarke	Foreman Fitter
Brothers Maurice Crowther	Labourer
Cliff. Crowther	Crane driver
Brothers in law - Leslie Noel Brewer	Senior Operating Foreman
Harold Shaw	Benzole Plant Operator.

of employment because of the closed shop type of arrangement. which brought about such an excellent labour relationship. In general the method of engaging labour was left to the discretion of the Manager and this fostered an autocratic image. The method of recruitment was successful although it was perhaps not always fair. Similar relationships existed at other coking plants and in other industries but Rotherham Main Coking Plant was outstanding in having such a high proportion of its workforce related. To what extent did such an inter-related workforce influence the activities of the trade union organisation at the plant? The coking plant workers were members of the N.U.M. cokeworkers section and they elected local officials consistent with N.U.M. rules. In practice the labour force was never very interested in electing its union officials and those who were elected held moderate views. Unlike the colliery, the coking plant was small and because management was both accessible and approachable union representation was unnecessary. After nationalisation of the coal industry local, divisional, and national consultative committees were established to improve industrial relations in the industry among other things, and recognised grievance procedures were established. The coking plant consultative committee was established but, unlike those at other coking plants, it was half hearted because the men could not see the need for its existence. It fulfilled its obligation by meeting management once a month to discuss plant problems but some of those meetings lasted but a few minutes.

The integrated labour force had much to do with the fact that the plant only had one strike in 60 years and it occurred soon after World War II and lasted for only one week.



Many of the workforce looked upon the strike afterwards as something which happened in haste and which ought to have been avoided. The ideals at the plant were no different in general terms from those at any other plant. Rotherham Main had the right combination of good luck and good management so that it became outstanding and epitomised all that was best in the coking industry.

#### Free Exchange of Ideas

The following details show how the tightly knit coking industry liberally exchanged information between companies competing for similar markets. It seems there were virtually no limits to particulars handed on and this must have been a great help, if not essential for the industry's growth and contribution to the national economy.

The contracting industries serving the coking industry in the 1920s were also closely knit because they were working in a specialised and highly competitive section of industry. There is clear evidence to show that A.C. Middleton, the first Manager of the new plant was very enthusiastic about his acquisition and also about his responsibility towards employees. The undermentioned examples are used to illustrate his searches for precise technical information from other companies, some of which were competitors, in order that he could maximise profitability at Rotherham Main. He ascertained that (192) :-

- (1) The Coalite company had been able to supply quite a lot of customers but they rarely received repeat orders. Many gasworks where vertical retorts had been installed were asking for inferior qualities of

coal to overcome the difficulty of the charge sticking in the retorts. It is evident that A.C. Middleton was anxious to compete with both these companies in the domestic solid fuel market.

- (2) The Consett Steel Company paid their coke oven department  $4\frac{1}{2}$ d per 1000 cu.ft. of gas in 1930. Rotherham Gas Corporation were able to disclose that Beatson Clarke, paid them  $6\frac{3}{4}$ d per 1000 cu.ft. of gas for glass melting while at their Stairfoot works near Barnsley paid  $5\frac{1}{2}$ d per 1000 cu.ft. of gas for glass melting. The Corporation were erecting a blue water gas plant with a capacity of two million cu.ft. of gas per day. A.C. Middleton was well aware of the value of town gas and *he was* keen to see that Rotherham Corporation were paying a fair price for coke oven gas.
- (3) The Manager of the nearby Nunnery Coking Plant supplied a detailed list of the number of men and boys employed there in 1932. Evidently this exercise was to see if manpower, and therefore wages, were in keeping with current trends. (193)
- (4) The Manager of the Yorkshire Coke and Chemical Company at Glasshoughton stated which sizes of coke nuts would sell well, the amount of winter production sold on the domestic market, the existence of a shipping market and the failure to sell to the London market unless they could supply a product equal in size and quality to that supplied by the Nunnery Coking Plant. Their cost of putting coal into stock was



1 $\frac{3}{4}$ d per ton and reclaiming it cost 1d per ton.

In reply to another question it was found that they paid the district wage rates but with a minimum of 40% <sup>of the rate</sup> instead of 32% to which 6d. per day was added, <sup>for a basic output of</sup> ~~This was the rate for 28 ovens per shift, to which was added~~ 1/28th of a day's wage was earned for every additional oven. These replies to direct questions by A.C. Middleton show the continued awareness of two very important features - the coke market and wages.

- (5) Contractors are always a good source of information and in 1929 Simon Carves reported that the Coalite plant at Askern was on low output because of coal sticking in the retorts. The self sealing doors at Billingham were working splendidly and the valves and foul main had remained clean since a regulator had been put to work. The contractors also stated that low temperature oil from the Barugh and Askern plants was the best quality and sold for about 2d. per gallon, and they gave prices of imported oil.

The above illustrations can be regarded as typical of some of the questions raised by Coke Oven Managers. Bearing in mind the period in which these questions were asked, it is worthy of note that they illustrate an absence of a mathematical approach to the problems and show only limited knowledge of elementary chemistry. In contrast there was a keen awareness of costs. Problems were dealt with on the following basis:-

- (a) Did some alternative method work better?
- (b) Was there a market for it?
- (c) Was it durable?
- (d) Was it cheap?

Undoubtedly the empirical approach worked though the question of whether a more scientific approach would have worked better needs to be considered? Coke Oven Managers were innovators. There weren't any text books dealing with the subject of coal carbonisation from a scientific point of view, though there were a few books dealing with the practical aspects of the subject. The simple criterion appears to centre on the question 'Is my method the best?' If the answer was yes a target was automatically set for other Coke Oven Managers to emulate. The industry therefore developed on the enthusiasm of Coke Oven Managers, perhaps for its own sake, or maybe because times were hard and good jobs were scarce, or even because of prestige within the industry. The traditional view of right and wrong in the industry begs the question whether or not the best, judged empirically, was in fact the optimum. In fact, though perhaps fortuitously, the two criteria were probably often close.

It has been shown that ideas were freely exchanged between managers and it is a likely assumption that they were disseminated downwards. Of course, to be successful, managers had to give as well as receive information and towards this end a group of Coke Oven Managers attended the inaugural meeting of what was to become the Coke Oven Managers' Association in Sheffield on 12th June 1915. (194) The idea of free dissemination of knowledge was well established through this official body and it was therefore relatively easy for it to be propagated on an informal basis.



## REFERENCES AND NOTES

1. A. Gatty, Hunter's Hallamshire, London, 1869, (2)
2. Aberconway, The Basic Industries of Great Britain, London, 1927, p.35.
3. A. Cochrane, 9th Earl of Dundonald, Account of the Qualities and Uses of Coal Tar, London, 1785.
4. Woodall Duckham Company Ltd., Fifty Years of Coal Carbonisation 1903-1953, undated.
5. J. Fulton, Coke, Scranton, Pa., 1905, p.186. The Newton Chambers oven was a modified Jamieson oven. N.B. W.E. Newton of London, who patented a beehive recovery oven in 1852, was not related to the Newtons of Chapeltown. Evidence of this can be seen in M.J. Habershon's, Chapeltown Researches, London, 1873, p.145.
6. This is described in detail later in the chapter.
7. Mines and Quarries General Report, Part III, 1909.
8. Compiled from Contractor's brochures.
9. W.B.M. Jackson, Iron and Coal Trades Review, 1907, June 14, p.2107.
10. Both plants are referred to in Chapter V describing some of the coking plants in more detail.
11. Compiled from Mines and Quarries General Report Part III 1909.
12. This is probably not true of most of the period 1900-1910 but by 1912-13 real wages were rising again. C.F. Clapham, Economic History of Modern Britain III, Cambridge, 1963 468-9 and 506-7.
13. C.F. Booth, Life and Labour of the People in London, 10 vols., 1892-97), London 1897.
14. B.S. Rowntree, Poverty, A Study of Town Life (2nd edition 1902, chapter iv), London, 1902.
15. W.H. Wilcockson, Sections of Strata of the Coal Measures of Yorkshire, The Midland Institute of Mining Engineers, Wakefield, 1950, 3rd edition.
16. Rotherham Annual, 1930, p.230.
17. The map, issued by the West Riding County Council to the former headteacher of Brinsworth County Primary School is substantially correct but it does not show the location of the school built four years earlier in 1907. It does however show the former school building on West Bawtry Road.
18. Includes 1175 people in the borough of Rotherham and the hamlets of Ickles and New York in 1891.
19. Rotherham Annual 1930, p.230.

20. A.E. Oakley - Ye Old Town of Rotherham. Book in manuscript form. *Rotherham Public Library.*
21. The original railway bridge at Canklow was a stone arch and inspection shows that a girder section was added on each side later to increase the number of rail tracks. There is evidence that a similar stone bridge on the same line south of Chesterfield was extended in like manner. The massive terminal at St. Pancras was built by the Butterly Company in 1867 - one of the steel girders of the terminal arch is inscribed to this effect.
22. Immediately after World War II more than 300 locomotives were based at Canklow, other sheds were located at Barrow Hill in Chesterfield and Grimethorpe in Yorkshire, with a shed for 60 passenger locomotives at Millhouses, Sheffield. Personal knowledge of H.J. Holder, former steam raiser at Canklow sheds. It is assumed the number of engines in the district was of the same order when the Canklow shed was built earlier in the century.
23. Adapted from notes belonging to H.S. Johnson.
24. Ministry of Fuel and Power Statistical Digest.
25. Rotherham Advertiser, 17th May 1980. The Companies Act of 1862 enabled seven or more associates, provided their object was lawful, to constitute themselves a company, either with limited or unlimited liability, by simply subscribing a memorandum of association. John Brown and Co. and Cammell and Co. of Sheffield, the Staffordshire Wheel and Axle Co. the Staveley Coal and Iron Co. and the Fairbairn Engineering Co. of Leeds are illustrations of the spread of company organisation during the first five years of the Act.
26. Rotherham Advertiser, 7th November 1888.
27. A slide belonging to H.S. Johnson is the only clear remaining proof of its existence.
28. Personal knowledge of Mrs. P.A. Brewer.
29. The Rothervale Colliery Company had already established collieries at Treeton and Orgreave only two miles away and they had built suitable houses for the labour force. Evidence of Cortonwood Colliery Co. doing likewise is provided by the Deed between Cortonwood Collieries Co.Ltd. and Bolekow Vaugh and Co. 1926 for 8 dwelling houses for persons belonging to the "working classes". Deed between Cortonwood Collieries Co.Ltd. and Dorman Long and Co. 1930 for 44 houses for working classes. Ref. Sheffield City Library Archives N.C.B. 961.
30. Personal knowledge of H.S. Johnson, former headteacher of Brinsworth County Primary School which superseded the National School.
31. John Brown & Co. also owned Atlas Works in Sheffield.
32. Reproduced from a photograph belonging to A. Foster, former Coking Plant Engineer.
33. See the section describing St. Mary's church, Catcliffe.



34. N.C.B. archives, Mansfield, Form D. Serial No. 47 in Statement of Interest.
35. Personal knowledge of Mrs. P.A. Brewer.
36. Reproduced from a photograph belonging to J.W.B. Bellamy, former Coking Plant Fitter.
37. The houses in Duncan Street had open back yards, but the occupants soon planted privet hedges and thereby made their own boundaries between adjacent houses. It is reasonable to assume that the same thing happened in Atlas Street. Nos. 2 and 4 Duncan Street became the vicarage until a separate vicarage was built at Whitehill. Personal knowledge of A. Clarke, resident in Duncan Street since 1917 and former employee at the coking plant.
38. Personal knowledge of A. Foster, former Coking Plant Engineer, confirmed by Mrs. P.A. Brewer.
39. Rotherham Advertiser, 21st September 1928.
40. Rotherham Annual, 1928 p.192, photograph. Anticipation of the development is shown in the Rotherham Advertiser 5th February 1927, p.6.
41. Broadly similar studies have been undertaken by G.D.H. Cole and R. Postgate, The Common People, London 1966 and J. Bullock, Bowers Row, Wakefield, 1976.
42. Reproduced from a slide belonging to Mr. H.S. Johnson.
43. Rotherham Annual, 1930, p.230.
44. Early in the present century St. Andrews church was in a run down condition because of insufficient support from a sparse population. Mrs. M. Hallatt had much to do with the survival of the church in the first part of the century, Mr. G. Marsden provided impetus for its survival later on.
45. R. Woodward, The Development of Education in Rotherham to 1944. Theses submitted for the Advanced Certificate of Education at the University of Sheffield, October 1968, p.38.
46. Reproduced from a photograph supplied by Mrs. P.A. Brewer.
47. Rotherham Annual 1930, p.230.
48. In the latter part of the 19th century a laissez-faire policy in education had prevailed. The Forster Education Act of 1870 attempted to remedy this by setting up school boards. Also, church schools were subsidised. For further details see W.H.G. Armytage, Four Hundred Years of English Education, Cambridge, 1964.
49. Personal knowledge of H.S. Johnson, second headmaster of the W.R.C.C. school at Brinsworth. Date of colliery opening confirmed in W.H. Wilcockson, Sections of Strata of the Coal Measures of Yorkshire, Wakefield, 1950, p.494.
50. Freda Crowder and Dorothy Green, Rotherham, Wakefield, 1971.

51. G. Gummer, Reminiscences of Rotherham, Rotherham, 1927.
52. Date inscribed in a stained glass window at the school.
53. Empire, Odeon, Regal and Whitehall cinemas and the Regent theatre.
54. These facilities are mentioned in more detail later in the chapter.
55. Op.cit. G. Gummer, Reminiscences of Rotherham, Rotherham 1927, p. 108-116.
56. Rotherham Advertiser, 14th February 1874.
57. G.D.H. Cole and R. Postgate, The Common People, London 1966.
58. Perhaps the best evidence for the attempted ideal of near self sufficiency for vegetables can be found in North Derbyshire where the sustained use of home grown vegetables in soil with a natural deficiency in iodine gave rise to a thyroid condition known locally as 'Derbyshire neck'.
59. There is no suggestion that the expression originated in the district or that its use was confined to it.
60. Early versions were made from the metal from which they took their name.
61. The concept of 'out of sight out of mind' was paramount. Also colour chemistry was insufficiently advanced to produce durable pastel shades.
62. Electricity was not brought to these houses until the 1950s or thereabouts though a few private houses benefited from electricity earlier.
63. The 'living room' was the dining room or dining room/kitchen, the 'sitting room' being reserved for special occasions and heated infrequently..
64. Rotherham Advertiser, 22nd September 1894, p.8.
65. The idea prevailed in spite of the fact that St. Andrew's church was badly supported because of insufficient population, in another part of the parish which would not be developed in the foreseeable future.
66. Rotherham Advertiser, May 1898. The author believes this account to be substantially correct except for the fact that it mistakes St. Andrews church for St. George's church. It has already been mentioned earlier in this chapter that St. Andrew's was built in 1885.
67. The author possesses a common brick marked 'Nunnery' and believes this to refer to the colliery at Nunnery Sheffield, rather than the better known colliery at Nunnery Handsworth. Thurcroft colliery had a brickworks but the shaft was not sunk until 1909-1912.
68. Personal knowledge of Mrs. C. Marsden, whose family have owned the building for more than 100 years.
69. Documentary evidence displayed in the hotel.



70. Rotherham Recorder, 1915, also Rotherham Advertiser, 12th December 1910, p.7.
71. Sheffield City Library, ref. N.C.B. 1402.
72. The building was converted into a pair of small semi-detached bungalows in the 1970s.
73. Rev. G. Harper, Vicar of Brinsworth. The vicarage is three times the size of other reasonable property in the area and it illustrates the illusions of grandeur derived from size and indicating status.
74. Deeds of St. George's church, Brinsworth, Sheffield Diocesan Solicitors.
75. Rotherham Advertiser 14th August 1909, p.10.
76. The section describing the development of houses in Ellis Street and Canklow Terrace shows how the use of gas gradually spread from the source at the coking plant.
77. Fitters from the coke ovens are known to have taken extending ladders to the church and repaired the bell.
78. None of the workpeople were regular church goers but they respected management and readily helped the church. In a sense when they were doing small jobs for the church they were not doing others for the coking plant but they could have refused to help. Co-operation of the workforce in this way would not have been considered at many other plants.
79. Rotherham Advertiser, 8th February 1896.
80. Sheffield City Archives, Ref. N.C.B. 439.
81. The only public house within the district was the Canklow Hotel.
82. Rotherham Advertiser, 31st July 1897.
83. Rotherham Advertiser 8th September 1928.
84. Rotherham Advertiser, 15th October 1927.
85. Documents belonging to the late L.N. Brewer, one time Manager's Assistant and later Coking Plant Manager, in author's possession.
86. The significance of coal crushing before charging the ovens was gaining importance - empirical knowledge was increasing.
87. Untypically, Dinnington Coking Plant built in 1906 and rebuilt later had an electrically driven rope hauled coke car.
88. The theory of coke cutting was not well understood.
89. It is assumed that central heating was restricted to gravity flow hot water systems in public buildings and to free standing closed stores similar to those used in St. Andrew's and St. Faith's churches.
90. Reproduced from an undated and untitled booklet.

91. Reproduced from a photograph published in The Gas World, 6th September 1930.
92. By-products were becoming increasingly important to meet the needs of a growing chemical industry and increase the profitability of the coking industry. Chapter VIII describes some of the achievements of Heinrich Koppers in this field.
93. Personal knowledge of A. Foster, former Coking Plant Engineer.
94. N.C.B. Archives, Mansfield, John Brown & Co.Ltd. Compensation Unit 9.
95. The section describing 'Compensation for Nationalisation' in chapter VII gives more detail on this topic.
96. There had always been attention to technical detail at Rotherham Main though it should not be assumed that technical efficiency and financial efficiency are synonymous.
97. Perhaps this had a bearing on Lord Aberconway's announcement in 1927 to rebuild the coking plant at Rotherham Main although the expected boom would be unlikely to have a major influence for technical reasons.
98. M.P. Fogarty and G.D.H. Cole, Prospects of the Industrial Areas of Great Britain, London, 1945, p.257
99. Personal notes of J.W.B. Bellamy, former Coking Plant Shift foreman, in author's possession.
100. Evidence of lack of experience by the contractors is supported by the fact that the water tower shown in figure 7 was either not built vertically or poor foundations caused it to lean.
101. Personal knowledge of A. Clarke, former Foreman Fitter.
102. Daily notes belonging to A.C. Middleton, Coking Plant Manager, now in author's possession.
103. The accuracy of the units of measurement was high - 30 mins. 0.5 cubic yard and a decimal of a penny. Unfortunately the manager failed to appreciate that accuracy of money and volume of material was inconsistent with the accuracy in time.
104. The principle of adjusting time in order to increase payment on local and unofficial terms is still continued today as a means of circumventing inflexibility in wages structures.
105. There is a long standing tradition in the industry that supervisors should know the location of every valve etc. and this contrasted with the introduction of young graduates into management positions after World War II. They possessed superior technical knowledge but often paid insufficient attention to practical details. Perhaps this state of affairs encouraged the development of sandwich courses at Loughborough College of Technology which later became Loughborough University of Technology and other institutions of higher education.



106. Rotherham Advertiser 3rd April 1954. Confirmed in W.H. Wilcockson, Sections of Strata in the Yorkshire Coalfield, Wakefield, 1950, p.401.
107. Sheffield City Library Archives, N.C.B. 453.
108. Sheffield City Library Archives, N.C.B. 439.
109. Simon Carves held the same view about the offices when they acquired the property soon after the colliery closed in the 1950s in anticipation of coking plant rebuilds in South Yorkshire. See the chapter describing Simon Carves Ltd.
110. Reproduced from a photograph supplied by Mrs. P.A. Brewer.
111. Personal knowledge of J.W.B. Bellamy, former Coking Plant Foreman. Independent information concerning the start of the waste heat batteries is indicated by a report of an inquest on a man killed at the coke ovens in the Rotherham Advertiser, 2nd April 1904, p.5. Bellamy confirms Mott's work which states that another battery of ovens was built at Rotherham Main and Tinsley Park in 1904. R.A. Mott, The History of Coke Making, Cambridge, 1936, p.81.
112. Personal knowledge of A. Foster, former Plant Engineer.
113. Journal of the Iron and Steel Institute, 1902, vol.1 p.26.
114. The road from Canklow to Rotherham was flat and straight and the author recalls the late L.N. Brewer saying that tram drivers would often set the tram off in the direction of Rotherham and then come into the saloon and talk with the passengers.
115. The only remaining clear evidence of the existence of the mill is a slide belonging to H.S. Johnson, late headteacher of Brinsworth County Primary School.
116. Personal knowledge of A. Foster, late Coking Plant Engineer.
117. Sheffield City Library Archives, N.C.B. 439.
118. Personal knowledge of J.W.B. Bellamy, former Coking Plant Foreman.
119. Chapter III describing the Gas Industry refers to similar conditions in a general context.
120. The people of Sheffield thought the new street lamps at Brinsworth and Canklow were a novelty and the area became a tourist attraction for a few weeks. E.A. Bellamy was the first lamp-lighter to light the new gas lamps and he also worked at the coke ovens during the day.
121. This is consistent with the fact that St. Mary's church, built in 1910, was not lit with gas in the early stages although the use of gas for such a purpose was anticipated.
122. Op.cit. J.W.B. Bellamy, former Coking Plant Foreman.
123. The section dealing with the deployment of labour contains details of the special circumstances prevailing between September 1928 and 7th May 1930.

124. Personal knowledge of the late L.N. Brewer former Coking Plant Manager, and confirmed in detail by records of J.W.B. Bellamy, former Shift Foreman at the Plant.
125. Personal knowledge of A. Foster, former colliery fitter and late Coking Plant Engineer.
126. Personal knowledge of L. Gush, late Chief Engineer of the London and Scandinavian Metallurgical Company Limited whose works now stand on the site of the goyt.
127. Reproduced from a photograph supplied by Mr. A. Foster, late Coke Oven Engineer.
128. Reproduced from a photograph supplied by Mr. K.W. Bellamy, former Coking Plant Fitter.
129. Reproduced from an undated and untitled booklet in author's possession.
130. Reproduced from a photograph supplied by Mr. A. Foster, former Coke Oven Engineer.
131. The forerunner was a smaller rectangular tank, one example can be seen at the National Railway Museum at York.
132. It should be contrasted with figure 10 in chapter V also showing a view of the coke car track at Glasshoughton which was much more typical.
133. Local knowledge claims that the land mine was intended for the steel works which almost bounded the sidings shown in figure 18.
134. Reproduced from a photograph taken in 1950 by K.W. Bellamy, former Coking Plant Fitter.
135. Reproduced from a photograph supplied by K.W. Bellamy, former Coking Plant Fitter.
136. Reproduced from a photograph supplied by K.W. Bellamy, former Coking Plant Fitter.
137. Reproduced from a photograph supplied by K.W. Bellamy, former Coking Plant Fitter.
138. Reproduced from a photograph supplied by K.W. Bellamy, former Coking Plant Fitter.
139. Personal knowledge of the author based on experience gained some twenty five years later.
140. Personal knowledge of J.W.B. Bellamy, former Coke Oven Foreman.
141. W.E. Harrison Ltd., Steeplejack, Sheffield, photostat copies of relevant accounts in author's possession.
142. The only other known premature failure of a coke oven chimney occurred at the Orgreave Plant of B.S.C. Chemicals Ltd. in 1979, This chimney was likewise fitted with steel rings within a few months of being brought on stream.



143. Personal notes of L.N. Brewer late Coke Oven Manager.
144. A Clarke, former Foreman Fitter believes that acid resisting concrete was not used for the internal lining.
145. Personal knowledge of the author.
146. Information supplied by C. Wright, former Divisional Mechanical Engineer, Coal Products Division, N.C.B.
147. Personal knowledge of the late G.R.H. Stancey, Divisional Chief Technical Officer.
148. This figure shows a team of fitters standing on the water main from the Ulley stream crossing the river Rother after renewing the gas main with the help of two Jones cranes. The men are, from left to right - Maurice Crowther, Ken Bellamy, Albert Clarke, Derek Bellamy, Cliff Crowther.
149. When Manvers was rebuilt in 1956 the new office block included drawing facilities for two draughtsmen and a separate office for the engineer.
150. Reproduced from a photograph supplied by K.W. Bellamy, former Coking Plant Fitter.
151. Sheffield City Library Archives, N.C.B. 442.
152. L.N. Brewer arranged for the purchase and installation at a nominal charge.
153. As tar production decreased because of contraction of the coking industry, Yorkshire Tar Distillers and Midland Tar Distillers amalgamated to become Yorkshire Midland Tar Distillers, thereby enabling surplus batch distillation capacity to be closed.
154. During World War I most gasworks of reasonable size were required to recover benzole as a source of toluene for the manufacture of T.N.T. By 1918 many coke ovens and all but the smallest gasworks were recovering benzole.
155. Personal knowledge of J.W.B. Bellamy. Certain specialist jobs carried exemption from National Service; senior staff were included in this category.
156. It has already been mentioned that an enlarged view of figure 7 shows what is believed to be a land mine crater in Canklow Wood immediately behind the water tower. It is understood that the land mine was intended for the steelworks which were very close to the boundary of the sidings shown in figure 18. Six of the fourteen open hearth furnace chimneys belonging to Steel Peach and Tozer Ltd. forerunner of the United Steel Co.Ltd. are just visible in the distance on figure 12, immediately between the end of the battery and the chimney.
157. Many coke oven batteries suffered badly as a result of war-time conditions but Rotherham Main was quite exceptional in this respect.

158. L.N. Brewer's classic career is described in detail later in the chapter. Other staff at the plant made similar though less career orientated changes. One example is Stanley Wilson who moved onto the plant and then joined the South Yorkshire Area Laboratory staff after nationalisation.
159. It would have been better if a temperature compensating barograph had been used.
160. Rotherham Advertiser, 3rd April 1954.
161. There were fewer coking plants in Derbyshire.
162. Personal knowledge of A. Clarke, former Coking Plant Foreman Fitter.
163. The date of the photograph has been determined by A. Foster, and confirmed by J.W.B. Bellamy, both of whom are former coking plant employees. Another photograph incorporating as many workmen as possible was taken in the afternoon.
164. Personal Record Sheet of L.N. Brewer in author's possession.
165. See chapter VII describing the Nationalisation of the Coal Industry for details.
166. Personal records show there was some delay in deciding the value of the extra remuneration for this job.
167. Reproduced from a photograph supplied by J.W.B. Bellamy, former Coking Plant Fitter.
168. Reproduced from a photograph supplied by A. Foster, former Coke Oven Engineer.
169. The staff shown have been identified with the help of J.W.B. Bellamy and A. Foster.
170. Sheffield University College was formed in 1897 and a full charter of incorporation as a University followed in 1905. Beginning with only 100 full-time students, the between-the-wars figure stabilised at about 750 students.
171. L.N. Brewer attended Sheffield University and obtained certificates in Chemistry, Mathematics, Machine Drawing and a City and Guilds certificate in Coke and By-Products Manufacture.
172. Most of the text books on this subject were published between 1908 and 1920. The Coke Oven Managers' Association was formed in 1915. R.A. Mott, The History of Coke Making, Cambridge, 1936, p.123.
173. Rotherham Annual 1930, p.230.
174. Rotherham Annual 1923, p. 128.
175. Op.cit. Personal record of the late L.N. Brewer, former Coke Oven Manager, in author's possession.



176. J. Burnett, A History of the Cost of Living, Middlesex, 1969, p. 298.
177. Compiled from personal details of the late L.N. Brewer in author's possession.
178. Compiled from British Labour Statistics, Historical Abstracts 1886-1968, H.M.S.O. 1971, p.53.
179. Archives, Sheffield City Library, N.C.B. 442.
180. The waste-heat ovens were not sufficiently sophisticated for the coking plant to have its own engineer but it did have a small fitting staff. The colliery engineer had overall responsibility until the new plant was built in 1929.
181. At this time there was an anomaly in the wages structure which enabled chargehands to receive more wages than Foremen, though they did not receive such generous holiday, sickness or retirement benefits. Consequently there was reluctance at this plant and others for some chargehands to become Foremen.
182. Personal knowledge of the author.
183. Many definitions can be attached to the expression 'good job'.
184. Letter from L.N. Brewer, Coke Oven Manager, to G. Falkous, Secretary of the South Yorkshire Coking Plant Owners' Association dated 24th December 1946. Sheffield City Library, N.C.B. 1402.
185. D.M. Kelly and D.J.C. Foresythe, Studies in the Coal Industry, London, 1969.
186. Fore-runner of the N.U.M. which replaced the Miners' Federation in 1944.
187. After the last oven was charged the oven top in the immediate locality was swept clean as usual.
188. Personal knowledge of B. Bellamy, former Shift Foreman.
189. J. Bullock, Bowers Row, Wakefield, 1976, p.57. shows that in the mining district of Castleford most families were related by marriage and often cousin married cousin.
190. National Federation of Iron and Steel Manufacturers, Statistics of the Iron and Steel Industries, 1930, table 23.
191. Based on an interview with B. Bellamy, July 1979.
192. Personal notes of the late A.C. Middleton, first Manager at the Plant, in author's possession.
193. The two plants were not identical and so the total number of employees would differ though job for job comparisons would be worthwhile.
194. Report of Council, Transactions of the Coke Oven Managers' Association, 1917, p.1.

## C H A P T E R   V I I

### SOME ASPECTS OF NATIONALISATION OF THE COKING INDUSTRY.

#### Introduction

Nationalisation of the coal industry did more than anything else to change the shape of the post World War II British Coking Industry. It can be argued that nationalisation was essential for survival of the industry and because of its importance, some aspects are discussed in detail.

In 1947 it was recognised that there were three basic industries concerned with the carbonisation of coal:-

- (a) Coal mining
- (b) The iron and steel industry
- (c) Gas and smokeless fuel production.

The chemical industry depended to some extent on each of these industries because it was based largely on derivatives of coal for its feedstock. The inter-related nature of the industries and their dependence on coal attracted attention towards their economy. It was already apparent that transport costs were becoming an increasing factor in the economy of an industry and this undoubtedly influenced the case for the centralisation of carbonisation plants. The following considerations, many of which are traditional parameters, were presented by advocates of carbonisation plants at the coal source(1) :-

(1) The characteristics of coal mined at the colliery  
or group of collieries.

(2) Daily output of coal.

(3) The types of products that can be made.



(4) Local demands for these products.

(5) Proximity of other collieries mining suitable coal for blending.

(6) The economic size of centralised units.

Coking plants supplying hard coke for the iron and steel industry were considered to be best sited at the point of utilization rather than the point of production on the grounds that collieries supplying the raw coal were in the neighbourhood and that coal blending from several collieries was becoming more important. The size of the coking plant was matched to the size of the blast furnaces it was to serve and not to the size of any particular colliery. Large centralised coking plants for the steel industry were therefore considered a desirable feature insofar as blast furnace gas could be used effectively for underfiring the batteries and thereby liberate coke oven gas for other purposes.

The demand for town's gas had started to increase in 1947 and methods of increasing the availability of gas from coke ovens for town's use were being considered. Attention was being paid to the discriminate use of valuable coking coal and the possibility of coal blending to enhance the quality of both domestic and industrial coke and to improve the gas yield. The case for centralised installations where coal throughput was in the order of 800-3,000 tons per day was beginning to emerge. Large units would enable the preliminary refinement of by-products to give way to the economical production of a variety of purer products for the chemical industry. However, this soon lost significance when the chemical and petrochemical industries took a massive

leap forward and depended less and less on coal chemicals as feedstock.

In 1951 the Gas Boards were thinking of coking plants of 1,100 - 1,200 tons per day as being the most economical units. (2) This view was developed almost entirely from gas production costs and flexibility of gas production by the use of holder capacity, variable load and the production of electrical power.

The grouping of British coking plants between 1935 and 1955 inclusive is shown in figures 14a. The industry increased in capacity by about thirty per cent over a period of twenty years and the average size of plants doubled. Was this rate of progress good enough? The answer must remain to some extent conjecture because of constraints not only within the coking industry but in related industry as well which restricted freedom of choice.

In order to present an indication of the magnitude of the coking industry some of the problems presented in the next section should be considered in respect of the following N.E. Divisional interests (3) :-

18 Coking Plants

3 Brickworks

2 Electricity distribution systems

4 Wagon repair shops

1 Briquette plant

1 Gas works



FIGURE 1.

Disposition of Coking Plants (4)

Capacity (tons per day)	1935	1946	1955
Above 4,000			
3,500 - 4,000			
3,000 - 3,500			3
2,500 - 3,000		2	2
2,000 - 2,500			3
1,500 - 2,000	3	7	12
1,000 - 1,500	10	12	9
500 - 1,000	33	34	25
Below 500	55	32	27
Total	101	87	81
Total capacity (tons)	59,117	66,881	81,245
Average capacity (tons)	585	769	1,003

Fig 1a  
Location of Coking Plants.

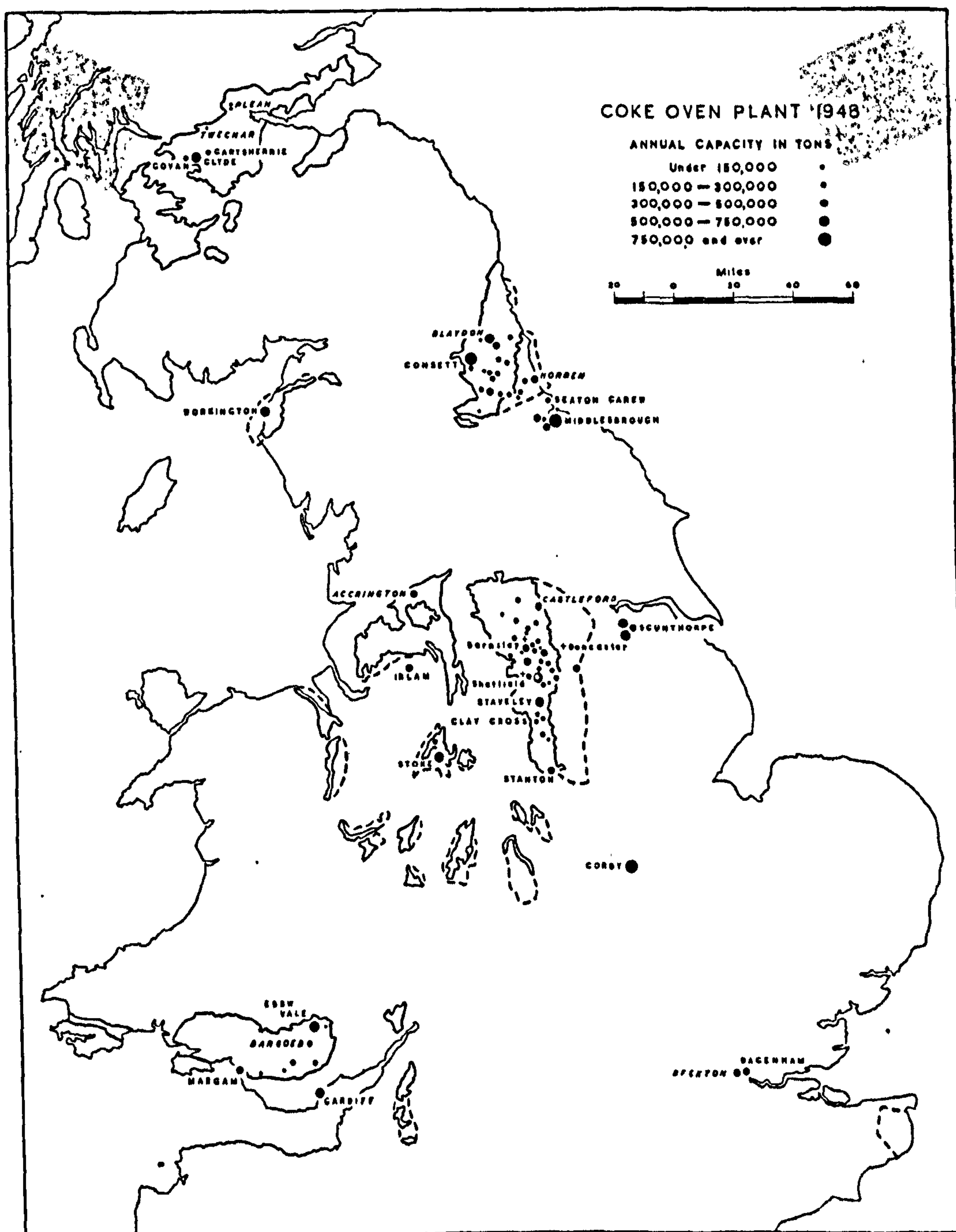


FIGURE 5—Coke oven plant in Great Britain, 1948.

Block capitals indicate coke ovens at iron and steel works (all are named).  
Sloping capitals indicate coke ovens at pitheads (only a selection named).  
Certain key towns are marked with a cross (e.g. Sheffield).  
Coalfields are shown by solid lines and concealed extensions by broken lines.



## Problems of Valuation

Coking plants were by far the largest item settled by the North Eastern Divisional Valuation Committee, and had an acclaimed value of £9.371 million and a certified value of £5.741 million. This figure should be looked at in the light of the global sum of £35 million for the N.E. Division and £164 million for the whole of the N.C.B. (5) The assessments were an artificial situation because they assumed a willing buyer and a willing seller, nevertheless the method of awarding compensation worked well although in practice it was fraught with problems. Perhaps the best illustration of the type of difficulty encountered can be seen by looking at the situation regarding slurry ponds. For many years the slurry produced at washeries was virtually a waste product and it had been disposed of by dumping on valuable land. Some collieries had altered their boiler furnaces and extended the boiler plants so that they could usefully consume slurry but generally such consumption could no more than equal the current make of slurry and the dumps of slurry continued to increase. Visible evidence remains at Glasshoughton Coking Plant. Owing to a shortage of high grade fuel towards the end of the war a market had been found for a small quantity of slurry, the largest consumers being the Ministry of Fuel and Power for the making of ovoids. One coking plant which had a small briquetting plant attached specifically to contribute towards meeting the shortage was the Waleswood coking plant, near Sheffield.

Claims for the value of the vesting slurry were invariably based on the assumption that the full amount of the ground stock could be sold immediately at the maximum price current on

31st December 1946. These claims became the subject of a special report by the Divisional Finance Officer and the Divisional Chief Scientist and their findings were embodied in a report on valuation of slurry subsequently adopted by the Sub-Committee, in turn most of the basic features were accepted by the Yorkshire District Board. As a result the original claims for almost 2.5 million tons of slurry at nearly £2.5 million was reduced to £0.56 million by the District Valuation Board. (6) This example has been given to show that valuation was complex but stringent efforts were made to try and ensure fairness.

#### Compensation for Nationalisation

Following the passing of the Nationalisation of the Coal Industry Act in 1946 and its implementation on 1st January 1947 the question of compensation had to be considered. The following paragraphs give an indication of the details which were examined before compensation was finally agreed.

The expected life of a particular plant had to be anticipated and this was often arrived at by examining the commissioning dates based on catalogues of the Koppers, Coppee and Semet-Solvay Companies and lists for Simon Carves, Otto, Simplex, Hussener and Collin ovens supplied by the contractors and checked as far as possible.

Another factor taken into account was that the reason for replacing a battery was that it ~~was~~ not economical to continue it. Often therefore it was replaced by a battery of more recent design taking a larger charge or with a narrower oven (to obtain a greater coke production per oven per day). From about 1924



and particularly after 1933, ovens were built to take charges of 15 tons of coal carbonised in 18 hours to give a carbonising capacity of 20 tons of coal per oven per day as compared with early batteries taking a charge of  $7\frac{1}{2}$  tons of coal and carbonising in 36 hours, giving a carbonising capacity of  $3\frac{3}{4}$  tons of coal per oven per day. In later ovens, following American practice, the operations of charging, levelling and door lifting were mechanised, and therefore speeded up, so that a team of as few as 6 men could operate the larger number of ovens to be charged and discharged per day.

In other cases the high labour costs of the older types of oven and the loss of revenue from the sale of ammonia in 1923, when I. C. I. produced ammonia synthetically, without compensating advantages of a sale of coke-oven gas for town supply or the higher yields of motor benzole to be obtained from high volatile coals of Yorkshire and Derbyshire (with fast coking ovens), or the working out of seams of coking coal stocks of suitable quality, caused the batteries to shut down and not be replaced. Since economic causes led to the dismantling of batteries whether these were replaced by more modern types or were abandoned, the records were treated as a whole.

Since there were special reasons why the earliest coke ovens of the period 1880 - 1900 had an especially long life, these batteries were omitted from the average. The earliest ovens, e.g. the Simon-Carves ovens at Crook, Bearpark, Altham, Bignall Hill and Malton were heavy construction, with a very long coking time. With the turn of the century oven walls were built thinner and longer ovens were of larger capacity, two features which shortened the effective life. Moreover, most

of these older batteries were maintained on special cokes, electrode coke or foundry coke and attained average lives of nearly 60 years. The same remarks applied to the Semet-Solvay ovens of the 19th century and these two groups were omitted from a table determining the average life of a battery which, for ovens built after 1899 and dismantled not later than 1946 was 23.1 years. One complication was that ovens still in operation at Vesting Date were excluded because many of them were in operation for special reasons such as the production of a high proportion of foundry coke. In any event it was expected that a large number of the old plants in operation at Vesting Date would have been dismantled very shortly thereafter.

Although the mean life of a battery of ovens for a particular period was worth knowing, each case differed markedly from the mean for a variety of reasons so that special circumstances in different coalfields often modified the general conclusion. One illustration is that in South Yorkshire foundry coke was not made so that the average price received for coke was low compared with districts in which foundry coke was made. This was balanced, however, by the fact that in Yorkshire, more gas was sold for town supply than in other areas. Since there had been encouragement to maintain gas supplies and to increase the production of blast furnace coke, these two factors probably allowed the retention of ovens which would otherwise be due for replacement. This applied to the Koppers ovens at Old Silkstone and Glasshoughton, the Simon Carves ovens at Monckton, Wharnccliffe Silkstone and Wharnccliffe Woodmoor and the Otto ovens at Crigglestone, which at Vesting Date were over 40 years old. In Scotland the need for local foundry coke enabled the batteries at Plean and Carnock to persist for over 49 years.



The position in South Wales was worthy of special consideration because those ovens suffered, by comparison with those in South Yorkshire, by giving lower gas and benzole yields.

As a result economic considerations demanded that this should be balanced by some other factor such as making a foundry coke which brought an enhanced price.

Another complication was that in 1946 it was obviously the policy of the large steel works to produce their own blast furnace coke and, outside the steelworks plants economic conditions would only be favourable to batteries of modern ovens giving high yields of gas and benzole if a high proportion of a coke of blast furnace quality was being made or, for the older ovens, if coke of foundry coke quality could be produced.

Notwithstanding the above general considerations each colliery and coking plant were examined in detail and the circumstances surrounding the payment of compensation to Messrs. Skinner and Holford Ltd. who owned Waleswood colliery and coking plant is given as a typical case study. (7)

The N.C.B. were well aware of a host of shortcomings at the colliery, not the least of which was the fact that the Parkgate seam had suffered as the result of a concentration of output from it in 1945 to the neglect of the necessary bye-work and the pressure of compressed air at the pit was so bad that output was constantly and seriously interrupted.

In order to put the colliery into a state which would have enabled it physically to have maintained production for 28 years it would have been necessary to spend more than £350,000 on development, reorganisation and new plant and equipment.

If this development and re-organisation had been carried out, the physical life of the colliery might have been extended for 28 years beyond the Vesting Day. But in view of the past history of the colliery no prospective buyer who would in any event have had to pay at least a break-up price for the colliery as it stood - would have regarded its prospects of earning profits after reorganisation as sufficiently assured to justify his embarking upon a programme of further capital expenditure which the National Coal Board estimated would be of the order of £350,000.

In the  $6\frac{1}{4}$  years preceding the Vesting Day heavy losses were made in every year except 1945 and early 1946. The profits that were made in 1945 and 1946 were made only because labour was concentrated on immediate coal-getting in the Parkgate seam to the neglect of essential bye-work with the consequence that although results from that seam improved temporarily this was only at the expense of future output. Heavy losses were again being incurred and six months before the Vesting Date the Claimants were anxious to close the colliery altogether. During the last 6 months, and indeed thereafter, the position deteriorated considerably.

In view of the depressing financial affairs of the colliery what were the prospects for the coke ovens? In the opinion of the N.C.B. deferred repairs amounting to almost £20,000 were needed at Vesting Day. The ovens would require rebuilding or extending in 1955 or thereabouts at a total cost estimated by the Claimants at between £100,000 and £126,000. Furthermore the plant had never achieved an output greater than 90% of rated capacity in its early years and it was therefore most unlikely



that it would do better in subsequent years when it could be presumed to be less efficient. Perhaps the designers were optimistic about throughput.

The Claimants had shown a declining trend from 1943 to 1946 and the three months immediately prior to Vesting Day showed a loss which the Claimants did not explain.

In view of the prospects of the Waleswood colliery the buyer would have to contemplate in the future either paying an annual subsidy to the colliery to enable it to continue in operation and supply the coke oven's requirements of coking coal or buying the whole or the major part of such requirements from other collieries, if obtainable, at market prices involving additional freight and handling charges and the making of alternative arrangements for supply of services previously obtained from Waleswood colliery. Chapter V describes this plant in greater detail.

Taking the above factors into consideration the N.C.B. submitted that no buyer of the coke ovens at Vesting Day would be prepared to assume that the coke ovens had any commercial prospect of making a profit in the future. How did the draft valuation tie in with the submission? The total of the valuations for the colliery and coke oven units amounted to £345,000 for assets that at Vesting Day were making losses at the rate of almost £53,000 per annum and averaged more than £5,600 over the preceding  $6\frac{1}{4}$  years. The total cash that must be provided by a purchaser of the two units amounted to £750,000 when deferred repairs, additional capital expenditure, working capital etc. were taken into account. In the view of the

National Coal Board these figures spoke for themselves and the sum of the combined valuations could not be justified by any reasonable appraisal of the return likely to be expected from the colliery and coke oven undertakings which together, when all proper adjustments had been made, had only been earning an average profit of £1,500 per annum over the immediately preceding  $6\frac{1}{4}$  years.

The foregoing paragraphs have attempted to outline the main features of the N.C.B.'s objection to the Draft Valuation of Compensation Unit. In conclusion and having regard to the circumstances affecting Valuation it was felt that the only reasonable basis on which compensation could be valued was that of break-up value. A proper figure for this, after allowing for costs of dismantling was £5,000.

In the event the claimant's valuation changed from almost £300,000 to slightly over £400,000 and settled down at £216,000 at the Hearing while the District Valuation Board Draft Valuation of £137,000 finally became £141,000.

The N.C.B. considered taking the action further but any further evidence would depend on technical views and opinions and there would be difficulty in fighting on these grounds. (8)  
In the event the N.C.B. in conjunction with their Chartered Accountants in London agreed to accept the D.V.B. Determination.

#### The State of the Coking Industry at Vesting Date.

Nationalisation of the coal industry and the associated coking industry is without parallel and it is worthwhile to look at the state of the industry when it transferred to public ownership.



The total annual output of coke in 1947 was 13.8 million tons and the plants which were responsible for this vital material can be classified as follows:-

- (1) Plants belonging to the iron and steel industry which were an integral part of steelworks.
- (2) Plants belonging to colliery companies, known as 'merchant' plants.
- (3) Independent coking plants not belonging to either of the above. They were few in number and liaised closely with the N.C.B. in respect of wage settlements and conditions of service.

With very few exceptions the plants referred to in item (1) above were built after 1930 and were relatively modern. Their function was to provide all, or almost all the coke needed by the blast furnaces on the same site. Those ovens were designed and operated to produce blast furnace coke and the amount of domestic and industrial coke was minimal. Blast furnace gas has a relatively low calorific value and was used for underfiring the batteries; a corresponding amount of coke oven gas was used on the steelworks. As a result the only fuel required for an integrated steel works was the coal for carbonisation. Special coals with low ash, moisture, sulphur and sometimes arsenic and phosphorus contents were required at these coking plants and the capacity of the plants was related to the requirements of the blast furnaces they served. The average capacity was about 1,300 tons of coal carbonised per day.

In sharp contrast the plants owned by the colliery companies existed simply to provide an economic outlet for the small coal

from the colliery washeries and without them large stocks of unwanted coal would have accumulated and embarrassed the colliery owners. Therefore these plants were generally much older than those associated with the production of iron although some modernisation had been carried out in the late 1920s and early 1930s. The capacity of these coking plants was dictated by the output of small coal from the washeries and in consequence they were relatively small with an average daily throughput of about 500 tons. Throughput varied widely and excluding Hazelhead beehive ovens which had a throughput of only 13 tons per day and were closed down soon after nationalisation, daily throughput ranged from 250 tons to 1,800 tons. Furthermore the quality of the coke produced varied enormously depending on the properties of the coal mined at the colliery. Some of the coke was hard and relatively unreactive and with a high purity which made it ideal for use in foundries. Other coke was suitable for blast furnace use and a third category was highly reactive and was therefore suitable for domestic and industrial heating.

The National Coal Board became responsible on 1st January 1947 for almost all the plants referred to in category (2). The Coal Industry Nationalisation Act of 1946 did not require the National Coal Board to produce coke and other manufactured fuels, but it gave it the authority to do so if it was considered 'requisite, advantageous or convenient'. (9) Under the vesting provisions of this Act, the coking plants which belonged wholly or substantially to the colliery companies automatically vested in the N.C.B. and the Board elected to continue to operate them. As a result 53 coking plants together with a small number of other related plants, employing about 8,000 men and spread over six of the Mining Divisions were nationalised.



Details of the coking plants vested in the N.C.B. on 1st January 1947 are given in figure 2.. An analysis of the data shows that the plants in the two areas designated North Eastern and East Midlands Divisions of the N.C.B. which form the area of study for this thesis comprise half the total number of plants nationalised. Similarly the plants account for half the production of blast furnace coke though the proportion of plants meeting this market was 61 per cent. The figure shows that almost half the coke produced in the N.E. Division was domestic and industrial quality while the proportion rose to 91 per cent in the East Midlands. The difference is accounted for by the fact that Derbyshire coals are less suitable for blast furnace coke production. It is worthwhile to consider to what extent the plants described in the thesis are representative of all the coking plants in Britain. The answer is complex but a simplified indication is given in figure 3.

Soon after nationalisation the N.C.B. carried out a survey of all their coking plants and the results showed that most had deteriorated because of the working restrictions imposed during World War II. Some plants were obsolete and some were not financially viable. Only a small number of plants had a throughput of 1,000 tons of coal per day and this was regarded as the minimum size which would be economically viable. The largest plant had a throughput of 1,800 tons of coal per day and was located at Derwenthaugh in Durham. The smallest had a throughput of only 13 tons per day and was located at Hazelhead in Yorkshire. The total of 53 plants included 11 plants operating waste heat ovens, three plants using beehive ovens and the remainder being regenerative type ovens had surplus gas for sale

**FIGURE 2**

**The Nationalised Coking Industry (10)**

Division	Number of plants in operation. 1947	Coke Produced in 1947. (million tons)	Pattern of Coke Disposals (Inland only)		
			Blast Furnace %	Foundry %	Domestic and Industrial %
Durham	18	2.46	51	19	30
North Eastern	20	2.13	52	-	48
East Midlands	5	0.63	9	-	91
South Western	5	0.38	20	46	34
Scottish	4	0.18	24	48	28
North Western	1	0.17	-	26	74
	53	5.95	42	14	44



FIGURE 3.

Contribution to the Coke Market. (10)

	Blast Furnace %	Foundry %	Domestic and Industrial %
N.C.B. Plants	30	82	63
Other Plants	70	18	37

to gas companies.

Not surprisingly, coal blending facilities were almost non-existent and the coke handling equipment varied from installations having coke cars, belt conveyors and screening plant, to installations having bench quenching, no screening plant and hand loading of coke into wagons.

After the initial survey the N.C.B. produced a comprehensive programme for the reconstruction of existing ovens and for building new plants. (11) The N.C.B., together with the iron and steel industry were responsible for re-shaping the coking industry. Figure 4 gives the average numbers of the various types of coke ovens in use, as well as the numbers of ovens shut down but available for use, rebuilding or under construction for the years 1945-56. The figures show that about 80 per cent of the ovens in operation in 1953 were of the regenerative type. In 1947, the last year for which detailed information of the types of ovens under construction was available, no new waste-heat or beehive ovens were being built, although a few were rebuilt.

Figure 5 shows the rate of capital investment reached a peak in 1956 and by the early 1960s it fell to zero and continued at that level until the end of the decade. (Figure 24 shows the massive over production which resulted from the modernisation, a lack of demand by industry, and an undeveloped domestic market.) Two points emerge; the first is the reason why it should take ten years after nationalisation before maximum capital investment was reached, and the second is the reason why investment should fall to zero for a decade afterwards. In order to understand the answers it must be appreciated that the coal industry was



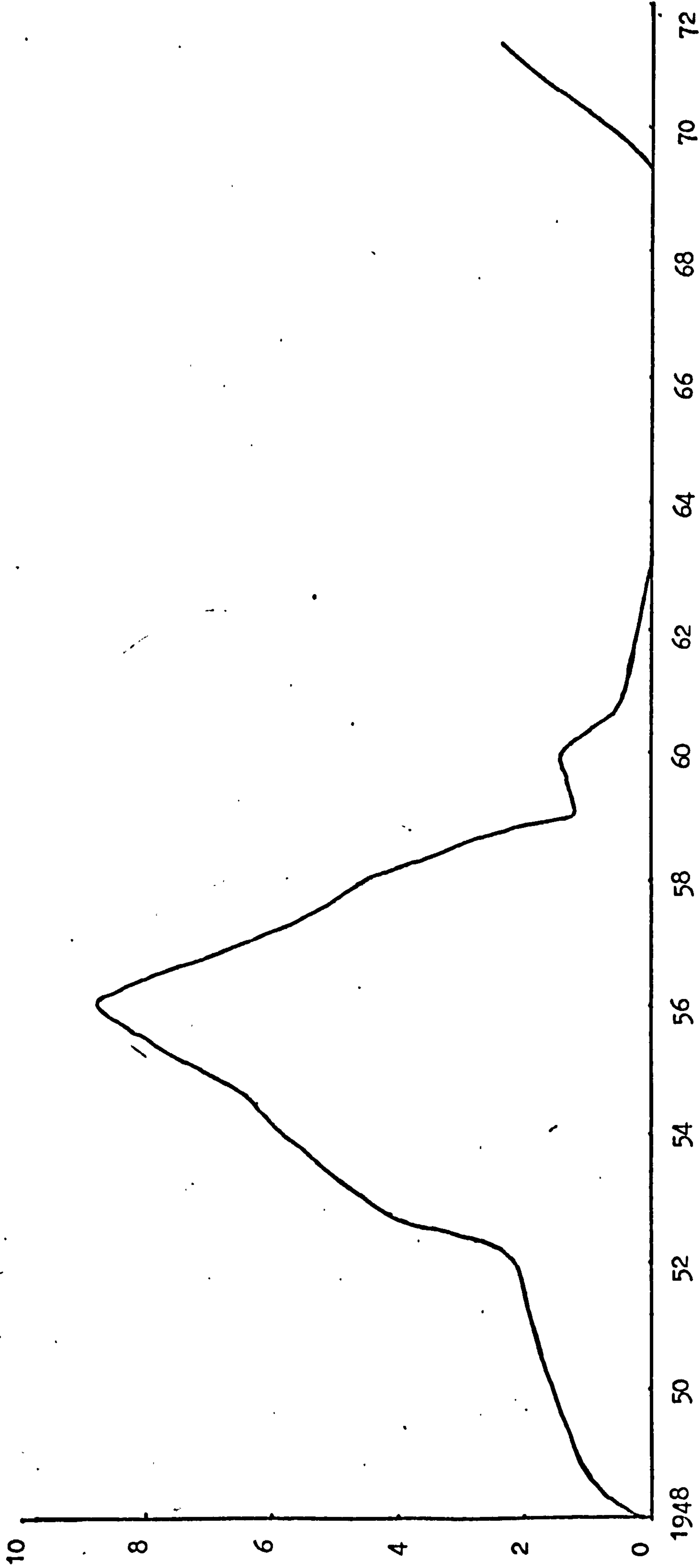
**FIGURE 4.**

**Coke - Oven Types in Britain. (12)**

	1945	1950	1952	1953	1954	1955	1956
Ovens Working:							
Compound regenerative	1,237	1,347	1,974	2,120	2,188	2,507	2,840
Other regenerative	2,569	2,407	2,120	2,094	1,960	1,846	1,707
Waste heat	1,083	778	775	730	755	735	721
Beehive	218	247	247	247	187	187	167
Total	5,107	4,779	5,118	5,191	5,090	5,275	5,455
Ovens shut down	269	50	51	28	42	1	2
Ovens rebuilding	278	112	140	127	132	63	64
Ovens building	194	369	254	480	454	321	455

FIGURE 5.

Capital Expenditure on N.C.B. Coke Ovens (13)





the first industry in Britain to be nationalised and inevitably there was lack of expertise in the industry in being able to perceive such large scale changes easily. Caution was perhaps a by-word because the Board was very anxious to pitch the scale of the future coking industry correctly. After all they had all the internal experience they could wish for and it ought to be possible to incorporate variables outside the industry which would influence the industry so that its overall contribution to the national economy would be optimal. Under the circumstances it was reasonable for the Board to move as quickly as it could with the planning of rebuilds and new plants without being hasty. Added to this was the fact that a coking plant uses one basic raw material but it produces several products, the demands for which may not be wholly compatible and in extreme cases might even be in short term conflict. Superimposed on these criteria was the fact that modernisation of the British coking industry, *though large*, was only part of world wide expansion and modernisation of coke making capacity, particularly in India and Australia. The result was that the major coking plant contractors in this country as well as those abroad enjoyed a boom period, the magnitude of which had never been seen before and is unlikely ever to be seen again. British contractors were held in high regard and Commonwealth links were strong so that the two large contractors received massive contracts in two Commonwealth countries. The contracting industry responded magnificently to the challenge of new business which departed from tradition in magnitude and scope but they were not always masters of the complete situation. For instance the silica brick manufacturers were unable to respond with the same success and in some instances a delay of up to four years was experienced in the delivery of silica bricks.

This delay had to be set against the estimated date at which older plants needed re-construction or replacement. The second point which concerns the almost total lack of capital expenditure in the 1960s is much easier to understand. The life of coke oven batteries is usually twenty or twenty five years so that with so much reconstruction and new work taking place in the 1950s it is inevitable that only minor capital expenditure would be incurred for a period thereafter. The coking industry was fortunate in so far as it rebuilt and modernised in the 1950s when, according to figure 6 chemical plant costs were relatively cheap. The net result was that with new plants costing relatively little the financial state of the industry later on was easier than it might have been. It is not intended to imply that the coking industry didn't have financial problems later, but to point out that they could have been worse.

In order to reduce operating and capital costs all new plants were planned to carbonise not less than 1,000 tons of coal per day, and some to exceed this capacity or to be capable of easy extension. (14) The effect is shown in figure 7, the small undulations early in the 1950s being attributable to the closure of one or two relatively large worn out plants. The planned increase in coke production is shown in figure 8 along with the capacity that was actually achieved. The N.C.B. have a tradition of optimism and figures 8 and 9 show one of the forms it took early on. The reasons for this are never simple and perhaps in the long term optimism has been to the good of the coking industry and the nation. Because only large collieries produced enough coking coal to supply large plants, mining and carbonisation developments had to be co-ordinated if the economic advantages of large scale coking practice were



FIGURE 6.

Chemical Plant - Capital Price Indices. (16)

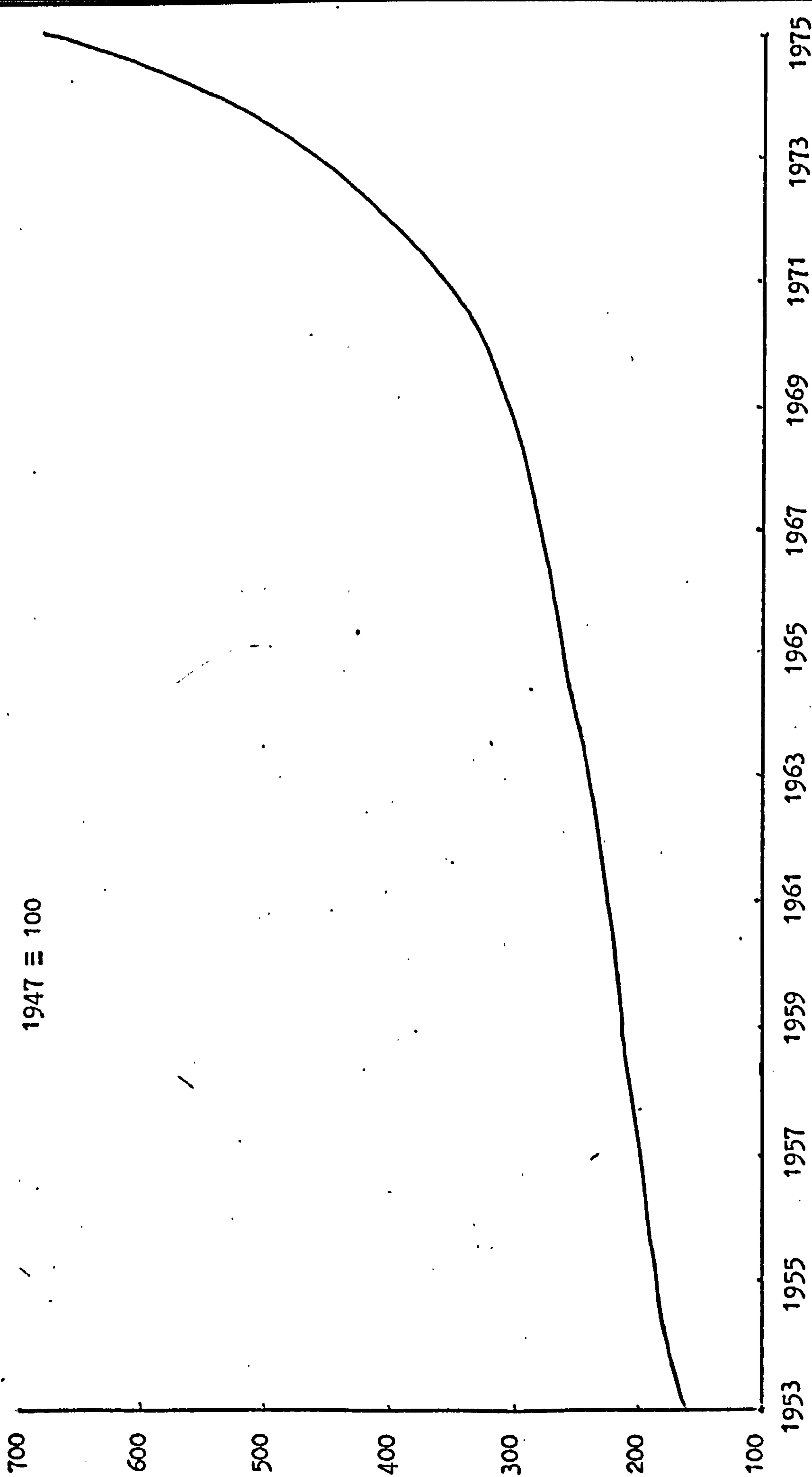


FIGURE 7

Average Throughput of N.C.B. Coking Plants. (17)

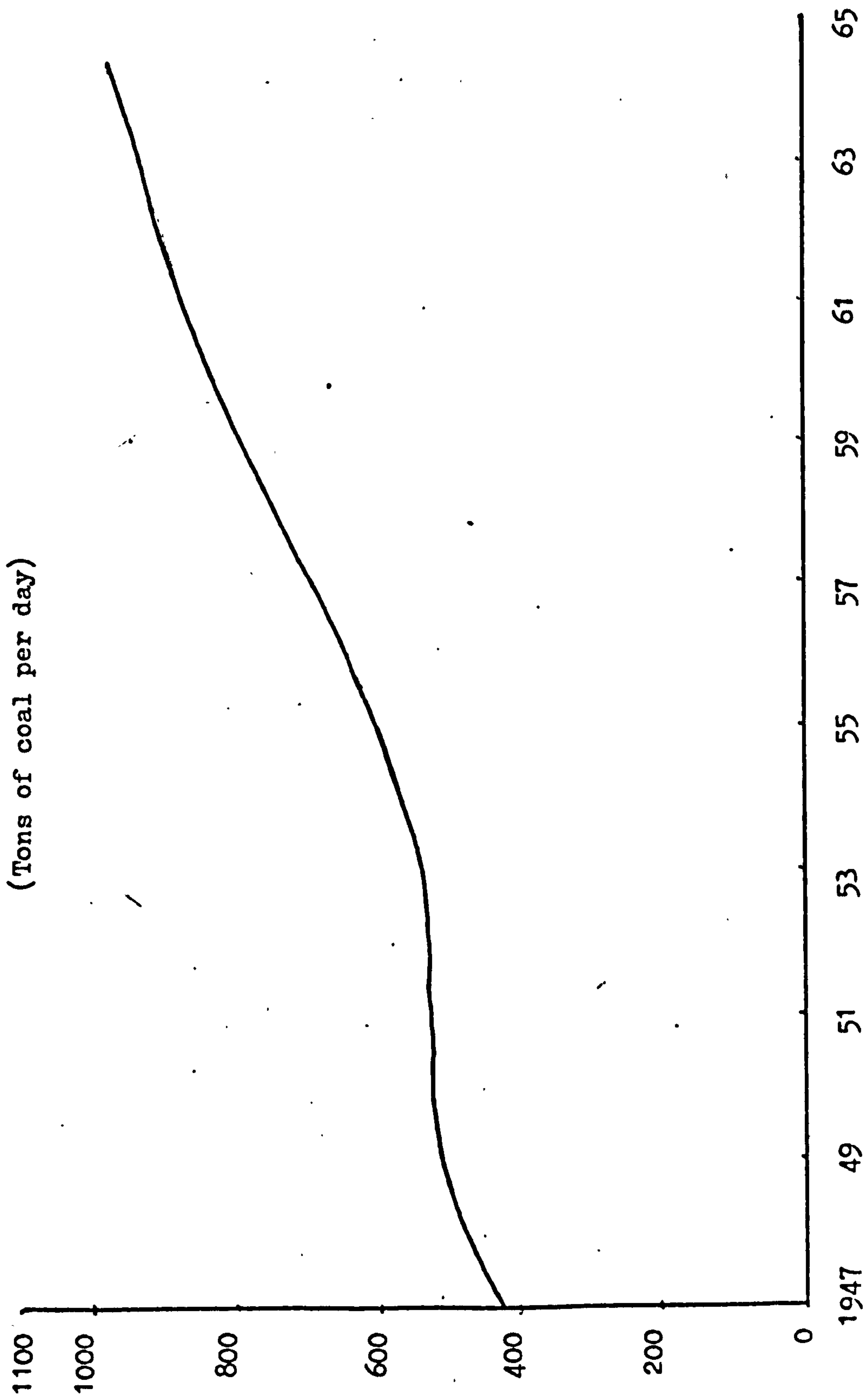




FIGURE 8

Coke Produced at N.C.B. Plants. (18)

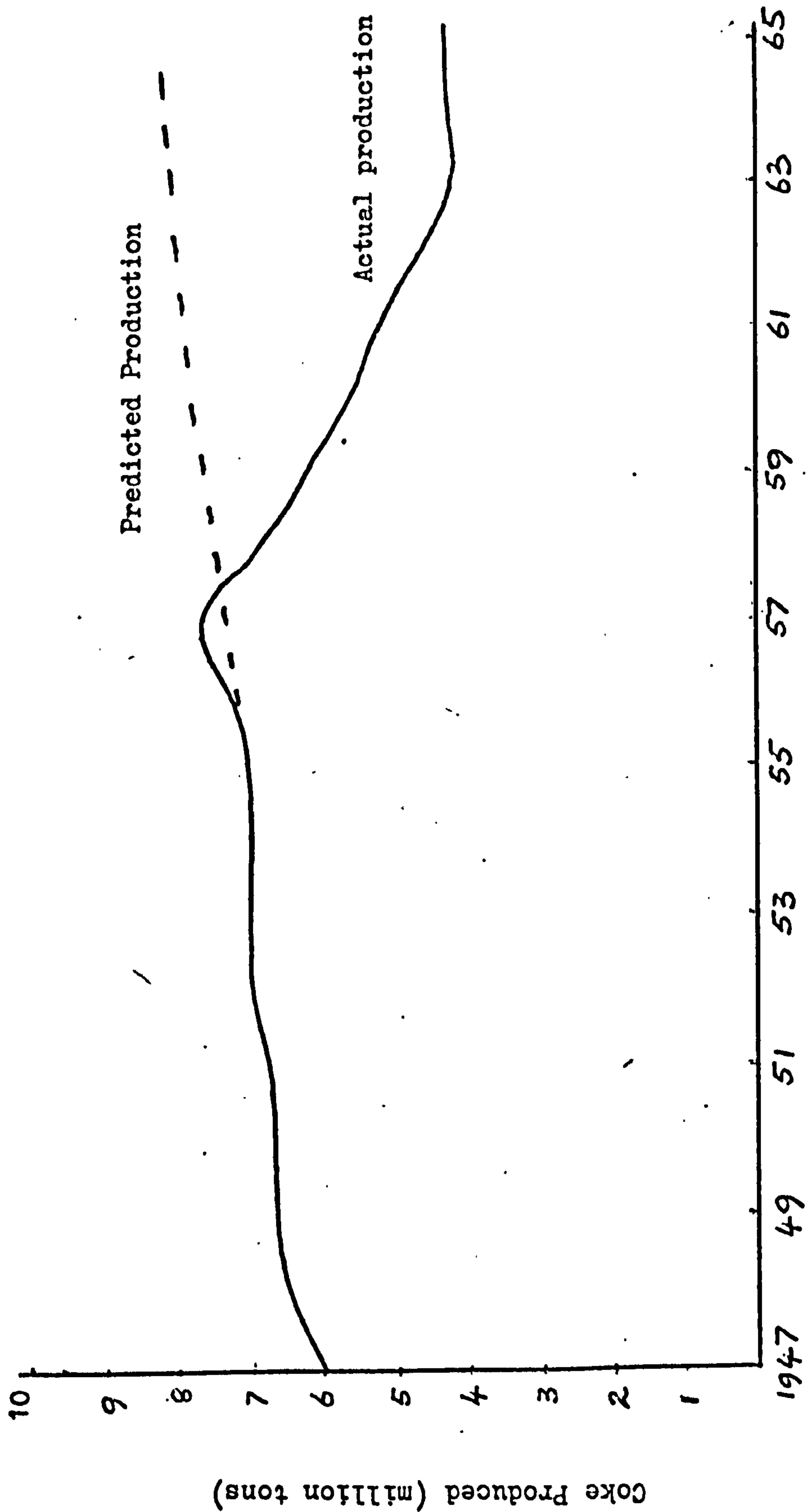
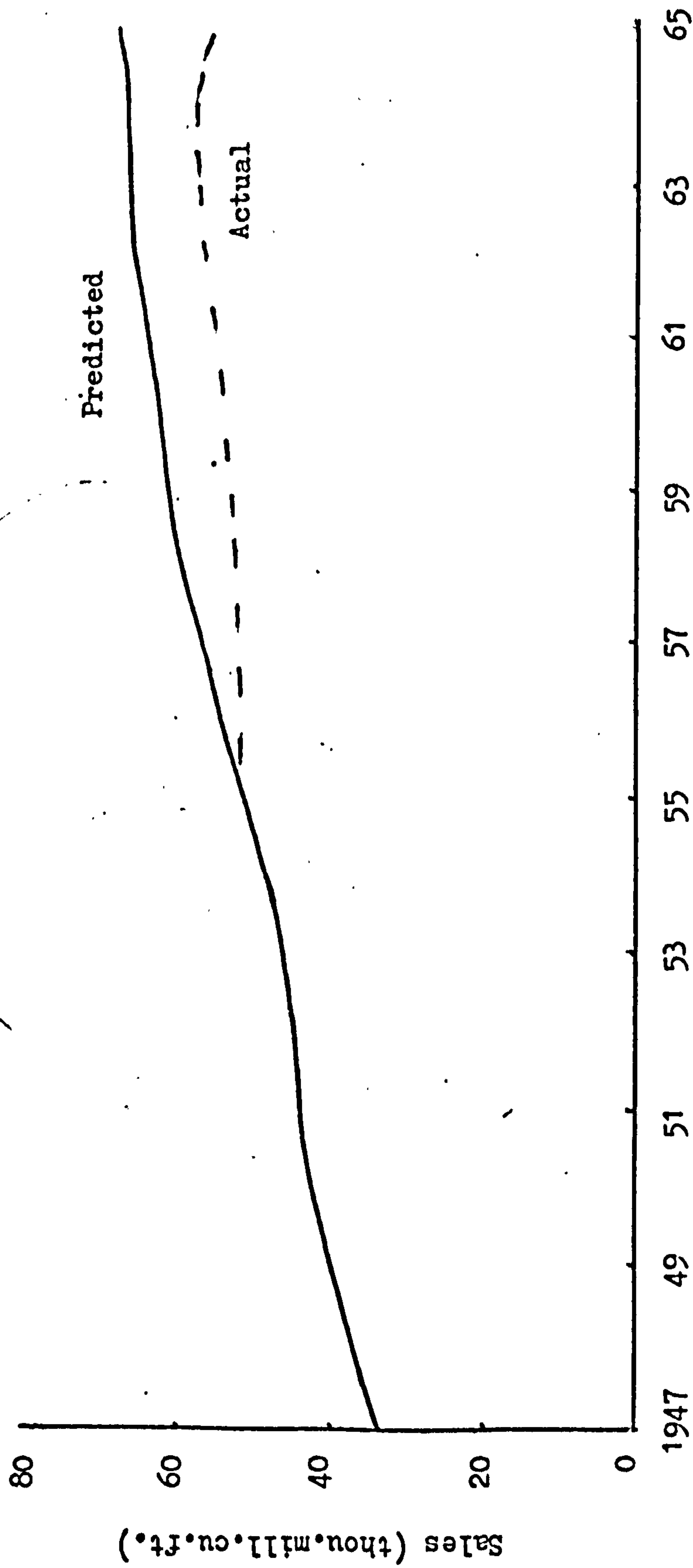


FIGURE 9

Gas Disposal at N.C.B. Plants. (19)





not to be nullified by high freight charges on transported coal. The siting of new plants had also to be carefully related to the markets for the coke produced so as to minimise the cost of transport between producer and consumers. Other problems centred around the disposal of the plants' surplus gas, which, after 1948, the Board were allowed by law to sell only to the Area Gas Boards. The amount for sale was about 7 million cubic feet per day from each new plant and represented, after coke, the largest single item of revenue. Figure 9 shows the expected gas disposal and actual disposal, and it must be considered in conjunction with figure 8 because the production of coke and gas are generally directly proportional, although some departure from proportionality can be achieved. (15)

The need to site plants where gas could be disposed of to best advantage was considered to be a further factor although the author believes too much emphasis was placed on this criteria.

In all cases compound ovens were installed so that if additional supplies of gas over and above the normal surplus were required by Gas Boards the ovens could be heated with producer gas. Blending facilities were also provided at every large plant so as to enable coke to be made consistently with the quality most suited to the market for which it was intended. The hope was that the coking industry would expand and that the N.C.B. would have to meet the requirements of an increasing blast furnace coke market. After all, this had been the general trend through the century. Did the expectation become a reality? Perhaps one factor more than any other mitigated against the traditional trend so far as the N.C.B. were concerned, this was the eventual nationalisation of the

iron and steel industry and associated coking plants.

Early co-operation in respect of blast furnace coke production changed and the integrated plants became more and more self-sufficient in respect of blast furnace coke.

The N.C.B. were justified in expecting a buoyant blast furnace coke market because until 1957 there was a growing shortage of iron on a world scale. Between 1946 and 1962 world steel production more than trebled from 110 million tons to 361 million tons and prices of iron ore rose accordingly. The N.C.B. saw nothing but expansion but they under-estimated the ability of the British iron and steel industry to modernise on a large scale and build new integrated coking plants. Neither did they foresee economies in the blast furnace process by preparation of the ore before it was charged to the furnace. The net result of this and other measures was an improvement in efficiency and a reduction in the coke rate shown in figure 10. Much depends on whether the general downward trend will continue, or even accelerate.

The relative coke production for the iron and steel industry and the N.C.B. widened rapidly in favour of the former and at the expense of the latter, especially during the five years or so after 1955. The Independent Coke Producers continued production at a small but relatively unchanged rate. Figure 1 in chapter IX illustrates the trend in respect of total coke production. What then was the situation in respect of blast furnace coke? Figure 11 shows the contrast between the iron and steel industry and the N.C.B. production of blast furnace coke was even more marked. The N.C.B. share of this lucrative market declined until by the early 1960s it was about the same



FIGURE 10

Coke Consumption per ton of Pig Iron. (20)

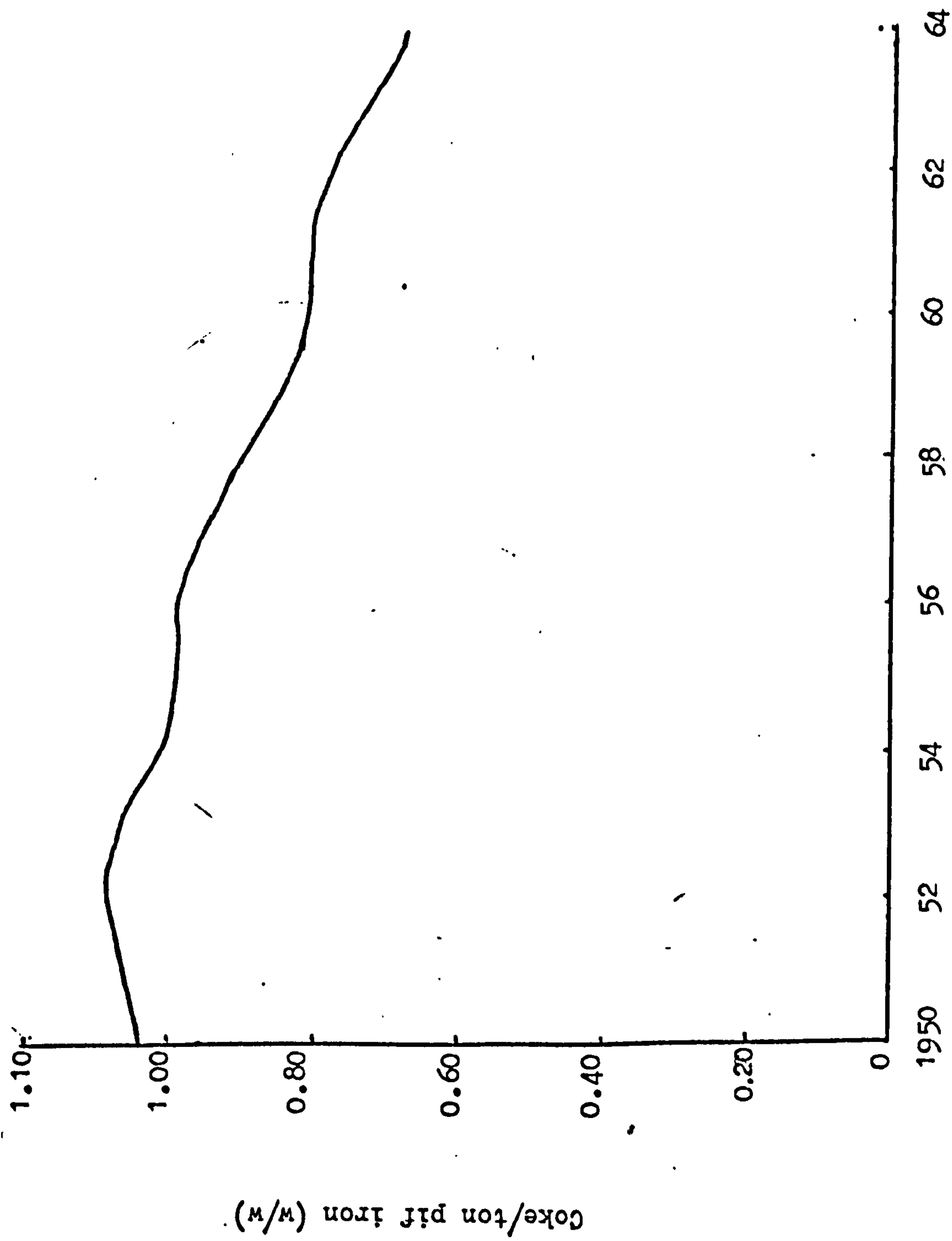
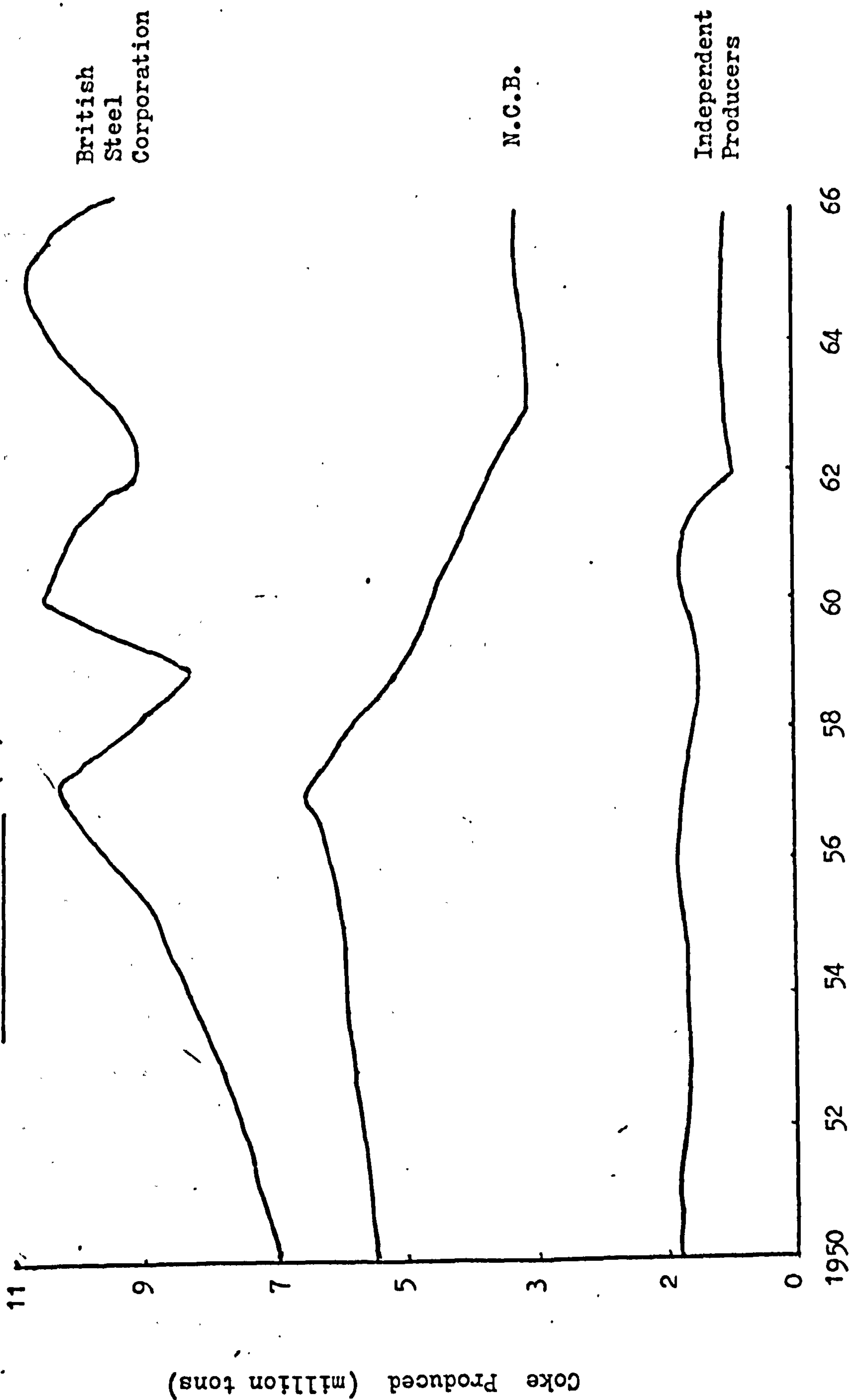


FIGURE 11.

Coke Production (21)





size as that supplied by the Independent Producers who had maintained a small but steady share.

The N.C.B. was relegated to being the main supplier of domestic solid fuel. This was bad enough but a world wide downward trend in the demand for iron led to excess coking plant capacity in this country during the late 1950s and early 1960s. There was reluctance to close more plants in the hope that the demand for coke would increase and coke stocks reached a record level shown in figure 24.

#### Structure of the Nationalised Coking Industry.

The first duty of the N.C.B. was to set up a structure to manage the vested plants. It decided from the outset that the carbonisation activity, which was second in size only to mining, should not simply be managed as part of the coal industry. A Carbonisation and Briquetting Branch was therefore established under a Director at National level responsible to the Heads of Production and Marketing Departments at N.C.B. Headquarters, Hobart House, Grosvenor Place, London, formerly the property of the Tasmanian Government. A list of the vested plants in Yorkshire and Derbyshire is given in figure 12.

Plants in Yorkshire became the responsibility of the North Eastern Division of the N.C.B. and those in Derbyshire the responsibility of the East Midlands Division. A Mining Director on each Divisional Board had specific responsibility for coking plants and had the initial task of acquiring appropriate office accommodation and appointing staff to administer the coking plants. In the case of the N.E. Divisional Carbonisation

FIGURE 12.

National Coal Board Coking Plants in Yorkshire and Derbyshire. (24)

	Date built	Date closed	Type of oven and dimensions	Oven charge tons	Coal Carbonised (excluding breeze)		Coke Produced 1946 (thousand tons)					Total
					1948 Year Book	Actual 1946	Foundry Blast Furnace	Industrial	Domestic	Breeze		
<b>Yorkshire</b>												
Cortonwood	1937	1961	23 Koppers Regen. 32'9"x13'1 1/2"x17 1/2"		160		59.6					89.5
Crigglestone	1911	1959	44 Otto Waste Heat 25 Otto Regen. 33'x8'6"x19 1/2"	9	160	118	1.7	41.9	24.4	16.8	5.0	89.5
Dalton Main	1935	1960	24 Otto Regen. Underjet. 36'1"x13'3"x17 1/2"	14	165	176		99.6			4.8	104.4
Dinnington	1938	1963	32 Still Regen. 36'2 1/2"x13'6" x18"	14	208	193 **	72.2	83.9	0.3	11.0		167.4
Gleashoughton	1933/36	1978		8.7	310	248	73.5				28.2	200.6
Houghton Main	1916/26	1950	50 Otto Waste Heat 10 S.C.Underjet Regen. 33' x 8'6"x20"	9.4	221	121	58.8		27.8		4.5	91.1
Kanwers	1933/35		45 Otto Regen. 35'10 1/2"x13'3"x18"		367	326 **	128.5				8.3	224.8
Kitchell Main	1938		20 S.C.Underjet 38'8 1/2"x13'6"x17 1/2"		155	130 **	70.4		24.2		6.1	100.7
Pannery Handsworth	1939/43	1961	30 Becker Underjet 41' x 12'6" x 15"	13.75	240	190 **		68.3		81.0	11.1	150.3
Pannery Sheffield	1937/39	1957	22 Becker Comb. 32'9 1/2"x12'6"x18 1/2"	13.3	150	116 **	25.2		62.8		5.6	93.6
Old Silkstone	1912	1958	80 Otto Regen. 32'9 1/2"x8' x 20 1/2"	9.25	197	174	1.6	83.2	13.5	29.2	7.3	134.8
Robin Hood	1933	1958	36 Gibbons Kogag Waste Heat 33'1 1/2"x 8'2 1/2"x19 1/2"	9.05	154	154	17.8				10.6	105.4
Rotherham Main	1930	1962	28 S.C.Underjet 39'4"x 10'6"x17 1/2"		150	150						
Smithy Wood	1943/45	-	59 Becker Compd. 40'8"x12'6"x16"	14.4	458	442	265.0		33.0		13.0	331.0
Thornhill	1908/11	1958	12 S.C.Regen. 28 S.C.Waste Heat 33'1 1/2" x 8' x 20"	9.0	76	65		25.5		31.2	4.9	61.6
Walewood	1938	1957	23 W.D.Underjet. 28'8 1/2"x12'6"x18"	9.0	96	88 *	58.0		2.5			60.5
Wath Main	1937		15 S.C.Underjet 35'11"x11'6"x17 1/2"		100	90 *	6.4	38.7	12.8	13.3	2.4	73.6
Wharfedale Silkstone	1912/24	1957	49 S.C.Regen. 33' x 6'6"x21 1/2"	9.6/ 8.4	100	100 *	26.4	25.5		5.2	1.2	58.2
Wharfedale Woodmoor	1917/26	1956	54 S.C.Waste Heat 32'4"x19'8" x 18 1/2"	8	100	78 *	49		9.2		0.5	58.7
Haselhead			Beehives - 72 Not working									
<b>Derbyshire</b>												
Blackwell					250							
Clay Cross					150							
Grassmoor		1960			197							
Hardwick	1935	1961			176							
Harworth	1935/7	1961			320							

\* - Dry basis



Department, Standfield House in the residential sector of the city of Sheffield was acquired for the Headquarters and the staffing plan that emerged is shown in figure 13.

Approximately 10 years after vesting date the staffing plan was revised and a larger Carbonisation Headquarters known as Moordale in the same district was acquired. The staff had been increased in the light of experience and the original property had become inadequate for the enlarged complement. Other changes had encouraged the re-structuring of the headquarters. The Mining Director, previously responsible for Carbonisation affairs was relieved of these duties, and throughout almost all the various Mining Divisions concerned with coking plant activities the Divisional Carbonisation Officer was appointed as Carbonisation Director. (22) The Director was responsible to the Carbonisation Department Headquarters at Chester Street, London. The revised Divisional staffing plan is shown in figure 14.

The structure of the Carbonisation Departments developed rapidly and in Yorkshire four Groups were scheduled to be formed, each with a Group Carbonisation Manager and supporting clerical and accounting staff and a technical officer. The Group Managers were responsible to the Divisional Carbonisation Director. Allocation of the plants is shown in figure 15. (23) Several features are worthy of comment and will be dealt with in chronological order. It was soon realised that the idea of having one Mining Director with additional responsibility for carbonisation activities within the Division was impracticable and it ought to have been seen as such at the planning stage.

FIGURE 13.

Divisional Carbonisation Department Staff Plan

Divisional Carbonisation Officer

Deputy Divisional Carbonisation Officer

Administrative  
Officer

Accountant

Chief  
Engineer

Technical  
Officer

Carbonisation Officer  
for coking plants in  
Nos. 6, 7 and 8 Mining  
Areas. (West Yorkshire)



**FIGURE 14.**

**Divisional Carbonisation Headquarters**

**Staff Plan.**

**Carbonisation Director**

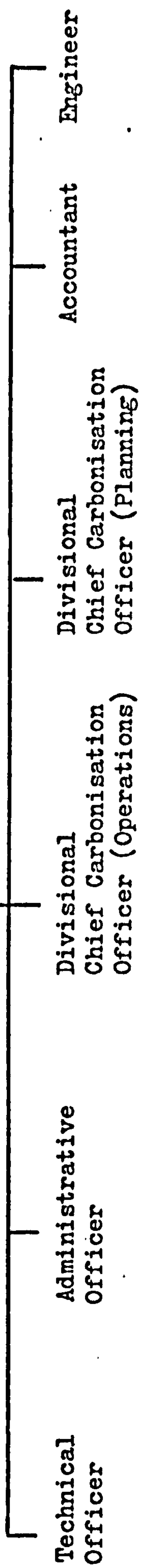


FIGURE 15.

Allocation of Coking Plants. (25)

Group	Plants	Closure Date
	Hazelhead	1948
	Houghton Main	1950
	Denaby Gas Works	Unknown
A	Nunnery Sheffield	14. 4. 57
	Waleswood	25. 5. 57
	Dalton Main	7. 5. 60
	Nunnery Handsworth	31. 3. 61
	Dinnington	7. 7. 62
	Rotherham Main	24.11. 61
	Smithywood	Operational
B	Wath Main	24.11. 56
	Mitchell Main	24.11. 56
	Cortonwood	31. 3. 60
	Manvers	71 ovens 16 3. 78
		91 ovens 12.12. 80
C	Wharnccliffe Woodmoor	7. 1. 57
	Wharnccliffe Silkstone	2. 3. 57
	Robin Hood	24. 5. 58
	Thornhill	24. 5. 58
	Old Silkstone	20. 9. 58
	Crigglestone	4. 7. 59
	Glasshoughton	13. 2. 78



There were three main difficulties with this appointment.

The first was that the relatively much larger mining activities occupied most of the agenda at the Board Meetings, the second was that the interests of the collieries were best served at the expense of the coking plants in respect of transfer prices for coal because of disproportional representation at Board level.

In fact as far as coal charges were concerned coking plants were treated like any other outside customer at best and at worst coal allocations operated against them. The final shortcoming was the failure to realise the highly specialised nature of the coking industry so that in reality a Mining Director lacked the necessary detailed knowledge and expertise and often enthusiasm to look after the interests of the Carbonisation Department. For these reasons there was a break from the Mining Divisions. The reorganisation was brought about following upon the recommendations of the Fleck Report which proposed enlargement of the Groups to include Drawing Office Staff but before this could be put into effect a programme of planned coking plant closures was commenced. (26)

#### Scientific services to coking plants.

The scientific service covering carbonisation activities was controlled by the Director of Scientific Control at the London headquarters of the N.C.B. through one of his deputy directors. The service included some investigational work in the Divisions and the provision of advice on scientific matters to the Divisional Carbonisation General Managers. The latter included advice on methods of sampling and testing but it did not cover any other aspects of plant laboratory work. (27)

Hitherto scientific testing had been carried out on a loose basis although it must have been sufficient in quantity and quality if the fact that the industry could seek out, or even generate markets for its products and retain them, is used to indicate success. The time had now come for a general increase in sophistication in British and other industry and the newly formed National Coal Board was able to play full part. Two Divisions will be examined to show the pattern of development;

(1) North Eastern Division

The Scientific Service was controlled directly by the Divisional Chief Scientist with one of his senior staff members taking a particular interest in the work. Investigational projects included the testing of coke in various domestic appliances (28) and the possible application of chromatographic methods of testing for carbonisation products.

Divisional scientific staff occasionally carried out surveys for specific purposes on the works at the request of the Carbonisation General Manager.

The chief chemists at the works operated directly under the Works Manager who specified the testing schedule required. The chief chemists reported test results to the Divisional Chief Scientist's office as well as to their Works Managers.

The result was a serious attempt to standardise procedures within the Division, and nationally without appearing to override the traditional supreme authority of the Works Manager. Was such a cautious approach necessary?



Traditionally managers had accepted full responsibility for all aspects of their coking plant but the advent of nationalisation meant they had to become accustomed to sharing some of the responsibility and to listen to the advice of specialists.

Another feature was that for the first time data was collected and correlated at Divisional and National level and until this was done specific parameters could not be laid down - the manager's intuition was still useful in the interim.

There were 5 or 6 chemists at the smaller works and about twice as many at the much larger Manvers plant.

## (2) East Midlands Division

Probably for geographical reasons the scientific service was controlled by a Carbonisation Chief Scientist stationed at the carbonisation department headquarters, and not directly by the Divisional Chief Scientist. The Carbonisation Chief Scientist had responsibilities to both the Divisional General Manager and the Divisional Chief Scientist. He had direct control of a deputy, an investigator and a staff member dealing with records.

The Carbonisation Chief Scientist was expected to visit the works laboratories regularly. Any suggestions or advice had, officially, to be routed through the Works Manager because the chief chemist and laboratory staff were under his direct control.

The method of control adopted by the North Eastern Division was more remote because the Divisional Chief Scientist was also responsible for scientific services to a large number of collieries. As a result the time he could devote to the numerically smaller coking plants was limited although this was compensated for by his small team of staff specialising in coke oven problems having their own laboratory. (29)

In contrast the scientific control adopted in the East Midlands Division, which had only a small number of coking plants and a Carbonisation Chief Scientist <sup>was precise</sup> so that a much more personal relationship developed. In retrospect each system was probably right for the geographical area concerned.

#### Cokeworkers Associations.

##### South Yorkshire Coking Plant Owners' Association

Prior to 1942 wages and conditions of employment for cokeworkers in South Yorkshire were identical with those of colliery surface workers, and were negotiated through the medium of the South Yorkshire Coalowners' Association. However, before the Minister of Labour would apply the Essential Work Order to the industry, which provided for the retention of workmen during the period of World War II, it was necessary to establish a body representing the Coke Owners in South Yorkshire for the purpose of negotiating with the Cokemen's Union wages and conditions of employment. The South Yorkshire Coking Plant Owners' Association was formed on 8th April 1942 for this purpose. (30)

The objectives of the Association were to:-

- (a) Watch, protect, promote and further the operations, trade, business, rights and interests of members as



proprietors of or persons or companies interested in coking plant or by-product plant or as coke producers or some or all of these things in the South Yorkshire district, and to consult, advise and actively co-operate for these purposes.

- (b) Act collectively and in a consultative and advisory capacity in dealing with wages and conditions of and agreements relating to employment in or in connection with coking plant and by-product works and any demands made and action taken by workpeople or combinations of workpeople so employed.
- (c) Co-operate with other associations and organisations having similar objects.
- (d) Do all such other fit and proper acts and things as are incidental to or conducive to the attainment of the above objects or any of them.

It may be said that the South Yorkshire Coke Owners' Association came into being as an indirect consequence of World War II and this raises the question of its necessity other than that of meeting Ministry of Labour requirements in respect of the war. The industry never had been uniform and the West Yorkshire Coking Plant Owners' Association had been in existence for a number of years. Perhaps the lack of uniformity worked to advantage because the South Yorkshire Association would almost certainly have been formed voluntarily much earlier if it had been thought necessary. In fact there was much unofficial as well as official co-operation between

neighbouring collieries and coking plants which rendered the formation of this particular Association unnecessary.

The coking plants paid subscriptions to respective Associations based on their production of coke in the previous year. The administrative expenses of the Associations were those incurred in the holding of meetings, postages and stationery etc. so the levy would be little more than nominal. Both Associations ceased to function after vesting date and those plants which vested were controlled by the North Eastern Division Carbonisation and Briquetting Branch of the N.C.B. . A similar situation happened between the Derbyshire Coke Owners' Association and the East Midlands Division of the N.C.B. What happened to the few plants which did not vest in relation to the aims and objectives of the disbanded Coke Owners' Association? In the interest of the whole industry the N.C.B. liaised closely with the independent coking plants in relation to wages and many other things so they had only marginal freedom to move within the broad pattern specified by the N.C.B. This situation came into being by mutual agreement between the parties concerned.

Membership of the South Yorkshire Association is given in figure 16 (31) and the plants which vested in the N.C.B., the West Yorkshire Coking Plant Owners Association and the non vesting plants and gasworks are given in figures 17, 18 and 19 respectively. The latter fell outside the scope of the Nationalisation Act; perhaps it was anticipated that they would close before long.



The South Yorkshire Coking Plant Owners' Association.

Vesting Plants. (32)

Proprietors	Postal Address	Plant nomenclature adopted by the N.C.B.
Cortonwood Collieries Ltd.	Wombwell, Nr. Barnsley	Cortonwood
Brown, John & Co. Ltd.	Rotherham Main Coke Ovens, Canklow, Rotherham.	Rotherham Main
Dalton Main Collieries Ltd.	Silverwood Colliery, Thryburgh, near Rotherham.	Dalton Main
Dinnington Coking Co. Ltd.	Dinnington, Sheffield.	Dinnington.
Houghton Main Colliery Co. Ltd.	Nr. Barnsley	Houghton Main
Manvers Main Collieries Ltd.	Wath on Dearne, Rotherham.	Manvers Main
Mitchell Main Colliery Co. Ltd.	Wombwell, Nr. Barnsley	Mitchell Main
The Nunnery Coke & Gas Co. Ltd.	High Hazels, Handsworth, Sheffield	Nunnery Handsworth
The Nunnery Colliery Co. Ltd.	Attercliffe, Sheffield.	Nunnery Sheffield.
The Old Silkstone Collieries Ltd.	Dodworth Near Barnsley	Old Silkstone
Thorncliffe Coal Distillation Co. Ltd.	Chapelton Sheffield.	Smithywood.
Waleswood Coking Co. Ltd.	Waleswood Collieries, Sheffield.	Waleswood
Wath Main Colliery Co. Ltd.	Wath on Dearne Nr. Rotherham.	Wath Main
Wharncliffe Woodmoor Colliery Co. Ltd.	Carlton, Nr. Barnsley.	Wharncliffe Woodmoor
Wharncliffe Silkstone Colliery Co. Ltd.	Tankersley Nr. Barnsley.	Wharncliffe Silkstone

FIGURE 17

The South Yorkshire Coking Plant Owners' Association.

Non-Vesting Plants. (32)

Proprietors	Postal Address
Barnsley District Coking Co.Ltd.	Worsborough, Nr. Barnsley
South Yorkshire Chemical Works Ltd.	Parkgate, Nr. Rotherham.
Sheffield Coal Co. Ltd. (Associated with United Steel Company Ltd.)	Brookhouse Coke Ovens, Beighton, Nr. Sheffield.
United Steel Companies Ltd.	Orgreave, Handsworth, Sheffield.
United Steel Companies Ltd.	Thurcroft, Rotherham.
Monckton Coke & Chemical Co. Ltd.	Royston, Barnsley.
Tinsley Park Colliery Co.Ltd.	Tinsley Park, Sheffield.



FIGURE 18

The West Yorkshire Coking Plant Owners' Association

Vesting Plants. (32)

Proprietors	Postal Address	Plant nomenclature adopted by the N.C.B.
Benzole and By-Products Ltd.	Crigglestone Collieries, near Wakefield.	Crigglestone
Charlesworth, J.&.J.Ltd.	Robin Hood Coke Works, Wakefield.	Robin Hood
The Yorkshire Coking & Chemical Co.Ltd.	Castleford, Yorkshire.	Glasshoughton

FIGURE 19

The West Yorkshire Coking Plant Owners' Association

Non-Vesting Plants and Gasworks. (32)

Proprietors	Postal Address
Hemsworth & United Kingdom Coke Oven Company Ltd.	Hemsworth, Pontefract, Yorkshire.
Hazelhead Beehive Ovens	Hazelhead, Sheffield.
Denaby Main Gas Works	Denaby, Rotherham.



### Union Representation and Wages Negotiations.

Unions representing the workmen at coking plants were:-

- (a) National Union of Mineworkers (Cokemen's Area)
- (b) Transport and General Workers Union (Cokemen's Area)
- (c) National Union of General and Municipal Workers.  
(Cokemen's Area)

The Carbonisation Department was well able to negotiate with the above three unions because there was much ground common to each. Without doubt it would have been less time consuming to negotiate with one union but notwithstanding that negotiations were generally cordial and satisfactory, Manvers had some workmen who were members of the N.U.M. while others were represented by the National Union of General and Municipal Workers and this caused problems for the workmen themselves rather than the N.C.B. Eventually the N.U.M. assumed responsibility for negotiations on behalf of all the labour force at the plant.

Wages and conditions of employment negotiated by the National Coal Board with these Unions were substantially applied on a voluntary basis at the non-vested plants, and in this connection administrative liaison was maintained between Carbonisation and Briquetting Branch and the individual Owners.

### Working Week.

Prior to 1947 cokeworkers, particularly continuous shift workers were required to work a 56 hour week, having one weekend off every three weeks <sup>through</sup> their mates working 12 hour shifts. In 1947 however, the 48 hour week was negotiated for all workmen under a rota system and without loss of wages for reduced hours.

This proved to be only an interim settlement and on 1st June 1948 an agreement was reached with the N.U.M. and the N.C.B. for the introduction of a 44 hour week, effective from the first pay week in January. (33) Cokeworkers, like mineworkers thought that nationalisation meant that they owned the industry and disillusionment set in when they realised it merely meant a change of ownership. The result was a determination to maximise pay and conditions now that the industry was state owned.

#### Manpower Deployment

It is worthwhile to examine the distribution of manpower at coking plants and the figures given for the operating plants in figures 20 and 21 can be taken as typical provided Manvers is excluded because it did not exist in its enlarged form at vesting date. Perhaps the most striking feature is that the manpower complement at a coking plant carbonising say 430 tons of coal per day was 125 people, about half of which were continuous shift operators. The remaining 55 - 60 workmen were divided in approximately equal proportions between craftsmen and non-continuous shiftmen. The latter included yard labourers some of whom lacked the ability to progress to plant operators while the remainder were waiting for vacancies as operators or were content to remain as labourers and benefit from finishing work at 4.p.m. each day. Each plant had two or three boys who would eventually become operators. With so few young people being set on it is not surprising that those who were engaged were nearly always related to another member of the workforce. (34) It is also not surprising that with such a small total complement in relation to the collieries



which were labour intensive rather than capital intensive; coke oven workers, like railway workers, were regarded as something of an elitist force although such a view was an exaggeration. It simply endorsed the point that it was more difficult to become a coke oven worker or a railway worker than a miner.

Some fifty per cent of the labour force at coking plants were skilled in as much as the normal method of entry was by apprenticeship or equivalent training or where skill had been acquired by several years' experience. For comparison purposes only thirty eight per cent of the labour force in all manufacturing industry were skilled though the range was wide. (35) It can be said that coke oven workers would come inside the top of the range. The analytical data for all the operating plants, except Manvers, is shown as a histogram in figure 21.

Bearing in mind that several plants were closed when the enlarged and modernised Manvers Coking Plant came into operation, the total number of people employed at plants in the North Eastern Division immediately after vesting date would be in the order of 1,300. The plants themselves were spread over an area measuring approximately fifty miles in north-south direction and fifteen miles in an east-west direction.

#### Plant Closures

The Fleck report made recommendations about improving the administration of the industry but it failed to appreciate the fact that economic circumstances were beginning to turn against the N.C.B. The main one was the determination of B.S.C. to

**FIGURE 20**

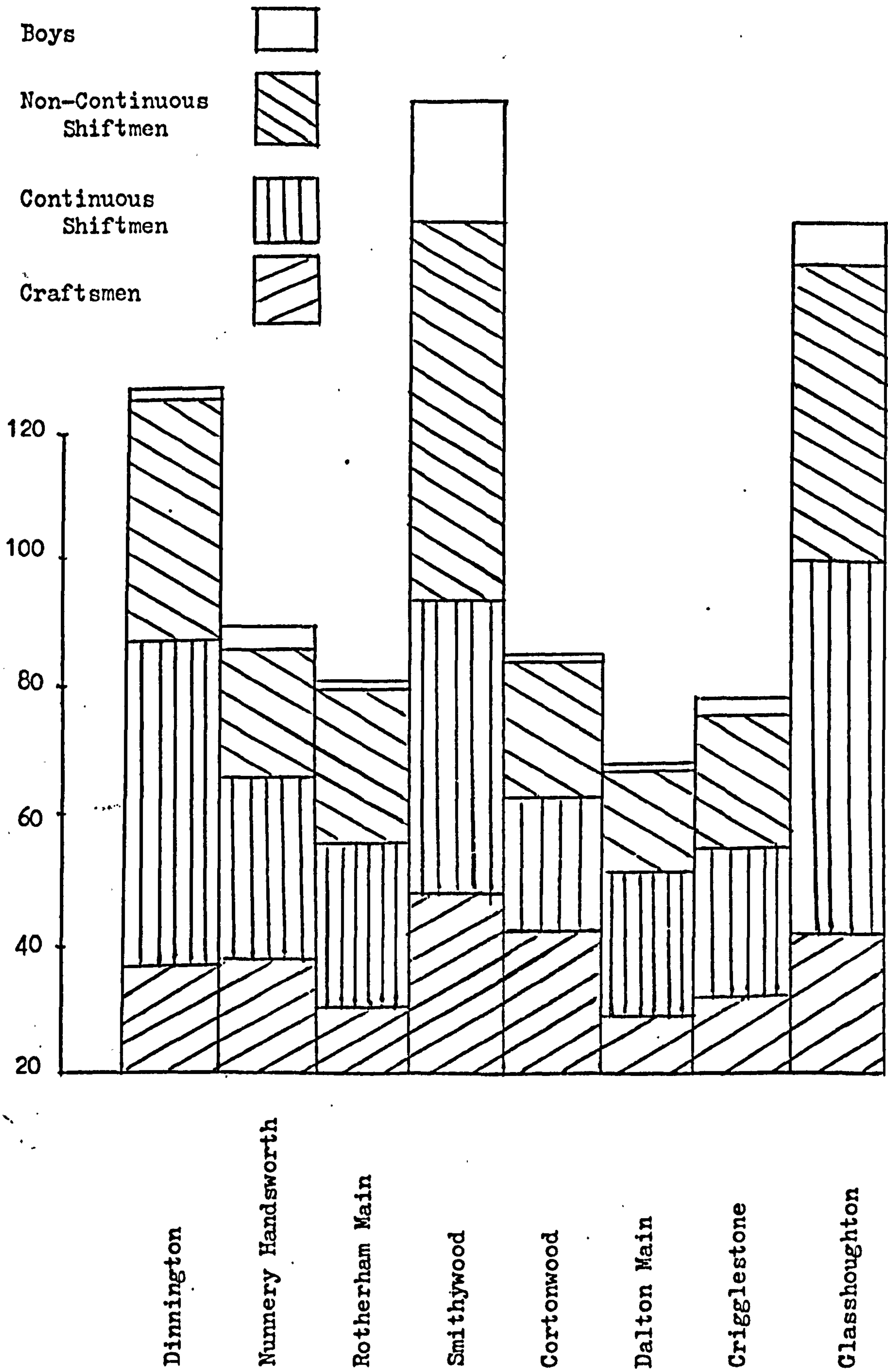
**Manpower at North Eastern Divisional Coking Plants. (36)**

Plant	Number employed at week ended 28th February 1959						Net Recruitment/Wastage period 22nd February 1958 to 28th February 1959					
	Craftsmen	Continuous Shiftmen	Non-Continuous Shiftmen	Boys	Total	+ or - comp. with prev. week	Craftsmen	Continuous Shiftmen	Non-Continuous Shiftmen	Boys	Net Total	
Dinnington	28	54	37	2	121	- 1	- 6	+ 13 - 8	- 1	- 1	- 3	
Nunnery Handsworth	32	64	33	7	136		- 4	23 15	- 7	+ 1	- 2	
Rotherham Main	20	60	41	4	125		- 1	10	- 4	+ 1	+ 6	
Smithywood	52	100	93	16	261		- 5	19 9	-28	- 3	- 26	
Cortonwood	23	48	33	2	106	- 1	- 2	8 2	- 8	+ 1	- 3	
Dalton Main	17	53	30	1	101		- 1	17 8	- 3		+ 5	
Manvers Main	130	277	192	20	619	- 4	+ 5	17 23	+ 3	- 4	- 2	
Criggilestone	23	52	34	1	110	- 4	- 2	7 1	- 5	- 5	- 5	
Glasshoughton	41	136	57	4	238	- 3	- 1	22 3	-38	- 1	- 23	
TOTAL Operating Plants.	366	844	550	57	1817	-10	-17	136 69	-91	-12	- 53	
Nunnery Sheffield		2			2			1			- 1	
Waleswood		4			4		- 1		- 1		- 1	
Wath Main		3			3							
Mitchell Main		3			3							
Wharncliffe Woodmoor		2	1		3			1			- 1	
Old Silkstone		4	7		11		-26	2 81	-55	- 1	-161	
Robin Hood		3	6		9		-27	61	-49		-137	
Thornhill		3	5		8		-20	10 65	-21	- 2	- 98	
Wharncliffe Silkstone		3	1		4							
TOTAL Closed Plants		27	20		47		-74	12 209	-126	- 3	-400	
GRAND TOTAL Employed	366	871	570	57	1864	-10	-91	148 278	-217	-15	-453	



FIGURE 21

Typical Manpower at Coking Plants (37)



build large modern integrated plants so they would become almost totally self sufficient in respect of blast furnace coke.

A downward trend in the coke market, a host of ancient plants and the need to build large modern coking plants started the Carbonisation Department on a course of plant closures over a five year period.

As a result of the closure of a large number of small plants Carbonisation Departments were re-styled and were no longer responsible to the Divisional Boards with effect from 1st January 1963.

#### Re-deployment of Labour

From the outset the policy was to redeploy as many of the labour force as possible in similar jobs at other coking plants nearby. Initially this was easy to achieve but as the number of active plants became fewer the task became more difficult. The problem of re-deployment was partly overcome by arranging with local collieries, independent coking plants and the Gas Board to accept any suitable workmen who were willing to transfer. In reality few coke oven employees have ever transferred to the colliery because the activities and the environment would be alien. (38) Each of these organisations stopped recruiting several months before a coking plant closed so that they could offer the maximum number of vacancies. In more recent times a greater number of employees have accepted early retirement so that fewer employees have required alternative employment. Glasshoughton was the last plant to close and the relatively high number of the workforce who were eligible for early retirement was a considerable help in enabling the remainder to be found other employment, not alas at coking plants



because there aren't any left in the district.

Gas Commitments during transition.

In respect of the closure of some of the Yorkshire Coking Plants whose gas contracts had not expired, Gas Producers were installed at Manvers in the mid 1950s so that some of the batteries could be underfired with producer gas and liberate a corresponding volume of rich gas for sale to the E.M.G.B. Producer gas was also added to coke oven gas immediately before sale to the statutory requirement and at the same time increased the volume sold. Experience had already been gained with the intermittent use of producer gas for underfiring the batteries at Smithywood during weekdays but not at weekends and it was believed the time was right to extend the principle. (39)

Gas Boards were undergoing a period of change in the 1950s and they were aware of some of the problems facing the carbonisation industry. The E.M.G.B. was perhaps a little generous when it accepted carbonisation department's offer to maintain contract quantities of gas into the grid if it could be allowed to relinquish some gas contracts with individual plants so that they could be closed down, see figure 22. In the early stages the arrangement worked well but as the coking plants aged and more were closed down the capacity to meet the gas demand became strained. This coincided with an expansion in gas sales and a reduction in the market for gas coke, with the result that the E.M.G.B. insisted that the daily contractual quantities of gas should be met. Figure 23 shows that nationally the amount of gas bought from coke ovens became a maximum in the late 1950s and early 1960s. The situation in the E.M.G.B. was consistent with the trend.

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FIGURE 22.

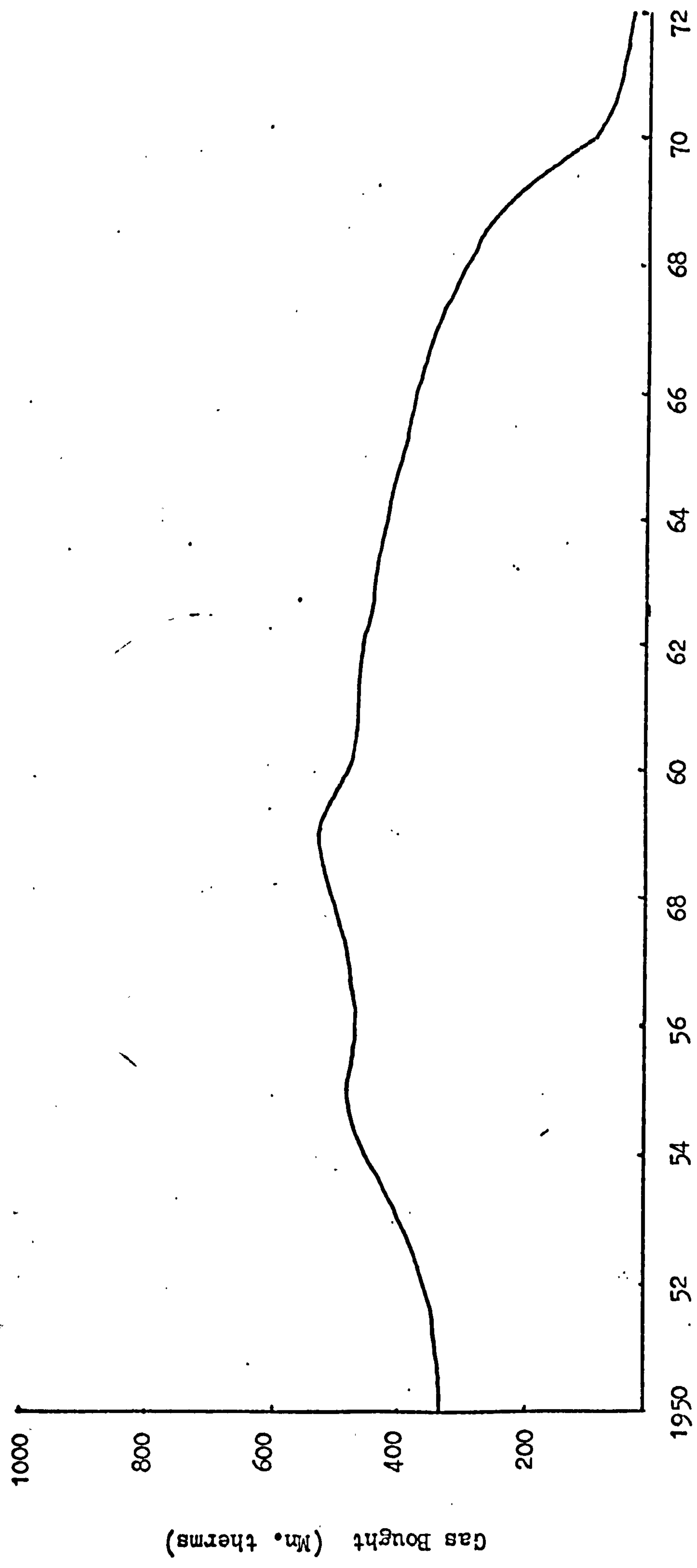
N.C.R. Gas Contracts with the East Midlands and North

Eastern Gas Boards as in 1961. (41)

Plant	Max. Contract mill.cuft per day	Calorific Value Btu/cu.ft	Purified or Unpurif- ied.	Price per 1000cu.ft.	Equivalent per therm		Date of Contract or last review	Date of expiry or next review
					Unpurif- fied.	Purif- ied.		
Cortonwood	2.47	515	U	2/5.06	5.64	-	1.4.61	on clo- sure in 1962.
Dinnington	10.55	515	U	2/5.06	5.64	-	1.4.61	31.3.71
Nunnery (Hands.)			U	2/5.06	5.64	-	1.4.61	31.3.71
Rotherham Main			U	2/5.06	5.64	-	1.4.61	31.3.71
Dalton	3.10	500	P	2/10.25	-	6.85	1.4.61	31.3.71
Smithywood	6.50	515	U	2/6.81	5.98	-	1.4.61	31.3.71
Glass- houghton	5.80	500	P	2/10.06	-	6.81	1.10.60	30.9.65
Manvers	15.75	500	P	2/9.75	-	6.74	30.6.58	30.6.63
Manvers	3.60	500	U	1/3.63	3.12	-	19.2.45	30.9.65
Manvers	0.15	500	U	2/7.00	6.20	-	19.2.45	30.9.65
Avenue	14.78	500	P	3/2.27	-	7.65	11.11.56	10.11.71
Hardwick	9.54	500	P	3/0.47	-	7.29	21.6.58	1.6.63
Grassmoor	9.54	500	P	3/0.47	-	7.29	21.6.58	1.6.63
Harworth	2.20	500	P	2/5.31	-	5.86	1.4.58	12 months notice
<u>Amended Contract Quantities and Expiry Dates</u>								
Dalton	3.1							31.3.71
Nunnery (Hands)	3.6							31.3.71
Rotherham Main	3.05							31.3.71
Smithywood	6.5							31.3.71
Manvers	19.5							6.1.72
Glass- houghton	5.8							13.10.75
Avenue	19.75							10.11.71

FIGURE 23.

Gas Bought from Coke Ovens. (42)

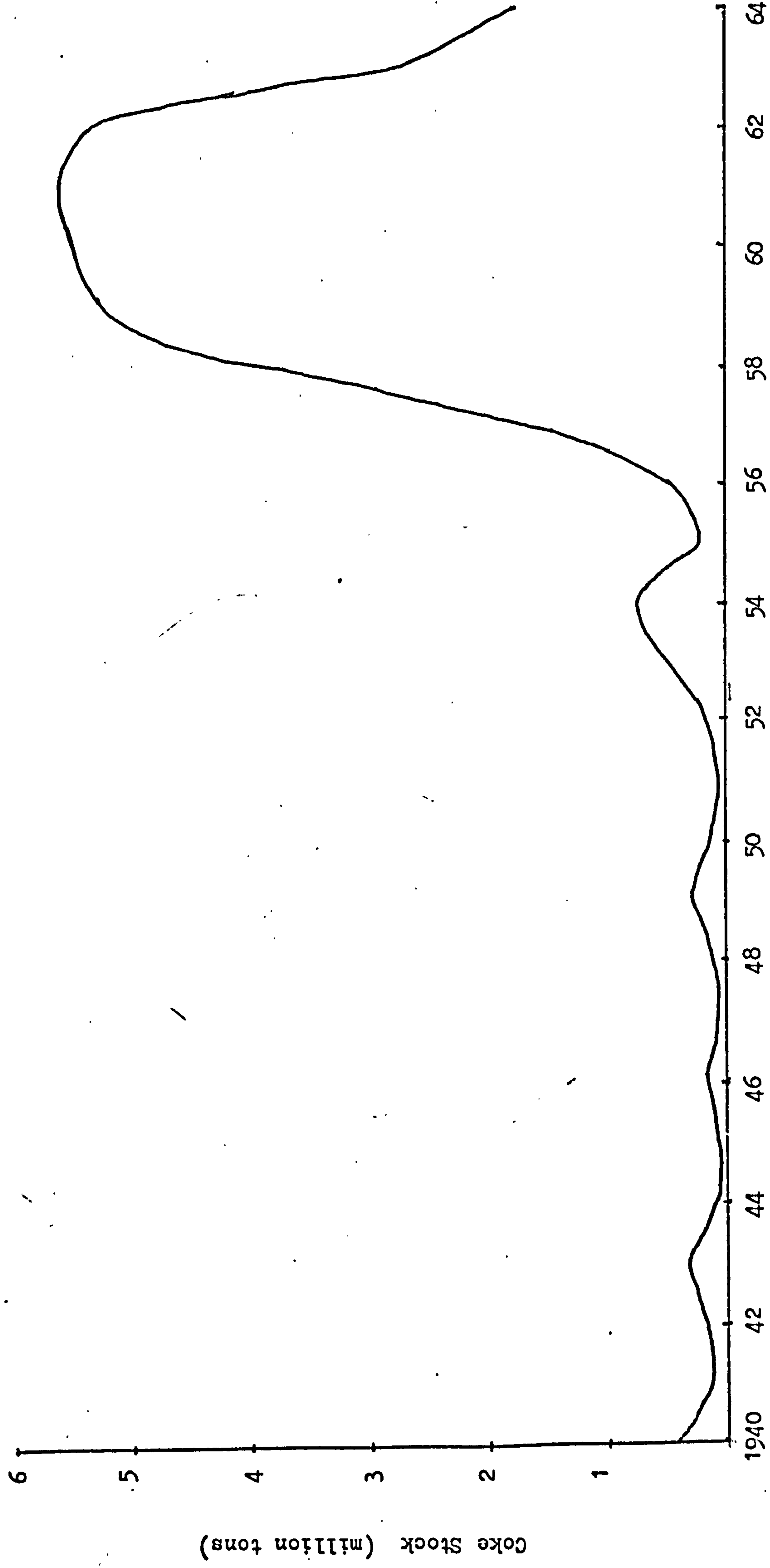




Although sales of gas were increasing coke sales were not and figure 24 shows that from the mid 1950s coke stocks started to increase. The trend, frightening though it was, continued until the early 1960s because of a general recession in the iron and steel industry on the one hand and unexpired gas commitments on the other. Carbonisation Department was unable to close any more coking plants and it adopted a system of variable working whereby plants were operated at high throughput during weekdays but reduced throughput at weekends and public holidays so that it could meet the needs of the Gas Board and at the same time minimise the amount of coke to be stocked. By tradition coke ovens had nearly always been operated at constant throughput. (40) It is most probable that operating the batteries on intermittent load caused them to deteriorate faster and contributed to their premature demise. Was the risk of damage to the oven chambers in order to satisfy the E.M.G.B. worthwhile? There had been a long tradition of close co-operation between the coking industry and the gas industry even though both were fragmented prior to each sector being nationalised. (44) Each had benefited from a close working relationship and it seemed reasonable for both industries to continue co-operation now that nationalisation had brought unification. It must be remembered that only a few years earlier the E.M.G.B. had been invited to rescind some gas contracts which had a few months or even a year or two to run and they had agreed to co-operate provided the N.E. Divisional Carbonisation Department maintained the total gas flow into the Grid. It may be argued that the Gas Board gave way on a technical point and that it was no hardship for them to do it.

FIGURE 24

Coke Stocks at Coke Ovens (43)





Nevertheless legal documents were to the advantage of the Gas Board and if it hadn't had confidence in the coking industry it would not have relinquished the contracts. The fact that it did so when the coking industry was in such dilemma placed the latter under strong obligation to reciprocate even though this time it was recognised that reciprocation could do physical harm to the batteries. Cautious optimism prevailed at the carbonisation headquarters but things were much different at the plants where each shift of oven men had pushed and charged the same number of ovens. Now they were being asked to vary the work load even though the remuneration was uniform. A further complication was that the oven men at the larger plants pushed and charged two or three times as many ovens as their contemporaries at the small plants for the same rate of pay. (45) One result of varying throughput was that at the larger plants men were working at or near to maximum capacity without any monetary recognition and they resented it. If they could not win concessions at the negotiating table some of the operators were determined to win at the place of work with the result that at the more militant plants repairs to oven machinery took longer than usual and this raised another question of principle. All coking plants had a long tradition whereby when ovens were 'lost' through breakdowns or other legitimate delays the men would 'catch them up' even if other shifts had to work harder to do so. The idea being that on average the work load evened out and so fluctuations in loading were accepted almost as a debt by the men to the company. Nationalisation had already brought about a loss of faith by the men and morale had deteriorated so that they were now more conscious than ever before that they were working

only for monetary reward. The result was that the coking industry kept face with its counterpart but in an intangible way it paid dearly for it and it did not bring anymore concessions from the Gas Board.

At the time the sharing the load agreement was operational the stock of mixed coke held at plants in the North Eastern Division of the N.C.B. reached an all-time record of two million tons, one million tons of this being held at Manvers. Similar stocks were held in the other divisions and the national situation is shown in figure 24. The unanswered question is - should the industry have responded faster to the increasing coke stocks at the expense of creating problems for the Area Gas Boards?

#### Wages and Conditions of Employment

A failure of the workforce to appreciate the significance of nationalisation caused the industry to meet problems in respect of wages and conditions of employment early on. The creation of new tiers of management did nothing to inspire the confidence of the workforce which responded by demanding a larger share of benefits from time to time. Money was the most important benefit but it was not the only one. When the fortunes of the industry were depressed the workforce demanded better conditions and this usually meant a shorter working week which in turn often necessitated more overtime and therefore better wages.

Wages have improved dramatically in the industry in comparison with other industries but the internal relativities have tended to vary. By way of illustration figures 25 and 26



FIGURE 25

Average Weekly Earnings of Manual Workers in

Manufacturing Industries. (46)

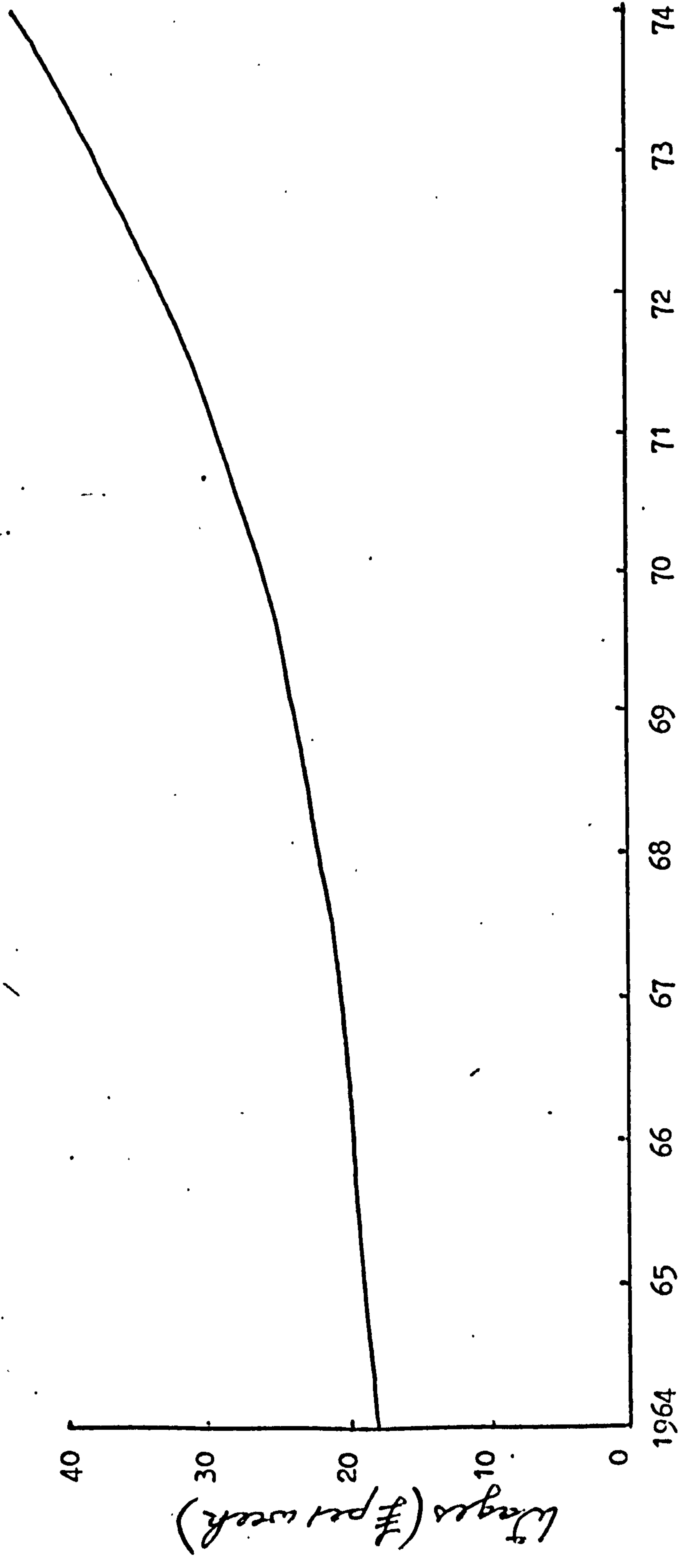
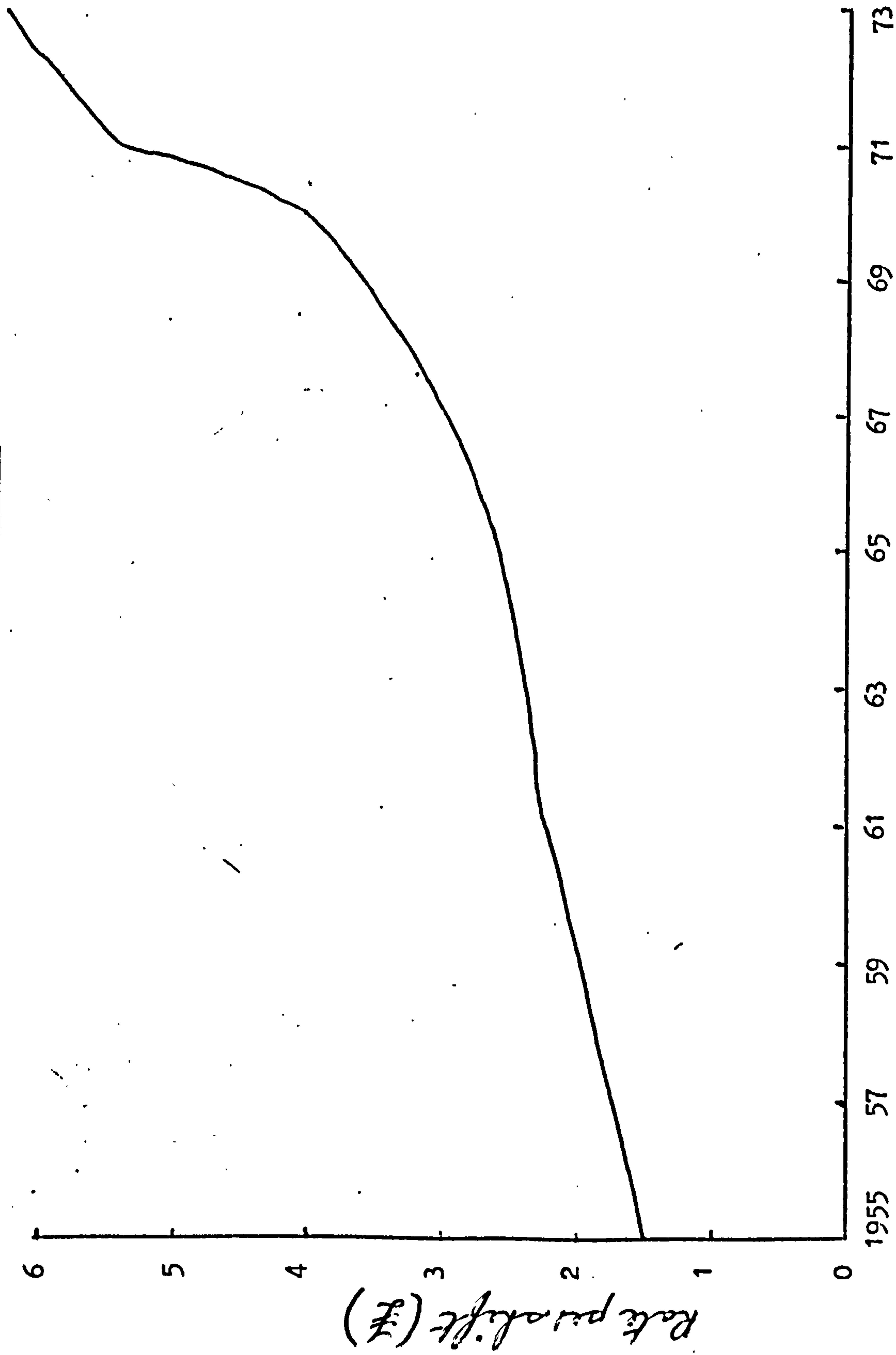


FIGURE 26

Coke Oven Craftsmen Grade 1 Wage Rates. (47)





show how the rate of pay for coke oven workers climbed rapidly in comparison with those of other manual workers in manufacturing industries in the late 1960s and early 1970s. Over the same period the rates of change of coke oven shift foremen's wage rates shown in figure 27 were much slower and as a result problems were created as well as resolved. For many years foremen had felt underpaid although their overall terms and conditions were arguably better than those of the men they supervised.

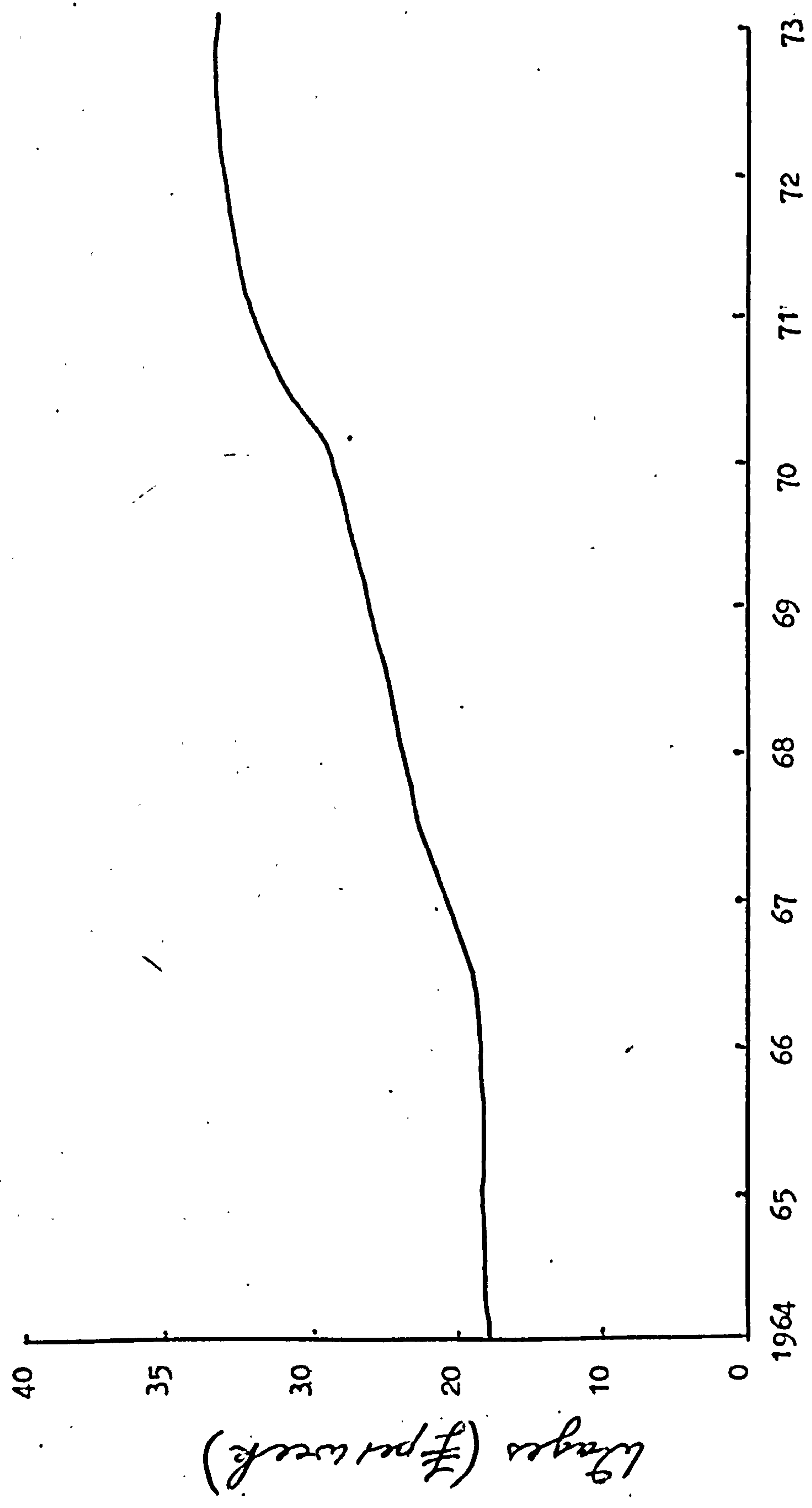
The conjecture about foreman's pay and conditions started in the early 1950s and rather than attempt to resolve the dichotomy it is perhaps best to look at the situation from the stand-point that potentially good foremen could not be persuaded to accept such appointments. The industry was in <sup>a</sup>dilemma and it circumvented the problem by paying chargehand rate to suitable workmen who would not accept appointment to the post of foreman. The chargehands carried all the responsibility of foremen but there was one important difference - their weekly wage was higher. Traditionally foremen had been non-militant and they had considered their allegiance lay with management rather than with the men. Early in the 1970s foremen held a small number of one-day strikes to demonstrate for the first time in the history of the industry that they were an important part of management. The strikes were arranged in such a manner that they did not harm the coking industry but they did bring about greater recognition of the importance of foremen.

#### Smokeless fuel crisis.

There was some controversy about the obligation to provide smokeless fuel for the public in 1970, which rested on the N.C.B. and also on the gas industry. Sir Henry Jones, Chairman of the Gas Council, acknowledged the undertaking given by Area Gas Boards

FIGURE 27

Coke Oven Shift Foremen Wage Rates. (48)





to local authorities about supplies but he didn't expect much demand for gas coke in the 1970s. However at the onset of winter in 1969 there was a fuel crisis. *Only* a mild winter and a massive number of conversions from coke boilers to other fuels prevented a major crisis in the winter of 1970.

Was the crisis due to bad management at the highest level and could it have been avoided? It had been evident for many years that the Area Gas Boards and the N.C.B. had been striving to improve profitability and expand. The gas industry was in a dilemma because it had started using petroleum feedstock to produce gas in a big way so that the quantities of gas coke declined rapidly. The N.C.B. were well aware of the trend in the gas industry and they would have liked to take up the shortfall but they were unable to do so because they lacked sufficient outlets for coke oven gas to justify building more coke ovens. (49) Oven coke is relatively unreactive and the N.C.B. hoped to produce sufficient quantities of smokeless fuel in their new plants which did not produce by-products but technical difficulties prevented the two early plants becoming profitable and they were not repeated in other districts.

There is no doubt that conversion of many coke burning appliances to other fuels occurred in 1969-70 but did it help or hinder the coking industry? The N.C.B. had a short change of policy when the Chairman, Lord Robens, offered local authorities financial incentive to change over from coke burning appliances to modern coal burning plant. The idea of conveying small coal pneumatically from lorry into storage bunker was increasing in popularity so that coal could compete with oil more favourably as far as handling was concerned. Coal burning equipment had been greatly improved to burn coal smokelessly

and more efficiently and the N.C.B. were confident they could compete with other industries for the central heating of public buildings. (50)

Local authorities had other ideas and instead of accepting the offer of a subsidy by the N.C.B. they changed over to fuels which would be less expensive in terms of labour and more convenient. The gas industry received most benefit from the conversions. The effect on the N.C.B. was that instead of replacing the sale of coke for heating public buildings by an equivalent amount of coal, in many instances it lost contracts. Only in Labour strongholds in the mining areas of South Yorkshire and North Derbyshire were appliances used for heating buildings such as schools converted for use with coal.

Ambitious area central heating schemes such as the one at Doncaster which heats the N.C.B. headquarters, the Institute of Higher Education, the law courts and public library with coal fired equipment failed to arouse public support. A result of a failure in policy by the N.C.B. together with changes in the gas industry and a bad winter left the coking section and the N.C.B. with fewer customers.

#### Coal Products Division

The coking industry had started to contract before the recommendations of the Fleck Report could be fully implemented so that the Report became outdated and a major re-organisation became necessary.

Coal Products Division was formed to manage the coking plants and chemical plants which had hitherto been managed by the Mining



Divisions of the N.C.B. (51) After the Mining Divisions had been relieved of their responsibility to the coking industry they also underwent re-organisation. The turnover of Coal Products Division, formed in January 1963, made it one of the largest organisations in the country though it lost money. (52) At the time it was believed the potential for the coking industry as a whole was immense but was unlikely to be realised unless it received specialist management. Could this belief be substantiated? Almost without exception specialist management was obtained by a host of internal promotions when Coal Products Division was formed. It is true to say that a few new products were introduced, the Division handled North Sea gas activities and it was given responsibility for managing a few new plants, including those producing smokeless fuel. (53) Enthusiasm for the industry was high but it was divorced from the realities of the market place. The problems of the industry were deep rooted and characteristic of the coking process so that a change in senior management alone ought to have been seen as a most improbable solution. (54) The re-organisation did very little to improve the industry in part because the means of justification placed too much emphasis on the introduction of new products and expansion. The industry was in a tight spot; it could not expand because the market did not require more coke and to venture into other products meant dealing with small quantities of high grade chemicals and there was a total lack of experience in this field. As a result virtually nothing happened in regard to high grade chemical manufacture. The re-organisation left the industry with more senior staff to support from a decreasing number of coking plants.

### Some Implications of Re-organisation.

As a result of the formation of Coal Products Division on 1st January 1963 it undertook responsibility for all plants formerly operated by the National Coal Board. There was a consequent merging of the following Carbonisation Departments to form the Midlands Region of Coal Products Division with headquarters at Wingerworth, Chesterfield:-

North Eastern

East Midlands

Lancashire - Altham Coking Plant

Warwickshire - in respect of the Coventry Homefire Plant which was then in course of construction.

While the Regions were responsible to London Headquarters of Coal Products Division, who undertook wages negotiations directly with the Union, nevertheless so far as labour relations generally were concerned, contact was maintained with the Mining Area and Divisional levels of the N.C.B. Carbonisation Directors (North Eastern, East Midlands and Lancashire Divisions) relinquished their seats on the Divisional Boards, and a General Manager was appointed to the Midlands Region of Coal Products Division. A similar procedure was followed in the other Divisions where vested coking plants operated so that the nationalised coking industry was sub-divided into three regions:-

Northern Region

Midlands Region

South Western Region

A break with tradition was made insofar as the General Managers for the Midlands and South Western Regions were appointed from outside the industry. Up to this juncture promotions had



invariably been made internally because it had been felt that a deep understanding of the coking process was a pre-requisite to higher management. The two external appointments added impetus to the idea of external appointments and some new posts were thus filled at Regional level. It is important to realise that although extra posts were created there was never any hope of real expansion of the industry.

#### Formation of Management Units

The organisation set up by Coal Products Division lasted until early January 1970 when it was believed that headquarters in the regions were too divorced from the production units and that greater efficiency would result from sub-division of headquarters.

On 18th January 1970 the Midlands Region was sub-divided into:-

- (a) Midlands Coking Management Unit controlling Avenue and Smithywood Coking Plants.
- (b) Yorkshire Coking Management Unit controlling Manvers and Glasshoughton Coking Plants.

Similarly the Durham Region was sub-divided into East and West Durham Coking Management Units, both sharing the same building which formerly housed the staff of the Northern Region. South Western Region, with fewer plants, merely changed its title for the sake of consistency. The overall organisation at the 18th January is shown in figure 28.

The formation of the Yorkshire Management Unit was particularly difficult because, unlike the situation in Durham, geographical location of their two plants made it unreasonable to have shared headquarters with the Midlands Management Unit at Wingerworth. Vacant property owned by the Yorkshire Mining Division existed slightly further west of Sheffield than the property used for the former Divisional Carbonisation Headquarters which was sold when the organisation was disbanded in 1963. The property known as 'Snaithing Grange' was transferred to Coal Products Division for a nominal charge of £9,000. (55) A similar amount was spent in decorating the building and equipping it with new furniture.

Since there had been no change in the number or size of plants since the formation of the Midlands Region of Coal Products Division it is worthwhile to examine the reasons for the change. (56) Management Units came into being for the purpose of developing closer relationships with local management. Ever since nationalisation of the industry the three tier management structure had generated criticism of isolation and remoteness of the tier above and to some extent this was true. Each M.U. having responsibility for only two coking plants and a staff which was not much smaller than the Midlands Region C.P.D. staff, in fact the sum total of the staff was larger than the original but purchasing and stores and scientific services continued to serve four plants. One consequence was that instead of three general managers, three accountants, three engineers or three technical officers representing former regions attending meetings at Headquarters in Harrow the number increased to five. Experience showed there was insufficient work to do at the Management Units and discipline became slack. The attitude



at plants showed an awareness of the easy going image in sharp contrast to themselves so that instead of the M.U.s becoming more identifiable with the production units they became elitist and had authority without responsibility. Once more the ideals of the new organisation failed to materialise and perhaps even misfired and in January 1973 the Yorkshire and the Midlands M.U.s merged again at the former Midlands Headquarters. Likewise in Durham. The re-formation was not as simple as it may appear because in the interim many extra staff had been engaged so that for all the senior positions duplication occurred. The organisation endured the extra cost of duplication for a while until natural wastage and re-deployment slimmed down the organisation. (57)

Perhaps the only benefit gained from the setting up and disbanding of the Management Units within three years was the dissemination of power which had been held by the former Carbonisation Divisions and later the Regions, and ultimately to transfer it to Divisional Headquarters at Harrow.

#### Product Grouping 1970 - background

In September 1966 the Chairman of the N.C.B. formed a close link with the Chairman of the Continental Oil Company with the result that the N.C.B. became a partner in a successful group in the North Sea. (58) The rich Viking Field was expected to provide some fifteen per cent of the total gas market and over a period of twenty five years it was expected to enhance the income of the N.C.B. by £200m. Did this success story influence top level thinking about the coke and by-products industry? Certainly the N.C.B. became more aware of the long standing but now modest contribution the coking industry had made to the chemical industry. All the coking plants recovered crude benzole

as a by-product which for many years had been used as motor spirit. The recent abolition of the subsidy on home-produced petrol meant that it was no longer an economically viable product. The N.C.B. did not wish to see benzole sold at a low price and so, in partnership with Stewarts and Lloyds who had a similar problem, built a large refinery capable of processing all the crude benzole from N.C.B. and what later became known as the B.S.C. coking plants.

Another partnership, this time with the Dutch State Mines, who had much experience and success in producing chemicals from coal, was formed and a plant built at Flixboro' to make caprolactam, the raw material for nylon 6. The feedstock for making caprolactam is cyclohexane which is in turn derived from crude benzole supplied by the N.C.B. and B.S.C. coking plants.

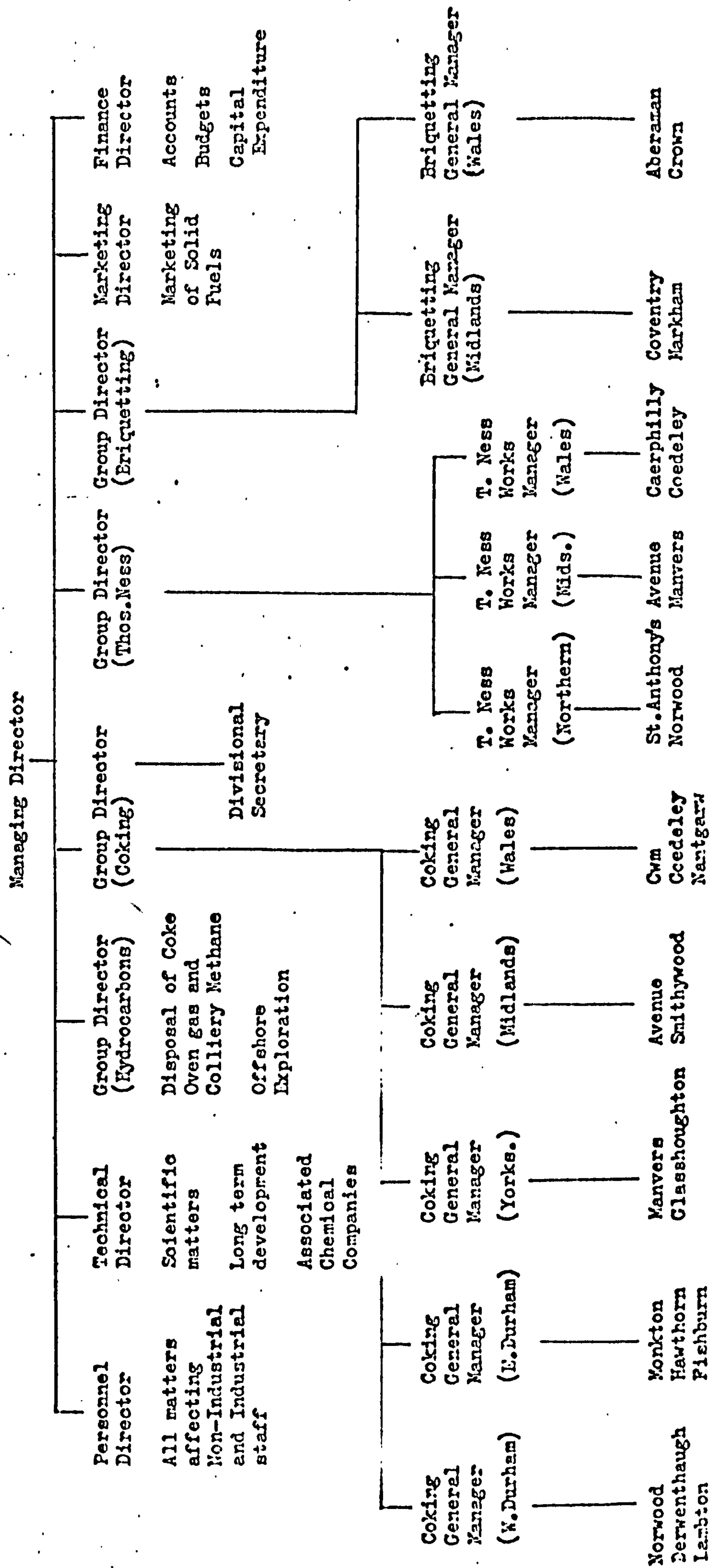
The N.C.B. were well aware of the success the Dutch State Mines had experienced in their venture into the chemical industry in a big way and they expected to do well out of the chemical plants. Nevertheless they were well aware of the commonly held misbelief that chemicals from coal could be the salvation of the industry. In fact if plants needed to make all the possible chemicals from coal economically, the potential market would only be a few million tons per year.

#### Mechanism of Product Grouping

In 1970 Coal Products claimed to be an expanding organisation. High expectations were held for the development of Char Briquetting, the Multiheat Plant, exploration for Hydrocarbons in the North Sea and the Irish Sea and work with associated companies such as Staveley Chemicals Limited, Phthalic Anhydride Chemicals Limited



•



and Vinatex Limited. It was therefore believed necessary to change the organisation of Coal Products to respond to the changing situation. One step was taken in 1969 when four groups were formed at Divisional level, each under a Group Director with full management responsibility. These were the Coking Group, Briquetting Group, Thomas Ness Group (Tar and Chemicals) and Hydrocarbons Group. The Board decided to take the process of specialisation further and put each Group Director directly in charge of the works operating for his Group.

In order to comply with the new structure the overall Regional Organisation was replaced by various Management Units as set out in figure 28. Each Management Unit consisted of two or three works of the same type and the Works Manager was responsible to one Group Director only. For the first time in the history of the industry a division of responsibility was brought about so that the coking plant manager no longer had overall responsibility for management and product control. He did however retain responsibility for providing services such as steam, water, electric power, and maintenance. Not all the Regional Services could be dealt with in this way and the Central Laboratories, Marketing and Thomas Ness Group sales services remained unchanged except that they were under the direct control of Division.

Ambition for the future prosperity of the industry could not have been higher but the reality of the situation portrays a different picture.



### Political Sensitivity

The first, and in the event the only price reduction in the history of the N.C.B. was made in 1964 when coking coal to the steel industry was reduced by 2s/6d. (12.5p) per ton (about 2 $\frac{3}{4}$ %). This was used by the Chancellor of the Exchequer, Regional Maudling as part of a scheme to keep down costs.

The Conservative Government had also been kind to the industry in earlier years. First a fuel oil tax of 2d. (1p) per gallon had been imposed and this helped coal to the extent of about £1 per ton. Also the Government had placed a total ban on coal imports but this had to be broken later.

The circumstances had been made right for an expansion in the demand for coking coal at a time when West Durham pits were becoming exhausted. The stocks of low volatile coking coal were being depleted at an alarming rate and as the seams under the North Sea were being developed the coal quality changed. The demand for foundry coke was running at 1 million tons per annum and the import of low volatile coking coal would become necessary unless major alterations were made. These came in the form of a stepping up of research into the effects of blending low and medium volatile coal at the Coal Research Establishment and the British Coking Industry Research Association. This piece of research only cost about £50,000 and it was successful. (60) As a result a commercial blending plant was built at Lambton in Durham next to Lambton coking plant at a cost of £300,000. (61) The success of the research was a major factor in avoiding the possibility of importing coke and preventing the closure of some of the Durham coking plants, thereby saving 3,000 jobs.

Although the special circumstance applicable to the Durham coalfield are not directly relevant to the coking industry in Yorkshire and Derbyshire it is mentioned to illustrate the concern the industry has always had not only for its survival but for its responsibility as a large employer in the community. Other sections show the generosity of the N.C.B. towards its employees when plants had to close.

#### General comment

The N.C.B. acquired a host of problems when the coking industry was nationalised, some of which could be anticipated *though* some were unforeseen. By the time nationalisation came it had passed its zenith so that it was no longer looked upon as a primary industry supplying the needs of the metallurgical and chemical industry as well as domestic consumption but as a secondary industry supplying blast furnace, industrial and domestic coke together with gas and by-products. A re-shaping of the coking industry was essential if it was to fulfil its secondary role and meet the needs of British industry which was itself modernising in order to compete with industries abroad. Nationalisation was the only realistic solution to an industry which had served the nation well in the past and now required re-vitalising.

Nationalisation brought many changes but the main one involved a reduction in the number of plants and an increase in size. Within these parameters lay many problems. The traditional pattern of coking plants supplying surplus gas to the local gas company changed with the nationalisation of the gas industry so that a greater degree of flexibility resulted. Both industries co-operated well while they were thriving but



external pressures on each caused them to make a closer internal examination and <sup>to take</sup> a fresh look at each other in the interests of improved profitability. It is inevitable that the coking industry should be tied to the mining industry but the way it was done in the early stages was far too rigid; nevertheless, in the absence of experience it seemed reasonable at the time. As the N.C.B. gained wisdom it re-examined its structure, sometimes on a voluntary basis and sometimes as a result of an externally initiated directive. Carbonisation section gradually became more autonomous until finally it became a wholly owned subsidiary of the N.C.B.

The nationalised coking industry planned as far as it was able, but like so many other industries it was the victim of national and world-wide fluctuations in trade. Unhappily it was also tied too closely to the financial vulnerability of the N.C.B. as a whole because of an early failure to appreciate that it should be regarded as an industry in its own right.

The outcome was that capital expenditure was adjusted to meet allocation which was in turn left to the whims and fancies of Government who used it as a pawn in the economy. Overall this may have been wise but it handicapped the coking industry because it was not always able to plan long term. Government has thought fit to alter the period over which the industry shall break even, change the method whereby it may borrow money, and eliminate cumulative debt to retain viability.

As time went by it became clear that the nationalised steel industry would develop its coking section independently to meet specific needs. The nationalised gas industry departed

completely from traditional methods of gas making and the nationalised coking industry was left without any firm base commodity market, in effect it remained holding the bits and pieces which didn't logically belong elsewhere. It can be said that for the past twenty years or thereabouts it has declined first, because plants have aged and not been rebuilt and second, plants have closed because of overcapacity in the coking industry as a whole. The merchant plants have not come off well and there is no reason to believe the downward trend will be halted.



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2. The Gas World, 17th October 1951.
3. N.C.B. N.E. Division, Final Report of the Divisional Valuation Committee 31st December 1956, p.10.
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8. Letter to Divisional Finance Officer from Messrs. Mann Judd & Co. Chartered Accountants, 8 Frederick's Place, Old Jewry, London EC.2.
9. Coal Industry Nationalisation Act Section 1 (2)
10. Sir Guy Nott-Bower and R.H. Walkerdine, National Coal Board - The First Ten Years, London, p.74.
11. Other industries were also in a poor condition and they too started a programme of modernisation. The British Steel Industry fell into the general pattern and invested some £1781 million between 1946 and 1964. Unlike investment in the coking industry their expenditure built up more gradually to a maximum in 1961 and then fell away.
12. Compiled from Ministry of Fuel and Power, Statistical Digest, 1948-1956, London, H.M.S.O. 1950-57.
13. Compiled from Annual Reports.
14. The paradoxical position arose that capital charges became so high that the cost of production from such new plant in many cases exceeded that of old plant.
15. This is a technical matter and further consideration is not relevant to the thesis.
16. Compiled from The Economist, March 1978.
17. Compiled from Annual Reports.
18. Compiled from Ministry of Power Statistical Digests 1959, p.131, 1961 p.85 and 1965 p.106.
19. Compiled from Annual Reports.
20. Compiled from Statistics of the Iron and Steel Board and British Iron and Steel Federation, 1965, p.33.
21. Compiled from Ministry of Power Statistical Digests, 1959, p.131, 1961 p.85, 1965 p.106.

22. The East Midlands Division was the only exception. Because of the small number of coking plants the Divisional Chief Carbonisation Officer was not granted director status.
23. Group D was not separately formed because of a schedule of plant closures which ultimately had to be adopted and all plants in West Yorkshire continued to be controlled by Group C.
24. Compiled from Vesting Date Surveys.
25. Compiled from information supplied by C. Wright, former Assistant Divisional Mechanical Engineer.
26. Report of the advisory committee on organisation of the National Coal Board. N.C.B. February 1955, paragraphs 165, 166, 167.
27. See chapter VIII describing B.C.R.A. and also describing applied research in the coking industry after nationalisation.
28. Up to now the customer decided how well the fuel burned but such random observations by lay people were no longer adequate.
29. The specialist staff were recruited from the coking plants.
30. Constitution and Rules and Regulations of the South Yorkshire Coking Plant Owners' Association.
31. Personal knowledge of G. Falkous, formerly secretary of the South Yorkshire Coking Plant Owners' Association and after nationalisation Administrative Officer, N.E. Division, Carbonisation & Briquetting Branch of the N.C.B.
32. Compiled from Transactions of the Coke Oven Managers' Association.
33. National Coal Board. Memorandum of Agreements, Arbitration, Awards, Decisions, Recommendations and Interpretations Relating to National Questions Concerning Wages and Conditions of Employment in the Coal Mining Industry of Great Britain, Vol.1-V 20th March 1940 - 31st December 1950.
34. The chapter describing Rotherham Main Coking Plant shows how, in what is perhaps an extreme case, considerable inter-relationship accrued.
35. British Labour Statistics, Historical Abstract 1886-1968, table 149.
36. Compiled from N.C.B. internal statistics, DCD/P(59) 34 2.3.59.
37. Compiled from N.C.B. internal statistics, DCD/P(59) 34 2.3.59.
38. The author has evidence of two people who transferred, though there are likely to be a few more, one was a joiner and the other was a sampler/first aid attendant.
39. See chapter V describing Smithywood and Mangers Coking Plants for more details.
40. There are sound technical reasons for this and the only times when the rule was not adhered to was for unscheduled breakdowns and planned maintenance.
41. Compiled from N.C.B. Reports.



42. Compiled from Annual Abstracts of Statistics, H.M.S.O. 1960 and 1977 tables 170 and 8.20 respectively.
43. Compiled from Ministry of Fuel & Power Statistical Digest 1964, table 61.
44. It has already been shown that in the pioneering days one intention was to merge the two industries but a realisation of the different objectives prevented it for technical reasons. Co-operation has been shown to include the Coke Oven Managers' Association and the Institution of Gas Engineers.
45. Rates of pay were based on national agreements.
46. Compiled from Annual Abstract of Statistics, 1973 and 1975, tables 163.
47. Compiled from N.C.B. statistics in author's possession.
48. Compiled from N.C.B. statistics in author's possession.
49. In the coking industry the prime consideration has traditionally been to meet the demand for coke and build markets for by-products
50. Such confidence turned out to be over optimistic. Judgement had been made on the basis of limited experience which later proved to be un-representative. The truth was that suitable coal was confined to one colliery in Nottingham and the cost of extra preparation and long haulage costs, and variable quality brought the scheme into early disrepute.
51. A Robens, Ten Year Stint, London, 1972, p.125.
52. There was an implication at the time that increased scale of operation was a panacea for all industrial ills. The underlying principle is difficult to understand and conflicts with later thinking whereby each section of a unit strove for profitability in order that the whole would be profitable.
53. Optimism abounded in respect of two smokeless fuel plants which were intended to be the forerunner of many. In reality both plants consistently made substantial financial losses because of technical and operational difficulties and one of them was closed down later on.
54. Sometimes this only meant a change in title and responsibility.
55. Personal knowledge of F. Sutton, former Administration Officer in the Yorkshire Management Unit.
56. Neither had there been any change in C.P.D. as a whole.
57. This was reasonable bearing in mind duplication of posts with all the attendant costs had been official policy three years earlier.
58. A. Robens, Ten Year Stint, London 1972, p.317.
59. Compiled from information supplied by National Smokeless Fuels Ltd.

60. Research Establishments associated with the coking industry have often been regarded as expensive luxuries because of their relatively small contribution to advancement of the industry.
61. A. Robens, Ten Year Stint, London, 1972, p.83.



## CHAPTER VIII

### RELATED ACTIVITIES

#### Introduction

Any thesis about a complex industry must involve activities which are peripheral to the main theme but are nevertheless important to the subject as a whole. Several such topics have played a part in the development of the coking industry and they are grouped together in this chapter for convenience. Each topic could form the basis of a separate thesis but it is confined to a subordinate role to show how the industry depended on progress in several directions in order to become successful. One common link between the topics is their contribution to the dissemination of technical knowledge as a basis for development of the industry.

The early problem was two-fold. By-product coking plant operations are necessarily technical and an elementary education for employees was essential for a reasonable understanding of the processes under their control. Any form of education over and above the minimum offered by the state was a pre-requisite for promotion so some supervisory staff developed their own method of acquiring the specialised knowledge vital to the industry. Early in the present century a shortage of education existed at all levels in the industry and it is not surprising that such a shortfall hindered progress. This is illustrated in chapter IV describing folklore and the problems associated with gas production and coke production. If progress was to be made at all it had to be made on several fronts. Improved standards of education were a pre-requisite for the growth and development of the following sections in order that each could contribute to the success of the coking industry.

## Simon Carves Limited

Henry Simon introduced into Britain two new industrial processes of considerable importance. Starting without capital or influence he built the first complete roller flour milling plant in this country in 1878 and the first by-product coking plant in 1881. Henry Simon died in 1899 but by then he had built up two highly technical businesses, developing them entirely out of profits and leaving them in so strong a position that Henry Simon Ltd. has ever since remained the leading British firm of milling engineers and Simon Carves Ltd. one of the two British leaders in the building of coking plants. The company continued to develop and the following ten departments came into being. (1) :-

1878 Henry Simon Ltd.	Flour milling engineers.
1880 Simon-Carves Ltd.	Coke Ovens
1900 Simon-Carves Ltd.	Coal washeries
1911 Henry Simon Ltd.	Mechanised handling
1915 Simon-Carves Ltd.	Chemical Plant
1925 Simon-Carves Ltd.	Steam power plant
1925 Henry Simon Ltd.	Engineering works
1931 Henry Simon Ltd.	Industrial gears
1945 Henry Simon Ltd.	Tyre retreading
1945 Simon-Carves Ltd.	Industrial buildings

The coke oven department varied considerably in size during a century of activity but it was never more than a relatively small component of the Group. The next section describes the coke oven department in more detail.



## Coke Oven Department

It has already been stated that Henry Simon realised the importance of by-product coking plants after he visited France in 1879 with a party of fellow-members of the Iron and Steel Institute. The outcome was that he formed a partnership with François Carvès, a distinguished French coke oven engineer, and having secured the British patent rights on the Carvès oven he read to the Iron and Steel Institute in 1880 a paper entitled 'An improved System for the Utilisation of By-Products in the Manufacture of Coke'.

Henry Simon's first success was an order for a battery of twenty five ovens at a Durham colliery, Crook, in 1881 and soon afterwards the order was doubled. In the next two or three years he built some more by-product coking plants, but although the Simon-Carvès oven was awarded a gold medal and diploma at the Inventions Exhibition in London in 1885 it failed to win approval from British ironmasters.

In the early days Henry Simon's work suffered because of a lack of reliable data, for although his early plants produced good results the owners were inclined to be secretive. In 1892 Henry Simon and the Société François Carvès formed a company to build and operate two batteries of ovens at a small colliery in Lanchester. In order to make the contract possible the contractor provided most of the capital and received payment by taking a share in the by-products for a given number of years. Why did they take this unusual step? There were two reasons; first they were willing to arrange to have the capital available if it was in their long term interest and second, it was the only way they could get the technical data they so

badly needed. In the event an average dividend of about 20 per cent was paid and a third battery was built and financed in the same way soon afterwards.

Because of the success with the Lanchester batteries a Middlesborough iron-making firm (2) ordered a similar coking plant and the results were so satisfactory that the plant was doubled. Unfortunately Simon Carvès' success attracted strong competition from a German firm who were keen to have a coking plant in Britain and as a result offered such favourable terms that the Middlesborough firm could not refuse them.

In 1896 Henry Simon turned the business into a limited company. (3) From this date until the end of the century another four by-product coking plants were built and, as before, the company provided the capital and took payment out of the profits earned. The result was that at the start of the twentieth century Simon-Carvès were established as the main coke oven constructors but the failure to convince most British ironmasters of the merits of by-product coking plants denied them the opportunity to expand effectively and it placed them at a serious disadvantage with their continental competitors.

Early in the twentieth century the technical staff was strengthened and the business remained moderately successful though it was handicapped by German competition and the smallness of the home market. How did the company attempt to overcome this problem?

In 1931 Simon Carvès made an agreement with the German firm of Otto, one of the two leading German coke oven contractors, to use their patents and technical knowledge under licence.



Simon Carvès made the Otto twin flue 'compound' oven and therefore had access to the important steelworks market, for which it was essential to be able to offer a well-known and well-proved compound oven design. (4) During this time, when prestige was so important, the company built the largest plant in Britain for Dorman Long. The underfiring for these ovens was outstanding and had a higher thermal efficiency than any other British steelworks plant. No doubt this influenced the contract for three large batteries which were won against fierce competition, for the Tata Iron and Steel Company who were the biggest steelmakers in India. During the World War II there was little new construction in this country but some ovens were rebuilt. Numerous by-product plants were supplied to the Government.

After the 1930s the amount of work increased considerably and enabled the staff to be increased so that a more efficient organisation was possible. By the end of the war Simon Carvès were in a strong position to take advantage of the burst of activity in the coking industry at home and abroad. (5) Home and export markets were busier in the late 1940s and mid 1950s than at any other so that the size of the staff enabled adequate research and development to be undertaken for the first time. The question arises - was the research started soon enough and was it sufficient? In retrospect the research and development was too late and in insufficient quantity to bring the post war coking industry up to date, but the company was in a dilemma; like its main competitor in this country it lacked the resources to invest in research before this time and, even if they had been available it is difficult to see why Simon Carvès should anticipate such a rapid change in the market. Most

certainly they would not have been able to foresee the nationalisation of the coal industry and the gas industry and the massive injection of investment which followed.

In the early days Simon-Carves' coke oven business was hampered by German technical superiority but this did not last. As early as 1943 steps were taken to strengthen the research and development department and soon afterwards the company became entirely independent of any overseas country regarding coke oven design. Two important achievements gave a boost to the coke oven department. The first was the development of an entire underjet oven in which rich gas and also lean gas and combustion air were sub-divided to individual heating flues by metal jets accessible from the battery basement. Development of the early underjet system gave better temperature control which in turn provided better fuel economy. The second concerned the increasing use of coke ovens at gasworks. The coke ovens at gasworks had traditionally been compound ovens usually heated by producer gas so that the maximum quantity of rich gas was available for sale, coke was merely a by-product. In order to meet this need the company developed a mechanical coke burning gas producer for use at coking plants in this country and abroad. (6)

Although it was right and proper for a major contracting company to have a research department it was never intended that laboratory research should take preference over practical experience obtained from building full scale plants. There were three reasons for this. First, problems on a coking plant have never been dealt with successfully on laboratory equipment largely because of the inability of early researchers to apply the correct 'scale-up' procedure. (7) Second, even if the



technique had been understood coal carbonisation is perhaps the most difficult process for which a mathematical solution might be applicable. The third reason was that research workers were essentially people who enjoyed empiricism rather than pure research and not surprisingly many of them lacked academic qualifications. This is dealt with in detail later in the chapter. The research facility existed to fill gaps in knowledge revealed as a result of building full scale plants, often in the light of a new contract. A few experiments could be carried out quickly to enable the contractor make an inspired guess at a solution before submitting a quotation.

The feed back from existing plants was very important and papers presented to the Coke Oven Managers' Association demonstrate its importance. On a less formal basis practical problems of mutual interest to the designer and plant operator were often discussed round the bar after meetings. (8) These problems of the coking industry and the solutions sought by Simon Carves Ltd. apply equally to the Woodall Duckham Construction Company Ltd. and others.

It made sound business sense for the company to pay an annual subscription to the British Coke Research Association after it was formed in 1944. The subscription bought Associate Membership status and entitled Simon Carves to be kept informed of all the B.C.R.A. publications. It also entitled the company to have investigations undertaken on its' behalf cheaply and with precision. Many problems were mutually important to both B.C.R.A. and the contractor. Were for instance the problems of leaking oven doors or working conditions on oven batteries the sole preserve of the contracting companies? ( 9 )

The essence of the Simon Carvès Coke Oven Department's entire history is the importance of a strong home market which could serve as a springboard for exports. (10) The company found itself without an adequate home market in the early days so that it was unable to build up the staff or to undertake large scale research and development, still less could it undertake many export contracts. When British markets began to expand before World War I the Germans were fortified by a large home market and as a result were able to capture much of the world market. The result was that even though Simon Carvès coke oven department was growing it remained dependent on German expertise. Only since 1945 has the home market been large enough for the company to attain technical independence and vigorously attack world export markets.

The successful post-war expansion brought its own problems because it was realised that the boom in coke oven building would come to an end and that when the home market returned to normal it would be far too small to support the Coke Oven Department on the scale it had reached, even without the presence of a strong British competitor. It was inevitable that the coke oven department would eventually decline and once again become a small part of the Simon Engineering Group.

The next section shows how another company flourished in the gas industry and then moved across to develop expertise in coking plants so that it reached a status equal to that of the Simon Carvès coke oven department via an entirely different route.



Woodall Duckham Company

The Company came into being in 1903 when the original patent in connection with the Woodall-Duckham Continuous Vertical Retort was taken out by Lt.Col. H.W. Woodall and Arthur Duckham.

Their method of carbonisation was first <sup>employed</sup> in the same year, ~~when~~ an experimental retort at the Bourne Valley Works of the Bournemouth Gas and Water Company. Two more experimental plants were built before the first commercial contract was received in 1906 for the construction of sixteen continuous vertical retorts capable of carbonising 40 tons of coal per day for the Bourne Valley Works.

Between 1906 and 1910 eight more contracts for the installation of new continuous retorts were received - including four from overseas. In anticipation of an international market for the retorts Licensees were appointed in France, Germany, Australia and America.

The Woodall Duckham Company was very successful with orders for continuous vertical retorts, In the first fifteen years 100 installations were ordered and in the next eight years the figure was doubled. By 1953 558 gas making plants had been built in twenty three different countries with a total annual carbonising capacity of 19 million tons.

On the strength of its early success with gas making plant they diversified and in 1923 they entered into an agreement with Stettiner Chamotte - Fabrik of Germany to build the Intermittent Vertical Chamber - a design of gas making plant which was in particular suitable for processing cheap coals. The first installation of this design was completed at Ramsgate in 1926.

By 1923 the Company was internationally known as designers and builders of carbonisation plant for the Gas Industry and it decided to build coking plants to produce coke mainly for use in the metallurgical industry. This natural progression happened because much of the applied research, albeit elementary, was common to both processes. Also, there were similarities between the flow diagram for a gas works and a coking plant, shown in figure 1. In the main the only differences in the by-product equipment concerned size and this wasn't a problem to the company because they were designers and not manufacturers of process plant. Woodall Duckham and Co, quickly realised that expertise gained in the gas industry could provide tremendous benefit for entry into the coking plant contracting industry.

The processes of carbonising coal for town's gas on the one hand and for the production of metallurgical coke on the other have much in common and any advance with the former had influence on the latter and vice versa. Therefore, in the early days of by-product coking, when recovery was confined to tar and ammonia, methods employed and plant adopted were modelled almost universally on gasworks practice. Later many of the improvements effected by coke oven constructors, especially in ammonia recovery processes, were utilized in modern gasworks. In the early twentieth century the principles enunciated and the experience gained in benzole recovery in by-product coking plants was of the highest value to those gas engineers working on the problem of increasing the supply of benzole and toluene for national requirements. In the 1920s the American Coking Industry, with considerable mechanisation, led the world with the outstanding design of Becker coke oven - built by the Koppers Company of Pittsburgh. By an agreement



FIGURE 1

Basic Features of Coal Carbonisation

Gas Works

Gas retorts

Gas collecting main

Foul gas main

Primary condensers

Turbo exhauster

Naphthalene washer

Secondary condensers

Electrostatic tar precipitator

Ammonia scrubbers

Oxide purification in towers

Benzole scrubbers

Storage in wet gas holder

Gas drying by calcium ohloride. \*

Final storage in dry gas holder \*

Coking Plant

Coke ovens

Gas collecting main

Foul gas main

Primary condensers

Turbo exhauster

Electrostatic tar precipitator

Ammonia removal, direct or  
indirect

Benzole scrubbers

Naphthalene removal

Oxide purification in towers

Storage in gas holder

\* These stages are unnecessary in the post World War II period.

between the two companies the Woodall-Duckham Company undertook the sale and construction of Becker Coking Plants in the British Empire (except Canada). The Nunnery Coke and Gas Company Limited at Sheffield provided the first order for these ovens in 1928 and twenty five ovens were constructed with a total throughput of 520 tons of coal per day. This is referred to in chapter V.

By the outbreak of World War II the company had built, or were building, Becker Coking Plants with a total coal throughput of  $7\frac{1}{2}$  million tons of coal per annum, and in 1940 the detail drawings and technical data of the Koppers Coke Oven Company Limited of Sheffield, who were building the Koppers (Essen) coke ovens in Britain, had been acquired. In 1947 they entered into an agreement with Koppers G.m.b.H., Essen, for the sale and construction of ovens of the Koppers (Essen) designs in the British Empire (except Canada).

Laboratories were first established by the Woodall-Duckham Company in 1920 with the object of providing facilities for the testing and analysis of materials used, treated, or produced in plants built by the firm, and to investigate problems connected with their operation. It has already been stated that at that time the Company was mainly concerned with continuous vertical retorts but subsequent additions to its activities and the resultant installation of plant and equipment in the laboratories close to the Company's headquarters then in Grosvenor Gardens, made the premises unsuitable. It had often been considered desirable <sup>to have</sup> accommodation elsewhere and in 1936 a decision was taken to erect a completely new building on the Croydon Factory Estate close to Croydon Gas Works. The laboratories were brought into use in 1937.



In real terms the laboratory made little, if any, contribution to the knowledge of coal carbonisation. It merely provided unsophisticated supporting information for potential contracts and an identical situation is mentioned later in respect of Simon Carves Ltd. The true source of information has always been the empirical knowledge gained from building plants and the immediate feed back of information from the guarantee tests and subsequent and much longer term information obtained from liaison with Works Managers. Their own laboratories were never intended to replace such practical experience which was quickly established and so the laboratory staff were a few practical chemists rather than academic researchers who could be found in Universities. Like Simon Carves Ltd. the Woodall Duckham Company Ltd. found it convenient to become an Associate Member of B.C.R.A. by paying an annual subscription when it was formed in 1944, thereby being kept informed of the latest techniques from that source.

#### The Importance of Koppers

Heinrich Koppers was a civil engineer who established a company in 1901 for the development and construction of coke ovens of his own design. Koppers was an entrepreneur whose early years of work were successful and he had a number of basic inventions. As a result of his pioneer work Koppers initially received orders to construct coke ovens in Germany and England. Other orders followed quickly and by 1914 he had built coking plants in fourteen countries spread over three continents. (11)

As early as 1907 Koppers had expanded into the gas industry (12) so that by 1960 approximately 75 per cent of all horizontal chamber ovens at West German gasworks were of Koppers design. Koppers also tackled the problem of by-product recovery at an early date and thereby started on a path which led to the construction of plants for the chemical industry.

Koppers was not content with the involvement so far and in order to meet the demand for synthesis gas he built large plants operating by his own system to produce synthesis gas from brown coal and built cracking plants for coke oven gas to produce gas rich in hydrogen. (13) He was the first to solve the problem of gasifying coal dust.

Koppers built numerous distillation plants to process synthetic hydrocarbons and the outcome was the construction of complete mineral oil refineries in the 1950s in response to the changing economic conditions in the field of energy supply.

The company expanded its activities in the field of metallurgical engineering and increased its activities from the construction of steelworks coking plants to the erection of plants for pre-treating ore fines to be smelted by sintering, and to the design and construction of high temperature hot-blast stoves. Furthermore, Koppers was granted a licence to construct Petrocarb plants for injecting coal into blast furnaces and in the 1960s the N.C.B. used Petrocarb plant for their coal injection trials at the Stanton Ironworks. The trials were successful but the economics of injecting coal as an alternative to using coke was unfavourable.

Although the list of Kopper's achievements presented in the next section looks impressive many of his undertakings were probably



not due to him alone. The list is presented to indicate developments in the industry rather than to highlight the man generally associated with them.

#### Some of Koppers' Achievements

- 1904 Heinrich Koppers invented a coke oven with single or cross regenerators, a design on which all present oven systems are based.
- 1904 Developed the 'semi-direct process' for the recovery of ammonium sulphate - this was an advancement in by-product recovery which was adopted in 90 per cent of all the coking plants in the Ruhr district by 1923. It was not so readily accepted in this country because it had disadvantages as well as advantages and the former figured more prominently in the minds of British colliery owners.
- 1907 When constructing his first coking plant in America, Heinrich Koppers drew up a specification for the manufacture of silica bricks for use in coke oven construction which embodied basic pre-requisites to the building of modern high performance ovens. While it must be recognised that Koppers was the first to draw up a specification for silica bricks chapter IV shows that the specification must have been very loose; any specification would be a forerunner of that used for modern silica bricks.
- 1909 Created the regenerative coke oven with lean gas heating for the Vienna Gasworks - the basis of many present day steel works coking plants.
- 1910 Devised the compound oven system for alternate heating with rich and lean gas, thereby forming the basis of long distance gas transmission.

- 1916 Built the first mechanical coke quenching and loading plant and thereby advanced the way for meeting the economic and social demands of the first half of the 20th century.
- 1922 Built a plant at Dusseldorf - Heerdt to manufacture silica bricks in tunnel kilns.
- 1927 Developed the Circulation Combination oven which met the increased requirements of large modern coking plants.  
By 1960 about 9000 of these ovens had been constructed throughout the world.
- 1930 Became involved with medium temperature carbonisation to produce solid smokeless fuel.
- 1931 Evolved methods for drying long distance gas with calcium chloride and for denaphthalising it with anthracene oil.
- 1934 Constructed its first continuous tar distillation plant with pipe still furnace and obtained a most precise separation of the fractions.
- 1935 Built the first gasoline recovery plant with pipe still furnace for removing gasoline from brown coal low temperature gas.
- 1935 Took up the problem of the synthetic production of motor spirit and invented a process for industrial use to produce synthesis gas from brown coal, briquettes, an unprecedented process which, at Koppers' own risk was implemented in a plant with a final capacity of 2000 million m<sup>3</sup> of synthesis gas per year.
- 1936 Introduced a pipe still furnace to recover benzole from coke oven gas.
- 1937 Invented the potash process - the first process to treat compressed coke oven gas with simultaneous recovery of hydrogen sulphide.



- 1942 Constructed the first slagging producers with oxygen gasification to produce carbon monoxide for chemical synthesis.
- 1949 Made marked progress in the processing of tar through continuous distillation with pipe still furnace under atmospheric pressure and vacuum by the Teerverwertung-Koppers system.
- 1950 Built the first commercial-scale coal dust gasification plant operating by the Koppers-Totzek process to produce synthesis gas for the synthesis of ammonia. This process was the answer to a problem which had remained unsolved for many years.
- 1951 Built the first wet catalysis plant for producing sulphuric acid from sulphur or hydrogen sulphide, and the first Perox plant for catalytic desulphurisation of gases.
- 1952 Constructed a final distillation plant for hydro-refined benzole with a stringency unattained at that time.
- 1954 Built its first benzole hydro-refining plant operating by the B.A.S.F. Scholven process.
- 1955 Developed the benzole cold scrubber for simultaneous recovery of benzole, denaphthalisation and drying of gas.
- 1957 Built its first plant to produce phthalic anhydride from naphthalene, thereby becoming more implicated in chemical engineering in the narrower sense of the word.
- 1958 Formed a special company to deal with problems of automation in all branches of industry.
- 1960 The first plant to produce ethylene and propylene from Sicilian crude oil, operating by a process developed by Koppers was successfully put into operation. A plant to produce maleic anhydride from benzole was built, and Koppers engineered, planned and built plants based on other chemical processes such as for the dehydrogenation

of cyclohexanole, hydrogenation of nitrobenzole and similar processes of the chemical industry.

1961    Awarded an order for the construction of a sintering plant for an Indian steelworks.    This was the first order in a new field of activity.

1962    Built its first high-temperature hot-blast stove for a steelworks.

The next section examines one large supplier of equipment for the coking industry to show how the industry, which was eventually based on two large coking plant contractors (14) also relied on equipment manufacturers for its success.

#### Bryan Donkin Company Limited

Around the turn of the eighteenth century scientists such as Sir Humphry Davy and Dalton and engineers such as Watt, Bramah, Brunel, Maudslay, Murdoch and Telford were in the zenith of their career. They were contemporaries of Bryan Donkin though he is not so well known.

Bryan Donkin is credited with perfecting and building the first practical paper-making machine, he invented the steel pen nib and he was the first person to successfully preserve food and fruit by canning. He received a gold medal from the Society of Arts for a Tachometer in 1810 and another gold medal was awarded in 1819 for a counting machine. (15)

The Company was founded at Bermondsey, London in 1803 and for reasons of expansion and in order to be closer to the sources of fuels, metals and skilled labour, it moved to Chesterfield almost a century later. It was well established in the items



already mentioned as well as boilers, steam engines and water wheels though trade in the latter declined. The contribution to the Gas Industry had a profound effect not only on that industry but on many other industries.

Regardless of the multiplicity of Bryan Donkin's interests in the field of engineering the first commercial work for the gas industry was not undertaken until 1847. The first task was to design a rack and pinion valve at the suggestion of the Chartered Gas Company of London; the same type of valve continued in production until 1964. Within ten years of their conception valves were being made in sizes up to 27 inches.

The company developed its connection with the gas industry by the manufacture of Gas Exhausters, beginning with a patent by Bryan Donkin the second and D.W. Farey in 1856 for a rotary engine consisting of a disc set at an angle to its axis, and rotating in a casing that formed part of a sphere. Several of these machines were made.

Early exhausters such as the one patented by Joshua Beale in 1848 suffered from the disadvantage that there was great friction between the slides. The peripheral speed of the guiding segments on a 38 inch exhauster revolving at 60 r.p.m. was as high as 600 ft.per minute. The segments had to run in circular grooves machined in the end plates of the machine. In 1877 Beale patented a much improved design in which the friction was only 30 - 40% of that of the earlier exhauster. Soon afterwards Beale retired and the Bryan Donkin Company purchased the business outright. As a result of modifications the velocity of the slide block was reduced from 600 to under

60ft. per minute and the block had a much greater wearing surface than the segments. More than 600 exhausters of the various Beale types were at work by 1897 and many of them were driven by steam engines built by the Bryan Donkin Company. About 100 of them were exported to the five continents.

An early achievement was the installation of sets of gas boosters at Beckton Gas Works in 1880 which pumped gas through 4ft. mains over a distance of 8 - 10 miles to London. This pioneer installation was one of the very few examples of gas boosting in this country before the present century.

Another development worthy of mention was the acquisition in 1910 of the rights to manufacture turbo exhausters and blowers on principles patented by Professor Rateau. The original turbo-compressor was built by Rateau in 1902. This innovation was most important to the rapidly expanding gas industry because it provided a means for dealing with very large volumes under constant pressure, giving an absolutely steady discharge and effectively reducing tar fog and economised on space.

The Beale exhauster was completely reliable but it had the disadvantage of being large at a time when the high capacity of carbonising units made floor space an increasingly important factor. Early Rateau machines were little more efficient than the Beale exhausters but, because of their high speed, they were able to deal with much greater volumes of gas and at the same time required smaller foundations and smaller buildings to house them. Because of their higher speed they were more suitable for direct coupling to steam turbines and electric motors which were starting to replace the slow speed steam engine.



By 1929 there was an awareness that these machines had reached their limit for some of the larger works and that faster speeds were necessary to keep down the size of the plant and make better use of higher efficiencies obtained from the use of high speed turbines. A Rateau Star type Turbo Exhauster was developed to meet this need and to withstand high speed a radially bladed impeller was machined from a high tensile alloy steel forging.

Boosters and exhausters were developed to cover a wide range of duties from 10,000 cu.ft. per hour and a few inches water gauge to 1,000,000 cu.ft. per hour at 15 pounds per square inch. Demand for the centrifugal booster increased as the Gas Industry developed and the volumes of gas to be handled became larger. More than 2,000 machines of various types and sizes have been supplied and many have been used by the Gas Industry.

In 1920 the foundry was extended so that castings could be made under contract with W.C. Holmes and Company Limited and Mr. P.F. Holmes joined the Board of the Bryan Donkin Company. In 1926 an agreement was entered into between the two companies for the manufacture of Connersville Meters, Exhausters and blowers. Messrs. W.C. Holmes and Co.Ltd. had already secured the rights under Licences for the patents covering the manufacture of Meters, Exhausters etc. from the Connersville Blower Company of Connersville, U.S.A. The secret of success depended largely on accurate design and good workmanship and the Connersville meter eventually superseded the wet drum station meter so that the demand for these machines grew rapidly. There was a similar big demand for the Holmes-Connersville design of exhauster for the Gas Industry.

The manufacturing association with W.C. Holmes was terminated in 1967, but with the experience gained on Roots blowers and the fact that a sister company, George Waller, of Stroud, Gloucestershire also had a small manufacturing facility for this type of blower it was a logical step for the production of Waller Roots type blower to be moved to Chesterfield. (16)

It was inevitable that sooner or later integration within the Gas Industry would take place on the lines of the West Yorkshire Gas Grid which was built up long before the war by the United Kingdom Gas Corporation. Nationalisation of the Gas Industry in 1949 provided the opportunity for the grouping of undertakings under Area Boards and the bulk supply of gas between undertakings or from manufacturing stations to distribution stations became common. As a result compression plant was in large demand. However the advent of gas manufacture from oil rather than coal in the late 1950s and early 1960s and the higher available pressures brought about by the manufacturing processes themselves, the need for reciprocation compressors fell away sharply.

New markets in the chemical, petrochemical and process industries had to be developed quickly. Simultaneously with this, the effect of general economic conditions on the design and selection of plant had to be considered. On the grounds of flexibility steam has been by far the most suitable source of power and in the 1920s and early 1930s and up to the late 1950s it was unusual to consider alternative forms of drive. Today steam raising costs are generally prohibitive unless waste heat boilers can be used. The outcome is that in



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other industries there has been a swing in favour of electric drive though the possibility of electric power failure needs to be considered. Although electric drives are generally favoured diesel, dual-fuel or gas engines have been installed.

The Bryan Donkin Co. Ltd. flourished in the first half of the century because it had a few entrepreneurs rather than because it undertook much serious research. Like Simon Carves and Woodall Duckham and Company it relied on information from customers in order to effect modifications and improvements, but unlike the former the Bryan Donkin Company were manufacturers and employed a large number of craftsmen with practical skills rather than academic flair. (17)

#### The British Carbonization Research Association. (18)

#### Early Research (19)

Coke research is one important component of the study of fuel technology and the first important step towards the organisation of this discipline was taken by the Institution of Gas Engineers and the University of Leeds in 1907 when the Livesey Professorship of Coal Gas and Fuel Industries was founded. W.A. Bone occupied the first chair until 1912 when he transferred to Imperial College. (20) He was succeeded by J.W. Cobb who, in conjunction with distinguished collaborators, produced a long series of papers dealing with coal carbonisation and the resultant by-products. The work at Leeds was concerned with carbonisation for gas making but the work at Imperial College was concerned with the constitution of coal. The lead produced by Leeds was soon followed by other Universities, notably Sheffield where the



appointment of R.V. Wheeler as Professor of Fuel Technology provided stimulus in and research on the more practical aspects of fuel technology, especially the production and use of hard coke. Wheeler was a former student and colleague of Bone.

Armstrong College at Newcastle upon Tyne and the Royal Technical College, Glasgow entered the field and it was natural for them and Sheffield to become the homes of the first bodies set up for the sole purpose of carrying out research on hard coke. Each of the bodies was situated in one of the major coke producing areas and they became known as the Midland, Northern and Scottish Coke Research Committees. The Committees were financed by grants from the coke producers and users, supplemented by grants from the Department of Scientific and Industrial Research administered by the Industrial Research Council of the British Iron and Steel Federation. The first meetings of the Midland and Northern Coke Research Committees were held in 1926 and followed by the Scottish Coke Research Committee in 1928.

Professor R.V. Wheeler was the first Honorary Director of Research of the Midland Coke Research Committee and W.J. Brooke was the only Chairman. Wheeler died in 1939 and he was succeeded as Director of Research by Dr. R.A. Mott, who had been Wheeler's assistant. Mott and Wheeler had produced 'Coke for Blast furnaces' in 1930 and 'The Quality of Coke' in 1939 incorporating the results of the Committee's work on coal and coke. One feature of this work was the development of a 5 owt test oven, with which many of the results reported in

'The Quality of Coke' were obtained. Recognition was given immediately to the value of the test oven and led to the wide adoption of the design. Another feature was the development of reliable methods for assessing the quality of coal for coke making and the quality of the coke produced. The work of the Committee was carried out in laboratories generously made available by the University of Sheffield.

The first Chairman of the Northern Coke Research Committee was Dr. H. Peile and the first Joint Honorary Directors of Research were Professor H.V.A. Briscoe and Professor G. Poole. In 1932 Professor H.L. Riley became Honorary Director of Research and in 1935 Mr. (later Dr.) A.H. Middleton became Chairman of the Committee. In the early stages the Committee carried out valuable investigations of foundry coke and its behaviour in the cupola. Later the researches changed emphasis because of the lack of adequate fundamental knowledge so that while studies of reactivity and combustibility continued, much of the effort was devoted to studies of the physical and chemical properties of coke and of the mechanism of coke formation. The work of the Committee was carried out in laboratories kindly made available by Armstrong College, later King's College of the University of Durham.

Mr. W. Thorneycroft became the first Chairman of the Scottish Coke Research Committee based at the Royal Technical College, Glasgow. Professor T. Gray became the first Honorary Director of Research. Studies on domestic coke and factors affecting the use of coke in cupolas as well as the use of carbonaceous additives in coke oven charges and the requirements of a good blast furnace coke were some of the research projects. The



work at Glasgow was suspended on the outbreak of World War II in 1939 but it was resumed in 1946 after the cessation of hostilities in 1946 under the direction of Professor Hay and in close co-operation with the newly formed British Coke Research Association.

#### Formation and Membership of the Association

The impact of wartime conditions on industry in general brought about an increase in measures of re-organisation and rationalisation along with a new impetus in research aimed at direct and indirect assistance to the war effort. The coking industry followed the general pattern and one result of wartime control was the decision of the industry's newly formed commercial organisation, The British Hard Coke Association, later known as the British Coking Industry Association, to centralise and expand the industry's research effort.

The British Hard Coke Association formed a Research Committee and thereby opened the way for the creation of a Research Association under the aegis of D.S.I.R. Pending inauguration of the British Coke Research Association the British Hard Coke Association accepted financial responsibility for the research work from 1st January 1944. This responsibility was handed over to the British Coke Research Association when it was incorporated on 20th June 1944 but for several years afterwards the Research Association continued to draw its funds direct from the British Coking Industry Association and not from the constituent Members as has been the case since 1960.

On the inauguration of the Association, Mr. Ralph Alsop, C.B.E., Chairman of the British Hard Coke Association, became Chairman of

the Research Association and Mr. G.W. Lee became Technical Officer responsible to Council and the D.S.I.R. for the conduct of activities, G.W. Lee was also attached to the then Ministry of Fuel and Power in an unofficial capacity to advise and help the Coke Supplies Office, later to become the Coke Directorate of the Ministry on technical matters.

Was such a combination of circumstances fortuitous?

The answer is obscure but the effect is not and the Association quickly found its feet, even during the war when the overriding requirement was to keep coke ovens operational despite shortages of labour and materials. The newly formed Association concentrated most of its efforts on these problems in the early days.

What were the financial arrangements for the conception of an Association which in retrospect has flourished throughout its existence? The terms under which the D.S.I.R. agreed to establish a research association were that the D.S.I.R. would add £7,000 to an annual industrial contribution of £10,000.

The early funding was in marked contrast to the income in 1968 which was just over a quarter of a million pounds per year, of which the Ministry of Technology - successor to D.S.I.R. - contributed about £55,000. It should be noted that the income of approximately £19,000 in 1945 was approximately four times the total annual income of the regional research committees and represented a considerable achievement by the original Council of the Association.

How are the Association's activities controlled? Control was, and continues to be, vested in Council which comprises coke



producers who agree to support the Association financially at rates proportional to their scales of production. The contributions are made on the basis of a levy which is subject to periodical review. Council also has representation from the Ministry of Technology - previously from D.S.I.R. To what extent has the evolution of technological society, part of which is the coking industry, changed the original balance of Council members? The original Membership comprised a relatively large group of companies but membership has fallen numerically over the years, due mainly to the nationalisation of the coal industry in 1947. Membership at present consists of the constituent companies of the British Steel Corporation and the National Coal Board. The independent companies have always been numerically small from the inception of the Association and now they are non-existent. The Articles of Association make provision for Associate Membership so that interested bodies contribute to the income of the Association by paying an annual fee which is subject to review. The main Associate Members are the major coke oven constructional companies and the United Kingdom Atomic Energy Authority. The Contractors were quick to realise the advantage of buying expertise when necessary rather than attempt to fund their own on a large scale.

#### Administration

In order to supervise the research activities of the Association Council called into being a Research Committee which replaced the original research committee appointed by the British Hard Coke Association and <sup>was</sup> composed of experts from the Members' staffs along with representatives from the Coke Oven Managers' Association.

The D.S.I.R. appointed its first Visitors to the Association in 1949 and a series of distinguished people, including Professor R.J. Sarjant, O.B.E. and Professor Roberts have served in this capacity.

From the outset it was decided that maximum use should be made of the regional coke research committees. At Sheffield the Midland Coke Research Committee continued and was maintained from the Association until 1946 with Dr. Mott as Director of Research but after that date the University had to end its kind arrangement with the Committee. As a result of the formation of B.C.R.A. the Midland Coke Research Committee ceased to function at the end of 1946 and Council of the Association established its own Midland Coke Research Station in Sheffield and took over the staff who had hitherto been employed with the Midland Coke Research Committee. New premises were acquired in 1947 and comprised a large detached house known as 'Lynwood' in a residential part of Sheffield. The process of equipping and modifying Lynwood was completed in 1950 when the Midland Coke Research Association was formally inaugurated by the Earl of Halifax (21) 'Lynwood' remained in use until 1958 when the Midland Coke Research Station was closed as a result of the establishment of the Coke Research Centre at Chesterfield. (22)

At Kings College the work of the Northern Coke Research Laboratory continued under the guidance of the Northern Coke Research Committee and maintenance by B.C.R.A. The Association's arrangement with the University continued after the establishment of King's College as the University of Newcastle upon Tyne in 1963. The laboratories are now housed in the Department of



Physical Chemistry and directed by the Professor of Physical Chemistry.

In contrast the activities of the Scottish Coke Research Committee, which ceased on the outbreak of war, were not resumed and the Committee was disbanded. As an alternative the Association sponsored work at the Royal Technical College, Glasgow, which subsequently became the Royal College of Science and Technology until 1959.

Headquarters of the Association were established in London, first at Pall Mall and then at Grosvenor Street where they remained until the establishment of the Coke Research Centre in 1958. The Registered Office of the Association was transferred to the Research Centre in 1966.

The other centre of activity established in the early years was the Pontypridd Test Plant which was staffed from Headquarters. The main feature of the installation was a 5 cwt movable wall test oven designed to allow accurate assessment of coking pressures. This test plant closed in 1957 in anticipation of the establishment of the Coke Research Centre and the movable wall test oven was transferred to Chesterfield.

#### Panels and Committees.

Following the inauguration of B.C.R.A. ten panels comprising some academic research workers but mostly comprising members from industrial organisations were formed to promote close collaboration between the Association and the coking industry and to obtain guidance in the development of research. (23)

After the Coke Research Centre was established in 1958 Council decided to institute a new committee structure more appropriate to the stage of development. The panels were disbanded in 1961 but three new panels were set up to advise on specific sections of the programme, These were disbanded in 1968.

The first meeting of the newly formed Blast-furnace Coke Committee, which was a Joint Committee with the British Iron and Steel Research Association took place in 1961. The Committee provided liaison between producers and users of blast furnace coke and between the research activities of the two bodies.

The British Coking Industry Association closed in 1966 and caused certain changes in the Association's activities. Probably the main development was Council's approval to the Air and River Pollution Committee of B.C.I.A. becoming the Air and River Pollution Committee of the Association.

#### Education and Conferences

As a result of the closure of B.C.I.A. the activities of that body in the field of education were transferred to a trust set up specially for the purpose. An arrangement between Council and the Coking Industry Education Trust enabled the office facilities and appropriate administrative assistance to the Management Committee to be provided by the Association.

Traditionally the Association has striven to encourage and develop the bonds which exist with various universities. Towards this aim Council established a scheme of Coke Research Fellowships at Leeds, Newcastle and Sheffield and later



extended it to include the Universities of Hull and Bristol. The fellowships were available for post-graduate research leading to the submission of these for Ph.D. degrees where desirable.

The main aims of the Coke Research Fellowship scheme were to secure the flow of a suitable number of highly trained graduates into the industry, and perhaps more importantly, to promote studies, mainly of a fundamental nature, and of a type best suited to academic conditions which were not part of the Association's Research Programme.

Conferences were regular feature of the Association's activities during the first ten years or more of its existence. A total of seven conferences were held, starting with the Inaugural Conference at Leeds University in 1944. There was an imposing gathering of distinguished people to launch the inaugural meeting, including Sir Hubert Houldsworth, former wartime Controller-General of the Ministry of Fuel and Power. The seventh conference took the form of a Joint Technical Meeting of the Institution of Gas Engineers, the Coke Oven Managers' Association and the British Coke Research Association. These meetings were then held annually for many years until, with the changed pattern of the Gas Industry they were no longer to contribute to, or derive benefit from them. Each of the three sponsoring bodies took turn to act as host and provide a speaker on a subject of mutual interest. This is referred to in the section describing the Coke Oven Managers' Association. When the Institution of Gas Engineers withdrew support the Association and the Coke Oven Managers' Association provided a speaker on alternate years.

This arrangement continues to date because it is believed that the annual Joint Technical Meetings have provided a useful forum for the exchange of views between different branches of the coking industry.

#### Types of Research Undertaken

What kind of research was undertaken following the formation of B.C.R.A. in 1944 until the late 1950s? The following research projects are given to indicate the way events progressed and the list should be regarded only as a sample of the type of work undertaken.

One of the first reports, produced in 1946, dealt with the testing of coal for coke making and another report concerned methods for the float and sink analysis of coal. By 1949 rapid determination of the forms of sulphur and chlorine in coal started to attract attention and in 1956 a recommended method for the determination of naphthalene in coke oven gas was proposed.

Other work included the measurement of coke yield at coking plants, the determination of the screen size of coke, the production, properties and use of coke breeze from coking plants, and the specification, determination and testing of grades of coke. Practical plant problems were considered, including improvements to working conditions on coke oven batteries and recommendations with respect to self sealing doors, door assemblies and door handling equipment.

The Research Association provided a suitable environment in which to attract graduates who were interested in all aspects



of coal carbonisation so that considerable impetus was given to the otherwise near non-existent academic standard at production units.

#### Modern Research Investment

Early in the 1970s there was an awareness that the 10 ton oven was not able to assist the investigations into coal carbonisation in the most beneficial way because since its installation in 1958 the demands of the industry had changed.

Following negotiations between the British Carbonisation Research Association, the N.C.B. and B.S.C. a new 17 tonne oven was built at the Research Centre. The chamber height was to be 6.5m making it taller than any industrial oven in the U.K. The total cost of £1.5m was to be borne by B.S.C. and N.C.B. The oven was officially accepted at an inaugural ceremony carried out at the Research Centre by Eric Varley, Secretary of State for Industry on 23rd April 1976. (24) Unfortunately research lagged behind practice so that by the time the oven was built there were similar, if not larger ovens working at commercial plants in Germany and America. Was the construction of this oven worthwhile? Perhaps the answer lies in the fact that when finance for research became hard to find early in the 1980s the oven had to be closed down to enable the smaller ovens to continue in operation.

In March 1974 B.S.C. had agreed to finance the installation of a Cerchar preheater and the Coaltek pipeline charging facilities for both the existing 10 tonne and the new 17 tonne oven. The result was an up-dating of the full scale research

equipment at the centre, the magnitude of which had never been seen before. Pipeline charging is referred to in the section describing Brookhouse Coking Plant.

#### Modern Function of the Association

The Carbonization Research Association, like other institutions serving, or served by industry has had to adapt to changing circumstances. Towards the end of the 1960s the research associations serving the coal industry were re-examined with the result that the British Coal Utilization Research Association (B.C.U.R.A.) had the main functions transferred to the Central Research Establishment (C.R.E.) of the N.C.B. and the Electricity Research Authority and was itself closed down. The Coal Tar Research Association (C.T.R.A.) had functioned for many years at Gomersall, Leeds, where it produced much fundamental information but very few applied results. As an integral part of an overall scheme to reduce the amount the coal industry was spending on research, because it was itself contracting, C.T.R.A. at Gomersall closed. In 1974 a few of the staff transferred to B.C.R.A. at Chesterfield where relatively small tar research laboratories were set up.

The net result is that the British Carbonization Research Association became the co-operative research organization of the carbonization industries in the United Kingdom. It continues to be financed by levies on the Ordinary Members, by subscriptions from Associate Members and also by contract research from other sources including the Chief Scientist's Requirements Board of the Department of Industry and the European Coal and Steel Community. (25) The organization of the Association has been developed to deal with all aspects of the research work and to control the various



facilities by which this work is carried out. The internal activities of the Carbonization Research Centre are organised as shown in figure 2.

The following section shows how traditional applied research at plants continued to receive stimulus in parallel with research carried out by B.C.R.A.

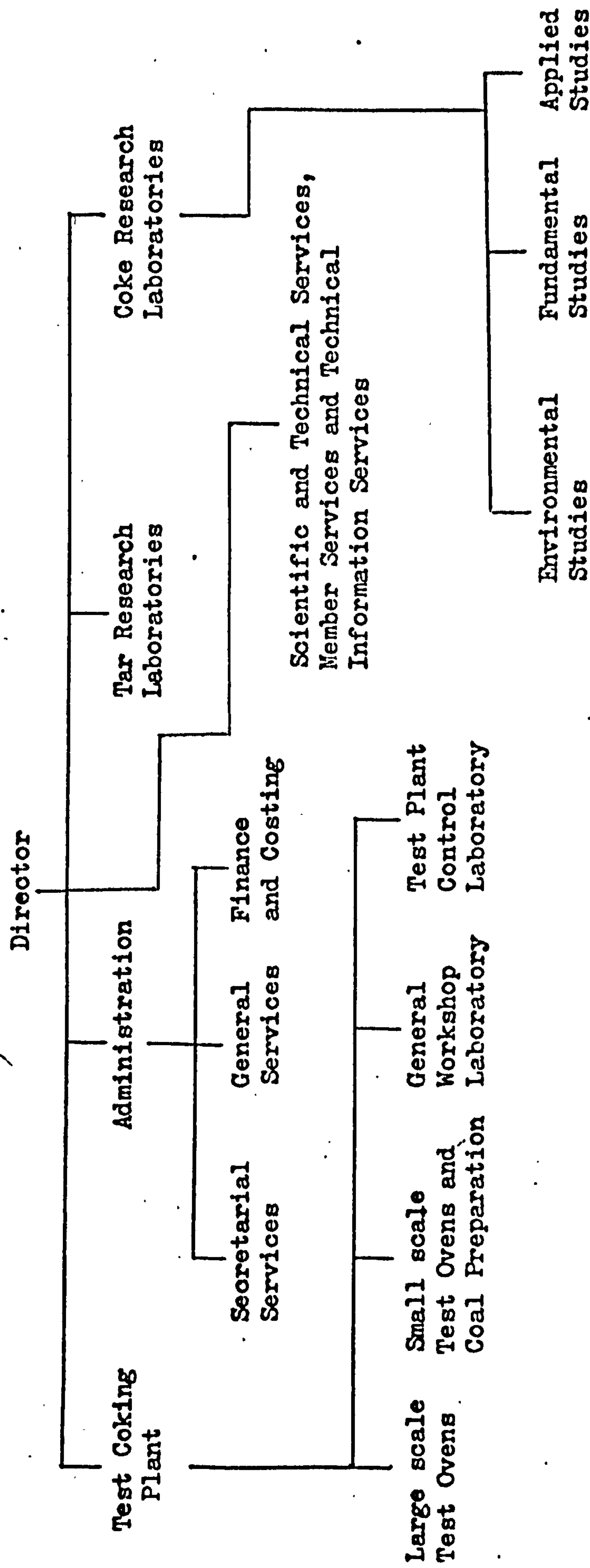
#### Applied Research in the Coking Industry after Nationalisation. (27)

##### (a) Smokeless Fuel Production.

The British Carbonization Research Association and the Central Research Establishment of the National Coal Board had much of the responsibility for the long term research in the industry. Coke oven managers had a tradition of being entrepreneurs and this attitude continued in the 1950s and 1960s. Even though B.C.R.A. had several different size ovens built specifically for research investigations the N.C.B. acquired a 9 inch wide test oven as part of the assets resulting from the nationalisation of Smithywood Coking Plant and they were prepared to carry on using it. One typical investigation in the late 1950s involved the determination of carbonization conditions necessary to produce a smokeless fuel capable of ignition with paper and sticks. Such specific research is revealing insofar as the precise qualities of an easily ignitable solid smokeless fuel had been ignored for the previous half century. Why was this so and why had it been decided to attempt a solution to this problem at this stage? The answer to the first question lies in the fact that it had become accepted that oven coke was difficult to ignite on a domestic grate so its use had to be confined to central heating systems used in large public buildings such as schools and hospitals. It is not surprising

**FIGURE 2**

**Internal Activities of the Carbonization  
Research Centre. (26)**





that demand for domestic coke should be minimal when coal was apparently much more suitable and readily available. Moreover the supply of domestic size coke was in keeping with the demand by local authorities.

The supply and demand situation for coke nuts in the late 1950s started to change dramatically. Coke producers had been content to meet the lucrative blast furnace coke market and then satisfy the foundry market before meeting the needs of local authorities. An expansion and modernisation of the coking plants vested in the British Steel Corporation left the N.C.B. with plenty of coking plant capacity and a decreasing share of the blast furnace coke market. Bearing in mind that coke ovens came into being to provide an outlet for the otherwise unwanted small coking coal produced by the collieries a fresh outlet for coke had to be found. The vast domestic market was a logical solution at a time when the public were becoming increasingly aware of the need to reduce atmospheric pollution. With this in mind two problems had to be tackled, the first was to produce better fuel and the second was to produce improved coke burning appliances. Hence the small test oven at Smithywood was brought back into use and played a part in a research programme involving small scale and full scale solid smokeless fuel production.

Before leaving the subject of this particular test oven the reason for it being built at Smithywood some time before World War II needs looking at. In the 1930s the company engaged a junior chemist, G.R.H. Stancey who later developed an interest in applied studies concerning coke production and utilisation as well as by-product recovery. Like his contemporaries Stancey studied part-time at Sheffield University but didn't enter a

degree course. He was content to use his new found technical knowledge as well as his personal skills to become Chief Foreman and then Assistant to the Plant Manager. (28) It is certain that Stancey was instrumental in having the test oven built originally as well as being responsible for its' revival in the 1950s.

Nunnery Handsworth Coking Plant was selected for the first full scale trials to produce reactive solid smokeless fuel early in 1959 for three reasons, the first reason, albeit perhaps the least important was the fact that it was originally built to produce smokeless fuel and had ovens only 14 inches wide. This is referred to in more detail in chapter VII. The second and probably the most significant reason is attributable to the plant being in poor condition and scheduled to be closed; any structural damage to the ovens caused by the experiments would therefore be of little consequence. The last reason was that the nature of the trials involved the emission of what can be described as gross atmospheric pollution at a time when coking plants were fast becoming unacceptable neighbours. Once again morals were ignored in the face of financial reality and so the plant was chosen because it was located furthest away from a populated neighbourhood. Short carbonising time was of the essence using a very clean coal from the Darfield Winter Seam and transported some twenty miles by road. The results were encouraging and other tests with lower flue temperatures were carried out later that year.

Other experiments were carried out also in 1959 at Cortonwood coking plant because that was much nearer to the



source of the Darfield washed smalls and it had almost all the advantages already mentioned in respect of Nunnery Handsworth. (29) In fact the only difference was that Cortonwood plant had 18 inch wide ovens. (30) By now there was an awareness that if the experiments developed on a commercial scale the *local authority* would condemn them as contravention of the Clean Air Act. Attempts to reduce atmospheric pollution were made by reintroducing the Darby quencher technique abandoned half a century ago. Because the number of ovens had increased so that the frequency of charging and discharging had increased the revival of the Darby quencher was unrealistic and the experiments were terminated.

The situation was looked at realistically and an answer sought by quenching coke produced by carbonising Darfield Washed Smalls for the normal time with a dilute solution of sodium carbonate. Several concentrations were tried and the optimum found which would give best reactivity with least loss. Unfortunately even the smallest loss of sodium carbonate was unacceptable to the Alkali Inspectorate. The only alternative solution to the problem was considered after taking advice. (31) Since Cortonwood Coking Plant was reaching the end of its working life any attack by the soda ash on the oven walls would not be too serious. The addition of dry soda ash to the coal charge before carbonisation increased the reactivity of the resultant coke.

Partly as a result of the research carried out at Cortonwood and partly as a result of similar research at Grassmoor coking plant in the neighbouring East Midlands Region, a new solid smokeless fuel was launched under the trade name 'Warmco'.

The N.C.B. were desperate to capture what they saw as a vast potential domestic fuel market and in their haste insufficient attention was paid to the snags with such a fuel. Grassmoor coking plant went onto full scale production to meet demand in the Home Counties before sufficient attention had been paid to the variable quality and the 'spitting' characteristics. The fuel was expensive and customer sensitivity towards value for money had been underestimated; as a result response to Warmco was mixed. Coincidentally attitudes towards domestic heating changed and central heating installations increased at a meteoric rate. It so happened that at this time, and perhaps as a result of enforced wartime conditions a decade earlier, the public were searching for convenience as well as value for money and this had impact on the central heating market. Traditional methods and values were questioned with the result that new solid fuel central heating installations took a poor third place to gas and electricity. Some of the solid fuel installations were re-converted later to more convenient alternative fuels. The solid fuel market never really became widely accepted and the blame can be placed in three directions. The potential of solid smokeless fuel as a growth market ought to have been foreseen many years earlier when traditional attitudes towards open fires predominated. The research into producing smokeless fuel was carried out far too speedily and inadequately. Technical aspects of the transition from research quantities to full scale production received insufficient attention because of the urgency to enter the market at the earliest possible time. Finally, considering the fuel was only coke with a low ash content and containing up to 2 per cent soda ash, the retail price was too high and caused



customers to look critically at features which might otherwise have attracted less attention for a while. In ~~that~~ case the industry would have gained respite but it could not have avoided the ultimate decline in the domestic solid fuel market.

(b) Underfiring with Methane.

Applied research was also carried out into the adaptation of methane drainage for underfiring coke oven batteries. The advent of large underground reorganisation and the use of rapid mining techniques drew attention to the necessity to remove methane from the coal face in advance of the coal being mined. Methane drainage came into being and by linking several South Yorkshire collieries into an eleven mile long methane grid sufficient methane was available in a quality which enabled some of the batteries at Manvers to be underfired with it. (32) After the scheme had become operational it was decided to compare the combustion characteristics of this gas with coke oven gas and producer gas. Hitherto the only similar experience had been gained with a Koppers plant in America and much more recently at Coedely in South Wales. The implications of underfiring the ovens at Manvers with methane were examined in depth in 1963.

(c) Artificial Fertiliser Production

Another important area of full scale applied research involved the production of ammonium phosphate at two technically different plants from 1960 - 1963. (33) For a long while there had been concern at the lack of remuneration from the production of ammonium sulphate as an integral part of the coking process.

Whether ammonia was recovered directly or indirectly mattered little and the profitability depended greatly on the price of sulphuric acid and this in turn depended on the world supply of sulphur. There seemed no hope of a decrease in the price of acid long term and so the traditional utilization of ammonia was brought into focus. Another influential factor was the proposed examination of the British Sulphate of Ammonia Federation by the Restrictive Trade Practices Court.

Ammonium phosphate already being made in America was considered worthwhile at a British coking plant even though the technical aspects of the methods of ammonia recovery were quite different. There are inherent dangers in operating a coking plant and one of them is a failure of the gas flow round the by-product plant because of a blockage. It was therefore thought prudent to attempt to produce ammonium phosphate crystals at an indirect plant even though the losses were expected to be high. Rotherham Main Coking Plant was selected for the experiments. (34) The existing ammonia plant was modified by the addition of extra storage tanks and new instrumentation. Negotiations took place with Albright and Wilson of Oldbury, the only firm able to supply reprocessed phosphoric acid. Even this acid was some eight times more expensive than the corresponding sulphuric acid but di-ammonium phosphate was expected to realise ten times more than ammonium sulphate on a weight basis. After carrying out initial experiments with some success the plant operators were trained and full scale production of di-ammonium phosphate crystals or a solution containing a mixture of mono- and di- salts began. Unsurmountable technical problems caused a high ammonia slip but otherwise the process was satisfactory.



As knowledge and confidence with the venture grew it became apparent that ammonia slip would be much less on a semi-direct plant but would the semi-direct process work? Once more the desire to maximise financial return proved to be a compelling force and Cortonwood was selected for the experiments because it had a semi-direct plant and if a mishap occurred to the small gas supply from the plant the deficit to the East Midlands Gas Board could easily be made up by increased supplies from other coking plants. This did not mitigate the dangers of an accident but it reduced the impact, so that ammonia plant was duly modified and a series of experiments to produce di-ammonium phosphate crystals was undertaken. (35)

Again the research was successful and di-ammonium phosphate crystals were produced although, like Rotherham Main, a solution of mono- and di- salts also resulted. Like Rotherham Main the operators were trained in the new techniques and the plant brought onto full production.

Meanwhile demand for the product increased and in order to satisfy the market Rotherham Main started D.A.P. production again even though the ammonia slip was unavoidably high. In view of the technical success at two different coking plants, both of which were small and high demand for the product whether it be the di salt or a mixture of mono- and di-salts in solution, Manvers Coking Plant was converted to the process. After a few years the supply of acid became more difficult, the price increased and the supplier wanted to substitute a higher grade acid which was even more expensive. The net result was that the process became financially unattractive and it was unlikely to change so that conventional ammonium

sulphate production was resumed. The venture into producing another fertilizer was at an end.

Since so much applied research was carried out at coking plants, particularly after nationalisation the next section has been included to show some of the educational shortcomings in the industry and the steps taken to overcome them. Education, training and quality of research are closely inter-related.

### Education and Training in Context

#### (a) Importance of Education

Whatever philosophers may say about education the following are the traditional requirements for employees in the coking industry:-

- (1) an ability to read, write and calculate.
- (2) the working skills of craftsmen and mechanics.
- (3) the engineer's combination of scientific principle and applied training.
- (4) high level scientific knowledge, both theoretical and applied.

Item (1) is difficult to evaluate because the relationship between primary education and industrial efficiency is both complex and obscure. The more obvious connections are probably the least important. Thus, although certain workers - particularly supervisory and office personnel, must be able to read and do elementary arithmetical operations in order to carry out their duties, a large share of the work in any industry can be carried out by illiterates. Most of the tasks in the early days of the Industrial Revolution were performed by illiterates and the same can be said about early coalmining and coke production. It is probable that the most important economic advantages of an



extensive and well run system of compulsory elementary education lie in the foundation it provides for more advanced work. A second, and possibly slightly less important advantage was its tendency to facilitate and stimulate mobility and to promote thereby a selection of talent to fit the needs of the society. The effect was to help optimise the allocation of human resources.

It is one thing to point out the significance of this mechanism and another to measure its effectiveness. There aren't any empirical studies of the relationships between education and selection, and between selection and industrial performance for the period around the turn of the century. There are only qualitative observations and data of a general nature on the length and generality of schooling and some percentages of literacy. The rest of the picture is necessarily obtained by inference.

Even as late as the last decade of the nineteenth century schooling was left to the zeal, indifference, or exploitation of private enterprise. Why did this state of affairs exist for so long? Notwithstanding the fact that Britain had pioneered the Industrial Revolution with abysmal education standards, there were several 'practical' men who believed that instruction was superfluous for farm workers and industrial workers alike. There were idealists who saw education as the salvation of an enlightened citizenry but they weren't sufficiently vociferous to shake the nation out of complacency. It was not until 1870 that local boards were empowered to draft by-laws of compulsory attendance and not until 1880 was primary education compulsory.

Although the picture of education in the late nineteenth century is generally very poor there are some bright spots, some elementary and grammar schools provided instruction to rich and poor scholars alike. (36)

The link between formal, vocational, technical, and scientific education and industrial progress is fairly evident and it became more so as the nineteenth century progressed; due to the greater complexity and precision of manufacturing equipment, as well as improved quality control. The askania regulator typifies quality control as it existed at Rotherham Main and other coking plants. There was also a growing awareness of the financial advantages of increased efficiency and the pressure of competition, Rotherham Main is quoted as an outstanding example of efficiency at its best within the limits of knowledge pertaining at the time. Another factor was the high cost of equipment which made on the job training increasingly expensive and helped to break down an apprenticeship system that had long been moribund. The third factor was the changed scientific content of technology<sup>which</sup> compelled supervisory employees and even workers to familiarize themselves with new concepts. This enhanced the value of personnel trained to keep abreast of scientific novelty, appreciate its economic significance and adapt it to the needs of production.

Technical training, like primary education, had been left to private enterprise and led to a most uneven and inadequate provision of facilities which are typified in Rotherham and the surrounding district. (37) London University was young by the middle of the nineteenth century and apart from mechanics' institutes with wide ranging qualities, and a few evening



classes and some courses in basic science in a few progressive schools there was nothing. Thereafter improvements came slowly. (38) Technical and vocational training waited another generation before becoming respectable.

The attitude of John Brown and Company<sup>u</sup> contrasted with that of employers earlier in the nineteenth century when even elementary education encountered suspicion and resistance. Some industrialists feared it would lead to the disclosure of or diminish the value of trade secrets. Many felt 'book learning' was misleading and instilled into the reader an exaggerated sense of their own merit and intelligence. Management's view was supported by foremen and master craftsmen who were themselves products of on-the-job apprenticeship and despised, feared and resented the skills and knowledge of the school trained technician. Other employers could not see the wisdom in spending money on anything that did not yield an immediate return; the situation became aggravated by notions imparted by institutions almost always called for new capital outlay.

In conclusion it must be emphasised that job and promotion opportunities for graduates in science and technology were few and unattractive. The most remunerative field was chemistry<sup>r</sup> and even there the best positions were often reserved for men trained abroad. There was virtually nothing for physicists until the last decade of the nineteenth century. The situation was worse in the lower ranks where many workmen were disposed to attach too little value to the importance of acquiring knowledge of the principles of science because they failed to see their application. (39) It is not surprising that the most

talented of those few young men who had the means to pursue their education beyond intermediate level followed the traditional liberal curriculum to careers in the civil service.

(b) Education in the Coking Industry.

Education has formed an important part of the Coke Oven Managers' Association almost since its formation in 1915. (40) During the formative years the educational activities were largely involved with the close liaison with the City and Guilds of London Institute, mostly in the form of classes and examinations in coal processing held on behalf of that Institute. City and Guilds certificates in this subject were for many years the accepted qualifications for membership of the Association. Although coal processing is no longer a subject for examination, certificates in other subjects may still be cited in applications for membership.

In 1945 the Coke Oven Managers' Association co-operated with the British Coking Industry Association regarding the training of process workers in the industry and as a result an education sub-committee was formed later that year under the chairmanship of Mr. (later Sir William) Robson-Brown. (41) As a result of a survey in 1946-47 by the Education Committee of the Coke Oven Managers' Association into the facilities available to young technical men in the industry and of potential candidates, the B.C.I.A. education sub-committee was augmented by representatives from C.O.M.A., the N.C.B. and B.I.S.F. The N.C.B. inherited virtually half of the coking plants from private ownership but from the outset the new national body associated itself with the Committee.



Early discussions of the education sub-committee inevitably turned towards university education and by March 1949 a university scholarship scheme was evolved. (42) By this time the Committee became known as the Scholarship 'Education Sub-Committee' but by the end of that year and until 1966 it was known as the 'Education Committee' and was directly responsible to the Executive Committee of the B.C.I.A. Eleven scholars were selected and entered university in 1949. A pattern was established whereby each university student was allocated a 'mentor' from the membership of the Coke Oven Managers' Association with whom he would meet from time to time during his course and from whom he would receive guidance on matters concerning his progress and well-being. The idea was good but reality was often quite different. Could the mentor appreciate the undergraduate's point of view when he probably never received much higher education? Some mentors tried hard though others were less inclined to deviate from traditional methods of training.

The first meeting of all the students and the Education Committee, held in the Royal Victoria Hotel, Sheffield in 1950 was spread over three days. Afterwards came the annual summer schools which enabled the students to meet one another and meet officials, the Committee and mentors and to receive addresses from people of eminence in all walks of life. Students were expected to take up vocational employment at coking plants as part of their training and to undergo post-graduate directed practical training. This system, established in 1949 continued until 1971.

Another feature established in the early days and which continued until 1970 was the series of residential management courses held at Brooklands County Technical College, Weybridge, Surrey. The course was designed for candidates who had not been able to gain entrance to a university and up to 15 students attended the first annual course in 1952 which lasted 13 weeks. Later courses were shortened to 10 weeks. The early courses contained much technical material but emphasis was subsequently channelled towards management.

The pattern of activity continued unchanged until 1966 when arrangements were in hand for the disbandment of B.C.I.A. In order to continue the work of the Education Committee during this period the Coking Industry Education Trust was formed as an educational charity supported with finance from the former members to pay the Trust each year sums of money proportional to their coke production and the N.C.B. agreed to pay on a similar basis.

Minor changes to the structure of the Trust followed in 1968 as a result of the closure of B.I.S.F. and the formation of the British Steel Corporation a year earlier.

During the period covered by these schemes 1949-1971, 83 university scholarships were awarded and 374 students attended the 19 courses at Brooklands County Technical College at Weybridge. There were few scholars who failed their university course and of the total who graduated 46 entered the industry and worked for varying periods, 24 were in the industry in 1971 and 8 were lecturing at universities or technical colleges. This contrasts with the figures reported up to 1964 when the



total number of graduates was 53 and the number lost to the industry was 18. (43)

It was evident when the Trust took over that the losses were increasing and from 1966 to 1968 there were nine graduates but only one entered the coking industry. The Management Committee responded to the situation by examining the method of selection and the possibility of binding the students legally on entry. Since this education scheme had come into being the number of industrial grants available to students had increased markedly and the attitude of students was to search for the best paying free university education. Under the circumstances it seemed unlikely that many students would be prepared to show loyalty to those who paid their grants. The situation was aggravated by the fact that candidates with sufficient 'A' level passes in the G.C.E. examinations not only had a place at a university but entitlement to a local education authority grant subject only to a means test. Industrial grants became an accepted way round this limitation and were regarded primarily in this light. Examination of the list of B.C.I.A. scholars and those of the Trust shows that many had parents holding senior positions in the industry. (44)

Introduction of the Industrial Training Act of 1964 influenced the Weybridge courses. Both the N.C.B. and B.S.C. had set up their own training schemes and they found it progressively more difficult to release staff to attend the college at Weybridge. It was generally accepted that the coking industry courses, which were pioneers in the field had been largely copied by other industries. As a result the N.C.B. and B.S.C. entered their last students for the Weybridge course in 1970.

The Management Committee was compelled to wind up the Trust in 1970 even though the seven year covenants, which were binding in law, had three years to run. Following legal advice the trustees asked the Department of Education and Science to devise a method whereby the Trust could be wound up. The Department prepared a scheme whereby no more covenanted money was collected and administration of the grants of students currently at university would pass on closure to B.C.R.A. along with any balance of funds. The scheme was accepted by the trustees and after meeting the legal requirements with respect to advertising the C.I.E.T. was terminated on 31st December 1971.

(c) Training in the Coking Industry

When Coal Products Division became established as a separate business entity from the N.C.B. on 1st January 1963 training for coke oven employees was minimal. The only training which did exist concerned an apprenticeship scheme for mechanics and electricians, some ad hoc induction training at a small number of plants and *employers were occasionally sent* to N.C.B. or external courses. In addition the City and Guilds Coal Processing Course for coke oven operators had been discontinued, <sup>as</sup> this valuable qualification early in the century lost much of its significance later in competition from alternative courses. Other aspects of training are referred to in chapter VI describing Rotherham Main.

In view of the fact that so little training had been carried out in the coking industry from its inception until Nationalisation in 1947 and on to the formation of Coal



Products Division it is reasonable to pose the question - why train?

Industry needs an efficient work force. The size and complexity of industrial processes complicate work patterns and relationships and there can be less reliance these days on a stable source of manpower with traditional skills. Furthermore the rate of technological change is such that men can be expected to change their trade or at least their method of working in a trade several times in the course of a working life. Training has a significant contribution to make in meeting this situation.

The coking, chemical and iron and steel industries are complex organisations and as such have relationships with others within the structure of the firm. Individual and corporate attitudes stem from the working atmosphere and can act either as an impediment to the achievement of basic goals of the organisation or can be harnessed to make an effective contribution in a combined effort. Training should be geared to the achievement of individual job satisfaction which can give each worker a feeling of dignity arising from a knowledge of the worth of his job. At the same time the training function can and should be utilized and directed by management towards achieving the objectives of the organisation and so contribute to improved efficiency and profitability.

How does this view of the training function compare with the approach of many companies in the 1950s and early 1960s. It is true to say that until fairly recently few firms made any attempt to train their workers. Apart from apprenticeship with its own special traditions the main training system was one

whereby the new employee or a worker moved to a new department was expected to pick up the job by watching an experienced worker. This practice, which has been nick-named 'sitting next to Nellie' depended entirely on the ability and conscientiousness of the 'old hand'. When these were of a high order it worked; but there could be no guarantee of good results - 'Nellie' might have been lacking in competence or, more likely, lacking in the ability to pass on skills or know-how. As a result practices which varied from adequate to downright bad were passed on. The time for planned training to meet standards set by management was long overdue.

What types of training were introduced or developed by Coal Products Division? Training courses for all industrial entrants were established, after consultation with the trade unions, throughout Coal Products Division from January 1966. The induction consisted of two parts; a conducted tour of the plant on the new workers first day, and a formal two-day introductory course soon afterwards at a N.C.B. training centre. Each entrant is given a booklet which describes the basic things he needs to know about his work. The formal initial course covers such subjects as the organisation of Coal Products Division, the place of trade unions and an elementary treatment of consultative and conciliation procedures, and a knowledge of wages and conditions of service. A brief description of the processes, the products and their uses together with the importance of quality control, is also given. (45) Emphasis is placed on safety with special reference to operational hazards and the precautions necessary to deal with them, together with a simple treatment of first aid, fire precautions, health, hygiene and human kinetics.



Training for process workers has been developed in stages. The need to fill the gap caused by the discontinuation of the City and Guilds course in coal processing was apparent. An outlet by way of training and education for workmen with initiative had to be provided. With the help of production and technical staff regionally organised operations courses lasting a minimum of 50 hours and run on a day or block release basis were organised for potential foremen, key operatives and able young workers. Subjects covered include the history of coking, coal and its importance in coke production, coke ovens and their construction, heating, operation and repair, the carbonisation process preparation of coke for market, gas flow through the by product plant, plant services, safety aspects etc. The author was included in the team of management and technical staff which prepared the notes on these subjects. He was then involved in delivering the technical lectures at these courses. There soon became an awareness that there was far too much material for the time available and each of the three regions changed the structure and duration of the courses. The Midlands Region held the course on a day release basis at Doncaster Institute of Higher Education starting in 1973. The idea was that staff at the College would take over the course and Coal Products Division would pay the normal enrolment fee. In the event Doncaster College of Technology lacked expertise to deal with the technical aspects of the coking industry and requested help from Midlands Region of Coal Products Division. As a result the author was seconded to the College to re-write all the lecture notes and deliver the revised and greatly expanded lectures on technical subjects relating to the coking industry.

Early in 1966 the N.C.B. agreed with the N.U.M. that the term of apprenticeship for fitters and electricians should be reduced from five to four years in keeping with the length of apprenticeship generally in industry. In order to maintain and improve standards of craftsmen certain major changes were introduced at the same time. Revised syllabuses of training were to contain more detailed guidance on the content of training with a final test of competence at the end of four years. Formal instruction courses were to be introduced in the second, third and final year of apprenticeship. The course was re-modelled again in the 1970s when Colleges of Further Education took over much of the training.

Craft apprenticeship schemes had existed for many years but the following additional schemes were introduced in the 1970s to bring young people into the industry:-

Junior process trainees (J.P.T.) scheme 1971;

Junior administration trainees (J.A.T.) scheme in 1971; and

Junior laboratory trainees (J.L.T.) scheme in 1975.

The J.P.T. scheme is an ideal method of providing training operators on a coking plant. Initially the scheme comprised a rigid two year course of practical plant training coupled with day release to attend Doncaster College of Technology (later Doncaster Institute of Higher Education) for basic instruction in related science and mathematics topics. Later the scheme was modified so that as soon as the junior trainee reaches the age of 18 years his training is complete and he becomes available as a process operator.

The J.P.T. scheme has been the object of much criticism from management, mainly due to the type of person recruited



initially. There were, for instance, trainees who either left during their training or shortly after they had completed training. Before the scheme was amended so that training was completed on reaching the age of 18 years some of the J.P.Ts were almost 19 years old before training was completed. Again, initially, the standard of supervision was not good enough and the trainees tended to become uninterested. These problems have been resolved so that a wealth of trained operators has resulted, but perhaps more important, some of them have emerged through the ranks to become foremen.

It is every coke oven manager's dream to have fully versatile, fully interchangeable operators and a J.P.T. type training scheme could eventually bring this about. The arguable question is - can the industry afford the cost?

Coal Products Division regarded the training of supervisors as a priority need since 1965 because the industry was so dependent on them for day to day control of the plants. It became necessary to establish supervisors as the first line of management so they were required to attend an intensive residential course. The courses were necessarily general in nature though they covered much the same subject material used for the operatives but at a higher level. Though much emphasis was placed on the management role of supervisors the N.C.B. failed to recognise their importance of increasing wages for some years to come. The result was that for many years good process workers were reluctant to become supervisors because of the poor wages. Foremen's posts were often filled by people who were unwilling or unable to earn high overtime payment as operatives.

A series of management courses were started in 1967 at the N.C.B. Staff College in an attempt to improve communications and to keep business objectives to the fore. The courses were well received in the early stages but enthusiasm declined when it was realised they contained insufficient new material acceptable to coking plant managers and other senior staff. In some ways, this reflected directly on the fact that senior positions had been filled mainly with people who had progressed from the ranks. They lacked academic qualifications and their attitude of mind was synonymous with that.

Eventually there came an awareness of the necessity to provide, within a career development framework, an influx of competent administrators, engineers and technologists into the middle and higher levels of the management structure. One result was that a training scheme for chemical engineers, whereby selected graduates received a two year period of planned training and experience commenced in 1966, following approval by the Institution of Chemical Engineers as suitable experience leading to Associate Membership. There was a marked time lag between the Mining Divisions and the Carbonisation Section in respect of training. (46) Traditional lack of directed practical training for young qualified people predominated long after an awakening to it by the Mining Divisions, showing how far apart these two sections had grown. Mining coal and coal carbonising have always attracted two quite distinct types of people who never clearly understood, or even wanted to know each other's problems. The Carbonisation Section did not awaken to the need for improved yields, improved quality



and improved efficiency until the era of an expansionist coking industry had passed and cost effectiveness gained popularity. Perhaps one reason for the delay was the long standing problem that, for technical reasons, coke production is inefficient. The resultant product of coal carbonisation is coke and while ever the iron industry expanded and the coke requirement on a ton/ton basis did not look like falling too much blast furnace quality coke attracted a high price.

Careful arrangements were introduced for the control and supervision of each person's training. Central to this was a mentor system whereby an individual trainee was put under the wing of a qualified chemical engineer or other senior person whose function was to act as the trainee's adviser in personal, career and technical matters and to encourage his development both in the organisation's and his own best interests. This formidable duty for senior staff was a reversion to 'sitting next to Nellie', the only difference being that 'Nellie' was deliberately selected from a senior position. Nevertheless far too much was expected from the mentors with the result that some tried hard to meet the objectives while others simply paid lip service to the system. In fact there were very few chemical engineers and still less in senior positions so that 'Nellie', in the time honoured tradition, lacked expertise which the young graduate had come to expect from his days at University.

A scholarship scheme, under which Coal Products Division offered a number of supplementary grants of £100 per year to chemical engineering students at Universities was used to produce some of the intake to the training scheme. The mentor was responsible for each scholar with whom contact was maintained by means of visits.

In 1969 Coal Products Division introduced a Student Apprenticeship Scheme for chemical, mechanical and electrical engineers designed to provide the organisation with an adequate supply of competent engineers and managers at the lower level. The intention was to fill the gap in career progression between supervisor level and plant managers and its introduction should have provided for better use of manpower at the technician and junior management level, if only because of provision for more interchange between the laboratory and the plant. The Student Apprenticeship Scheme put forward was virtually a revival of the traditional method of progression in the coking industry, the objective being to raise the quality of the men available for posts at this level. Student apprenticeships should have lasted four years but because they included an educational course leading to the Higher National Certificate or Higher National Diploma they could be extended up to five years, depending on the type of technical college course taken. The aim was to provide a sound basis in the particular specialism combined with experience in process plant operations. On successful completion trainees would be expected to move into supervisory posts and thereafter into junior management and engineering positions. A small proportion were expected to be good enough to move onto a shortened scheme of graduate training. Similar supervision and control arrangements would apply to student apprentices as already existed for graduates.

In addition to these schemes, which were intended to provide a significant and increasing proportion of future technicians and technologists, Coal Products Division also evolved a training scheme to provide for junior management posts



in the administrative departments. Selected graduates with potential for attaining positions at the highest level were to be given intensive training and experience over an 18 month period in the fields of marketing, administration, personnel and finance.

All the training schemes were a welcome attempt to keep the coking industry up to date and efficient and they acknowledged some of the past shortcomings. In the event a decline in the industry meant that some schemes were still-born and others died early because vacancies had to be filled with people from closed down plants. Also, graduates were able to anticipate the decline of the industry and they looked for employment elsewhere. The low level courses - Junior Process Trainees, Operatives and Apprenticeships have remained intact and provide valuable education and training for the workforce.

Training, education, and applied research at plant level have become more sophisticated with the passage of time but even before the 1920s when training and education in the coking industry were minimal, a need for co-operation on technical matters existed. The following section describes one form of co-operation which has served the industry well for more than sixty years.

#### The Coke Oven Managers' Association

As soon as the industry began to develop from an art into a science the need for an association of those engaged on technical aspects of the industry emerged. The need gained momentum for a few years until the fact that many associations

of men engaged in other industries were able to derive assistance and enjoy social relationships hitherto out of reach of coke oven managers, decided a few managers to attempt to inaugurate such an Association. At the same time there was increasing awareness of the growing importance of the coking industry.

Accordingly a meeting was held at the Grand Hotel, Sheffield, on 12th June 1915 and twenty one coke oven managers attended. (47) It was decided at that meeting that an association should be formed having the following objectives:-

- (1) To advance the interests of the coking and by-product recovery industry in all or any of its branches.
- (2) To facilitate the exchange of information and ideas among its members.
- (3) To promote or defend the interests of the coking industry.
- (4) To improve the standard and methods of education in applied science and chemical engineering to ensure that suitable men should be available for the industry.

These objectives are worthy of <sup>examination</sup> to see if they set the Association on the right course and whether they have remained valid throughout its life. They illustrate dynamism which existed in the industry in its own right and also in the context that, in the main, jobs were difficult to obtain and poverty was commonplace. Although the fortunes of the British economy have fluctuated the 1920s and 1930s were generally depressing. The first objective was ideal for an industry which was young in



respect of waste-heat slot type ovens. By-product ovens did not gain popularity until later but there was clear anticipation that by-product recovery would grow from the almost incidental recovery in 1915-20. This objective embraced the concept of the industry creating a market as well as meeting a need. Chapter III describing the growth of the gas industry gives further details.

The second objective was also appropriate and demonstrates an awareness of the fact that the exchange of information and ideas was sporadic. Perhaps the fear of competition reduced some of the incentive to propagate as a natural follow up to the initiation of ideas. From the earliest days the Association has succeeded most with this objective. Chapter VI describing Rotherham Main Coking Plant shows that by 1930 many of the fears from internal competition had been overcome.

The first and third objectives are allied but in the latter there is a hint that the industry sometimes met resistance for its own sake. One example is the innate conservatism of the ironmasters regarding their unwillingness to change from beehive oven coke to coke produced in slot-type ovens.

The final objective shows foresight soon after the turn of the nineteenth century and it has traditionally remained high on the Association's priorities. Perhaps the Association could have done more to fulfil the objective if more resources had been allocated for the purpose. It was not until after the Nationalisation of the Coal Industry that any major attempt was made to improve the standard of education and to ensure a supply of suitable men for important posts in the industry.

There is a feeling that in the intervening 40 years the industry tolerated sparse methods of training and the type of managers it produced because they were able to get results and keep the industry pointing in the right direction. How much more easily this would have happened with more and better qualified staff is indeterminable. Bearing in mind the large number of coking plants in this country in the 1920s (48) figure 3 indicates a shortage of graduates but, by comparison with other industries shown in figure 4 it was well off, especially as the analysis is necessarily confined to members of the Association. The definition of scientists and engineers adopted in figure 4 includes men who were not graduates but had equivalent qualifications by virtue of membership of certain professional institutions. If a similar definition is used in counting the 'graduates' recorded in the membership list of C.O.M.A. for 1956 a total of 203, which is 0.97 per cent of employees in the Industry is obtained.

The first Presidential Address of the Association was delivered by Mr. G.H. Crisp at the Grand Hotel, Sheffield, on 13th November 1915 (49) and the first dinner was held on 15th January the following year when the guest was Professor W.A. Bone of Imperial College. This is referred to in an earlier section describing B.C.R.A. The Association received a boost when it became recognised by the Ministry of Munitions on 25th March 1916 as representative of the British Coking Industry and this greatly encouraged those members responsible for the formative years. Expansion followed and sections for the North, South and Western Districts of England were soon formed.

Another boost came when the Right Honorable Lord Moulton, Director General of Explosive Supplies, Ministry of Munitions,



**FIGURE 3**

Number of Graduates who are members of C.O.M.A. (50)

(Excluding the Indian and Overseas Sections)

	1 9 3 8			1 9 6 3		
	Total	Graduates		Total	Graduates	
		Number	per cent		Number	per cent
<b>Class of membership</b>						
Honorary	19	11	58.0	16	10	62.6
Life	—	—	—	40	3	7.5
Members	118	11	9.3	181	60	33.2
Associate Members	220	17	7.7	226	27	11.9
Associates	29	1	3.4	55	8	14.5
Graduates	—	—	—	9	2	22.2
Students	8	—	—	14	—	—
<b>TOTAL</b>	<b>394</b>	<b>40</b>	<b>10.2</b>	<b>541</b>	<b>110</b>	<b>20.3</b>

In the 1963 list four members appear as both Honorary and Life Members. In this table they have been counted as Honorary Members only.

FIGURE 4

Proportion of Qualified Scientists and

Engineers in Industry in 1956. (51)

	Per cent
Atomic Energy Authority	10.9 (52)
Mineral Oil refining	5.2
Electrical authorities	2.9
Chemical and allied trades	2.7
Electrical engineering	2.0
Aircraft manufacture	1.9
Construction engineering	1.5
Gas Council and Area Boards	1.2
Non-ferrous metal manufacture	1.1
Rayon, nylon etc.	1.1
Other plant and machinery	1.0
Average for all industries	0.8



was the guest of honour at the annual dinner in 1917.

In his speech he spoke in glowing terms of the willing co-operation which the coke oven managers had shown in connection with supplies of toluene and other raw materials required for the war-time production of explosives.

One of the first occasions on which the Association was able to collaborate with other technical bodies and take its place among them was in 1919, when it was invited to appoint a representative on the Sub-Committee of the British Association Fuel Economy Committee. The year 1926 was marked by a wider acceptance of the importance of the Association. Lord Gainford, in his evidence before the Royal Commission on the Coal Industry a year earlier had referred to the Association as 'the representative body concerned with the technical development and research into matters affecting the manufacture of coke and by-products'. It was believed that closer co-operation with other technical associations would ensure that this view would become generally accepted with advantage to the Industry.

Arrangements were made to meet the Director of Fuel Research who had indicated that he would be prepared to co-operate with the Association and a representative Committee was instructed to meet him to discuss the possibility of co-operation. The same Committee also met a Committee of the Society of Chemical Industry which had recently formed a Fuel Section. The net result was the formation of a Joint Fuel Committee by the Society of Chemical Industry, the Institution of Gas Engineers and the Coke Oven Managers' Association. Later the recently formed Institute of Fuel joined the Committee.

About this time representatives of the Coke Oven Managers' Association were invited to serve on the World Power Conference and the Midland and Northern Coke Research Committees which were associated with Sheffield University and Armstrong College (later the University of Durham) respectively. The close relationship between C.O.M.A. and B.C.R.A. which succeeded the Midland and Northern Coke Research Committees, has continued to the mutual benefit of both Associations.

Some idea of the importance of the Association can be obtained from the fact that in 1928 it was invited to give evidence before the National Fuel and Power Committee. Afterwards and following the Committee's recommendation to the Government the Area Gas Supply Committee of the Board of Trade was formed for the purpose of considering the technical and economic aspects of an Area Gas Supply system. (53)

There had been a supply of coke oven gas to public undertakings since the turn of the century or soon afterwards and the Area Gas Supply Committee was largely responsible for the more general utilisation of coke oven gas for town's use, notably leading to the formation of the South Yorkshire Gas Grid. (54)

Another indicator was the fact that in 1930 the National Smoke Abatement Society invited the Association to help in promoting the use of solid fuel for domestic use. By 1931 representatives of the Fuel Research Station, the National Federation of Iron and Steel Manufacturers, the Midland and Northern Coke Research Committees and the Association had met to explore the possibilities of collaboration. One outcome was that a study of the use of oven coke was started at the Fuel



Research Station.

The Association has always actively promoted technical education. Early in its life it arranged for evening classes in coke and by-products to be organised under the auspices of the City and Guilds of London Institute. The Association also had representatives on the following educational bodies:-

Sir John Cass Technical Institute Advisory Committee.

City and Guilds Advisory Committee on Coke and  
By-Product Manufacture.

Mining and Fuel Committee of the University of Sheffield.

South Yorkshire Council of Further Education. (55)

Advisory Committee on Coke Ovens and By-products at  
Barnsley Mining and Technical College.

From these early beginnings it is worthwhile to examine the formula for expansion and survival adopted by the Association which has enabled it to remain as vigorous as ever. The affairs of the Association are managed by the President and a small Council elected annually by the members. There are now five Sections, viz: Northern, Midland, Southern, Indian and Overseas. (56) A programme of monthly technical meetings is arranged by each section for the period September to April at which a paper is presented for discussion and the Committee and Sectional business is conducted. One important feature is that the papers are practical rather than academic and aim to provide solutions to plant problems. (57) Papers are given by members who are frequently colleagues in research establishments (B.C.R.A. and the Coal Research Establishment (C.R.E.) at Stoke Orchard), supplemented by contributions from contractors to the

industry, many of whom are also members. In recent years overseas lecturers have been welcomed from Germany, Holland and Sweden.

One of the highlights of the Association has always been the Annual Dinner of the parent body in London in November. In 1951 the decision was taken to extend the programme to include a technical paper and the now familiar two-day meeting came into being. On the first occasion the meeting was held jointly with the Institution of Gas Engineers. These meetings also received support by the British Coke Research Association, now the British Carbonization Research Association; each organisation being responsible in turn for acting as host. These tripartite meetings continued until 1968 when the Institution withdrew because the advent of natural gas meant that carbonization no longer had the same interest. This is referred to in the section describing the British Carbonization Research Association.

In 1969 the B.C.R.A. and the Coke Oven Managers' Association inaugurated a Carbonisation Science Lecture which would be given annually in London by an expert in this field. It was decided to strike a gold medal to be known as the Carbonization Science Medal, for presentation to the lecturer. The first recipient of the medal was Professor Dr. W. Reerink from West Germany.

Another feature of the Association worthy of examination is the size of membership since its inception. When the first meeting was held it was exclusively attended by coke oven managers though provision for chemists and engineers to attend came early in the life of the Association. In 1933 the ranks



were opened to allow other people associated with the industry to join the Association. Associates included teachers and people with technical knowledge employed in industries allied to the coking industry. It also provided a Student class of membership for technical staff at coking plants between 18 and 21 years of age. As time has passed the number of managers attending has fallen dramatically, mainly because coking plants have become fewer numerically but much larger in size. The Association has striven hard to become attractive to members (58) and, particularly since the end of World War II there has been an almost perpetual drive to extend membership at Associate Member, Associate and even Affiliate grades to young people engaged in the industry. The outcome is that with only a handful of coking plants in Britain total membership of the Association in this country has remained fairly constant at 650 - 700 members. In order to achieve size the annual subscription has always been kept at less than half the annual subscription demanded by the Institute of Fuel or the Institute of Chemical Engineers. There has never been an attempt to suggest that C.O.M.A. is an alternative to these institutions, merely to show relatively good value for money. How has this been achieved? Unlike the major institutions C.O.M.A. is run by volunteers and it does not have to maintain an official presence in London, or even headquarters. Furthermore there is long standing benevolence by the coke oven companies and the contracting companies and in more recent times by National Smokeless Fuels Ltd. The overall result is that industry has provided direct and indirect subsidies for the Association, for example, section chairmen and section secretaries, as well as council members

have traditionally been granted facilities to serve the Association in company time. This has been taken a stage further to include typing facilities and postage which, in the case of section secretaries can be considerable. Other costs such as rail fare associated with the Annual General Meeting and the Carbonisation Science Lecture held in London and the cost of overnight accommodation have been paid by companies, B.C.R.A., and the nationalised industries on an arbitrary basis. Traditionally much indirect assistance has come from B.C.R.A. which still provides refreshment for the joint meeting held annually by the Midland Section of C.O.M.A. and the Institute of Fuel at the Research Centre. Such direct and indirect funding brings into question the morality of nationalised industries and a Research Association using public money to support an Association which would perhaps otherwise cease to exist.

The Association has served the industry well in former years but there is an increasing risk of it becoming obsolete because of changes in methods of education at all levels and communication, especially since the end of World War II. This poses the question - does the Coke Oven Managers' Association continue to meet all of the original objectives in the best possible way? Certainly it has become less important as a technical organisation in the last decade and this may point towards gradual transformation into a body which places greater emphasis on social events.



## Summary

Two coking plant contractors have been discussed because each contributed to the growth of the coking industry in separate and quite distinguished ways. Both of them were more successful than a host of other companies who built plants early in the century and with the contraction of the industry after the post World War II boom they became the only two companies of any standing to remain in Britain - this has been the position ever since the end of World War II when they were able, in conjunction with overseas counterparts, to become involved in the vast coke oven rebuilding programme both in this country and overseas.

In general there is a long established tradition whereby coking plant contractors do not compete for rebuilds although chapter V describing a series of individual plants shows a small number of exceptions. The fact that coke oven batteries last some twenty five years means that a successful contractor must be extremely resilient and the two most successful companies have stood the test of time in this respect. They have been successful where others have failed because they formed or strengthened ties respectively with other companies either in Germany or America. This achievement must be attributable to each company being firmly established in Britain so that the respective partnerships with overseas companies provided mutual benefit.

The Bryan Donkin Company on the other hand is a manufacturing company which has been able to produce equipment common to both the gas and the carbonising industry. Contraction of the gas industry in the late 1960s and 1970s brought about amalgamation with their only competitor - George Waller and Co. at Stroud. Glos.

Unlike the two contracting firms already mentioned equipment supplied by Bryan Donkin Ltd. is essentially built to last half a century or thereabouts so that after initial installation only infrequent overhauls can be expected. This company has singularly been able to find alternative new markets in the chemical, petrochemical and process industries.

Progress in the scientific side of the industry cannot be said to be rapid. Comparatively little was done in research work early in the twentieth century, except by those who for competitive reasons kept the information to themselves. A notable step towards remedying this, and providing the best type of training for the industry, was taken by the University of Leeds, which instituted a department specifically for the study of fuel problems, and particularly those connected with the carbonisation industry.

The British Carbonization Research Association is a unique organisation. Research into coking plant problems, first at the University of Leeds and later at Sheffield as well as at Armstrong College and the Royal Technical College, Glasgow was inadequate to meet the needs of the coking industry.

A separate research organisation to undertake applied research and pure research on behalf of the industry provided a logical solution. Research carried out in formative years shows how pitiful was the true state of knowledge in the industry.

The Research Association remedied this state of affairs as part of an on-going programme and it is now recognised internationally as the body for dealing with problems related to the industry.



Nevertheless its contribution to the wellbeing of the industry in relation to the cost of the Association is obscure.

Would the changes suggested by the Association have been forced on the industry in the time honoured tradition or would the industry have been allowed to continue in well trodden paths? The former alternative is arguably the correct prediction. One indisputable feature is that the formation of B.C.R.A. provided a much needed umbrella for graduates to participate in and contribute to the coking industry.

Certainly existence of the Research Association has not prevented the N.C.B. undertaking considerable full scale research on a variety of subjects relevant to the coking industry, and in more recent times B.S.C. (Chemicals) has spent large sums of money building full scale pre-heating and coal injection plants at two works following successful research by B.C.R.A.

Was full scale research justified and was proper financial assessment made? The post war research carried out at coking plants after nationalisation was little more than formalisation of the type of traditional applied research with the important difference that resources were far less restricting. Prior to establishment of research organisations all research, albeit invariably empirical, had to be carried out at the production units and inevitably much reliance was placed on this source of information. Of course much early research lacked sophistication but it carried the industry along. In the 1950s and afterwards many senior staff in the industry continued to favour the type of research best known to themselves and bearing in mind the rivalry between Divisions, full scale research had several advantages.

It has always been convenient to overlook the real cost of such research in terms of loss of throughput, low yield of by-products and indifferent quality because such information would have almost invariably militated against the experiments; what was the alternative in the early days? In contrast the cost which might accrue as a result of implementing the experimental processes and the effect on revenue have always been examined closely and this has been a forte which has not received the acknowledgment it deserves. Undoubtedly the coking industry would have been poorer without full scale research but the actual benefits are unquantifiable.

Another section shows how the industry has been successful even though early technical education was available only for those who were willing to make sacrifices to benefit from it. Such a state of affairs could not continue but it was not until the nationalisation of the industry that training was formalised for all workmen and staff - the industry moved to keep pace with changes taking place in other heavy industries.

The final section has dealt with a highly unusual organisation - the Coke Oven Managers' Association. The Association has been successful because it was formed by coke oven managers for coke oven managers and as such it had no counterpart. It provided a platform for the free exchange of ideas between coke oven managers, contractors and gas companies alike at an applied level, usually with the objective of increasing revenue, saving capital, or both. The fact that the Association is now larger than ever despite massive contraction in the industry shows it has adapted to new



situations most successfully. It could not have flourished in such adverse conditions without generous direct and indirect assistances from the Contractors, B.C.R.A., B.S.C. (Chemicals) and the N.C.B. so that it has been arguably worthwhile.

The unanswered question is - does the Coke Oven Managers' Association continue to meet a serious need or has it become obsolete?

## REFERENCES AND NOTES

1. Op.cit. A. Simon, The Simon Engineering Group, Stockport, 1953 p.VII - XIII.
2. The author believes the firm to be Dorman Long & Co.Ltd.
3. The French shareholding was bought out in 1922 in order to secure full control of the company.
4. The first Simon-Carves compound battery was laid down in 1934 and between then and the outbreak of World War II approximately twenty contracts, more than half of them for compound ovens, were received from British and overseas clients.
5. Chapter VI describing Rotherham Main indicates over-optimism by Simon Carves Ltd.
6. Mechanical gas producers were installed at Smithywood in 1953 and at Manvers in 1957.
7. This mathematical technique was probably unknown to the industry.
8. The former Grand Hotel, Sheffield, provided the venue for many meetings of the Midland Section of C.O.M.A. although later meetings were held at the Royal Victoria Hotel, Sheffield.
9. The problem appears to be with coke oven operators but solution by a contractor would bring rich rewards.
10. This applies equally well to many other industries.
11. Op.cit. 50 years of Coal Carbonisation, 1903-1953, Published by Woodall Duckham Construction Company.
12. This is in marked contrast to the Woodall-Duckham Company Ltd. who first became well established in the gas industry and then decided to build coke ovens.
13. The significance of this achievement is dubious because the extent of 'cracking' is unknown.
14. Other sections have shown that early in the century there were about a dozen contractors but fierce competition brought amalgamations and bankruptcies so that by the 1970s three contractors remained in Britain but only two of them were large.
15. Op.cit. A Brief Account of Bryan Donkin, F.R.S. and of the Company he founded, Bryan Donkin Company, Chesterfield.
16. Early Roots blowers were only moderately successful. Later Roots blowers were improved by a draughtsman - designer at the Connersville Company and they were made much more successfully in the U.S.A.
17. Perhaps the best analogy may be found with the railway workshops at Doncaster, Crewe and Derby.
18. In the 1970s the Association adopted the spelling 'carbonization' because it was considered to be more correct according to the Oxford dictionary.



19. Op.cit. Twenty Five Years of Coke Research, 1944-1969,  
The British Coke Research Association.
20. See 'The Coke Oven Managers' Association'.
21. The Earl of Halifax was Vice Chancellor of Sheffield  
University at the time.
22. The house was later acquired for offices by the coke marketing  
department of the N.C.B. and soon after they relinquished  
the property it was demolished to make way for high class flats.
23. There was an awareness of the need to tackle problems encountered  
in the industry and to translate research results into forms  
applicable in commercial practice.
24. Steel Times, June 1976, p.469.
25. B.C.R.A. has always appreciated the work of C.O.M.A. and it  
has contributed many technical papers. Senior officers of  
C.O.M.A. are often filled by staff from B.C.R.A. so that  
business of the former is carried out on a mildly unofficial  
basis at the Research Association.
26. The Director of B.C.R.A. is acknowledged for this information.
27. Op.cit. N.C. Brewer, reports in author's possession.
28. Compare with the career of L.N. Brewer described in chapter VI.
29. The author was primarily engaged in producing a series of  
unpublished papers on solid smokeless production in 1959.
30. This supports the postulation by the author that oven chamber  
width had little significance on the reactivity of the  
resultant fuel because of other overriding factors.
31. The author was a member of a team who visited the British  
Ceramic Research Association at Stoke on Trent for advice  
on the possibility of soda ash reacting with hot silica and  
hot firebricks.
32. The technical implications of underfiring coke oven batteries  
with methane from collieries are considered in an unpublished  
paper by Dr. D.G. Edwards and N.C. Brewer in 1963, a copy is  
in the author's possession.
33. A series of unpublished papers on this subject were prepared by  
Dr. D.G. Edwards and N.C. Brewer.
34. Ammonium phosphate production at an indirect ammonia recovery  
plant had never been undertaken anywhere in the free world  
before and it is believed that it hadn't been attempted in  
this manner in the U.S.S.R. either.
35. This applied research by Dr. D.G. Edwards and N.C. Brewer  
was unique.
36. Thomas Rotherham College, founded in 1547 and named after an  
Archbishop of York, developed high standards at an early stage  
partly as a result of restricting its intake to fee paying  
pupils. Recipients of scholarships, notably those provided  
by the C.W.S. were also accepted later on.

37. Thomas Rotherham College had been formed in 1547.  
Primary education was not formalised in Brinsworth until the West Riding County Council built an adequate school in 1907 to meet a vigorously expanding population.  
The sum of £17,500 from the Miners Welfare fund (established under the Mining Industry Act 1920) was paid towards the cost of erecting and equipping of the Chelmsford Mining and Technical Institute at Dinnington in 1928.
38. Royal College of Chemistry 1845, Government School of Mines 1851, Owen's College, Manchester 1851.
39. The same attitude is evident in Colleges of Further Education today.
40. The first mention of education in this context occurs in the 1918 Year Book of the Coke Oven Managers' Association.
41. Conservative M.P. for Esher, Surry, at the time.
42. Transactions of the Coke Oven Managers' Association 1949, p.68-73.
43. Transactions of C.O.M.A. Jack & Lee 1966, p.217-248.
44. A list of students are given annually in the appropriate Transactions of the Coke Oven Managers' Association.
45. Soon after the inception of induction courses the author became involved with lectures on process operations at the centres operated in Yorkshire.
46. The N.C.B. produced a Guide to the Scheme of Directed Practical Training, the second edition appeared in 1953 and the revised edition came in 1955. The nearest courses available for training engineers other than mining engineers were for electrical, mechanical and combustion engineers, p.9.
47. R.A. Mott, The History of Coke Making and of the Coke Oven Managers' Association, Cambridge, 1936, p.123.
48. There were 120 by-product coking plants in use during World War I, 40 of which were within easy reach of Sheffield. A significant change from beehive ovens to waste heat ovens was taking place.
49. The Institution of Chemical Engineers was not founded until 1922 and the Institute of Fuel, later known as the Institute of Energy was founded in 1927.
50. Compiled from Transactions of the Coke Oven Managers' Association.
51. Compiled from Ministry of Labour and National Service and Office of the Lord President of the Council, Scientific and Engineering Manpower in Great Britain, London, H.M.S.O. 1957, p.6.
52. The high percentage is partly due to the fact that the Atomic Energy Authority is primarily a research and development and pioneering organization.
53. Evidence given to this committee on behalf of the Association in September 1929 is in the author's possession.



54. The first use of coke oven gas for town's use occurred at Lanchester in October 1906.
55. The Yorkshire and Humberside Council for Further Education was formed in 1928. P.H. Horton, Yorkshire and Humberside Council of Further Education Golden Jubilee 1928-1978 undated publication.
56. The Indian and Overseas Sections were formed as a result of the burst in coke oven activity in the 1950s.
57. Traditionally coke oven managers are people with sound practical experience and ability though rarely have they had academic qualifications. A typical illustration is provided by E. Morgan, N.C. Brewer et.al. ('Coke oven Wall Repairs', Transactions of the Coke Oven Managers' Association 1973 p. 80 - 100.
58. One early method was for the company to pay the annual subscription for its coke oven manager. Evidence for this is provided in chapter .VI describing Rotherham Main Coking Plant.

## CHAPTER IX

### OVERVIEW

There has not been a simple transition from the slow and wasteful carbonisation in the coke heap to the comparatively rapid carbonisation in narrow ovens with recovery of by-products. The outstanding feature is that methods of coke production have been adapted to the kinds of coal available by a process of trial and error. Coke production has been essentially the art of the practical man because the complex composition of coal and a detailed knowledge of fundamental aspects of carbonisation were not only not understood - the fact that there was more to be understood was not appreciated. It is an unproven possibility that better knowledge of coal carbonisation would have enabled the industry to progress more rapidly and it may be claimed that insufficient attention was paid to research.

The coke heap in which large coal was heated by combustion of some of its volatile matter was wasteful insofar as the yield at first was only one-third and it never improved much. Another problem was the difficulty in controlling the rate of carbonisation of the coal heap supplied with coals which nowadays would be classed as 'non-coking'. Therefore early coke production had to be confined to Derbyshire, Nottinghamshire, Staffordshire and Shropshire where, today, coke production is non-existent except for one plant in Derbyshire. Even in the 1930s coke production in these areas had declined markedly because the use of large coal made it uneconomic, and the



fragile coke which resulted from carbonisation no longer suited the relatively fast driving of the tall blast furnaces. Some 43 per cent of British iron came from Shropshire in 1788 but by the 1930s only one blast furnace remained in operation. Similarly in South Staffordshire where in 1823, 30 per cent of the British iron production originated there were only 5 furnaces in blast in the 1930s and most of the coke requirement came from South Wales. Two important features have been established and will be alluded to again - the close relationship between iron making and coke demand, and the mobility and vulnerability of the coking industry.

The coke heap was made less wasteful by increasing its size so the heap rose from 10 tons up to 60 tons in stages. Thereafter increase in scale of operation traditionally became a panacea for high costs and low value products. Yields were increased by quenching with water, instead of cooling under a layer of wetted coke dust, up to 50 and even 75 per cent for high volatile coals. Wet quenching has remained the most popular method of cooling the incandescent coke. The Ford Motor Company at Dagenham is the only major company in Britain to use the alternative dry quenching system.

The beehive oven followed naturally; it was capable of carbonising the friable and strongly swelling coals of County Durham which could not readily be obtained in the large sizes necessary for the coke heap and whose swelling power prevented free access of sufficient air for combustion. The use of beehive ovens soon spread to other areas because they were seen to be capable of development, also the resultant

coke was obtained in long columnar pieces of pleasing grey colour, and had a sonorous ring which contrasted with the fragile and dull hearth coke of irregular shape. The beehive oven increased in popularity and beehive batteries were used to carbonise an increasing output of small coal from the mines. The last such battery of ovens worked at Winfield County Durham until 1958. (1) The use of a battery as opposed to several single ovens, enabled a modest amount of machinery to be used, including a small rail tub pushed across the oven tops to charge the coal. Manual quenching of each charge at the end of the 24-48 hour cycle and manual discharge of the coke afterwards remained handicaps of the beehive batteries.

Difficulties in applying these processes were experienced in France and Belgium because those coals had a carbon content of up to 90 per cent and less than 22 per cent volatile content, in consequence the coal was both friable and weakly swelling. A solution was found by increasing the rate of heating and using a rectangular beehive oven with a 9 inch layer of coal which carbonised in 24 hours. Coke was extracted from the oven using an embedded rake and a winch which quickly gave way to a narrow oven, side heated and discharged with a steam powered ram. Controlling combustion in side flues gave many troubles in early ovens. Early use of beehive coke ovens in this country at first hindered the progress of the narrow retort ovens and in fact led designers away from the essential advantage to be gained from the narrow oven. As knowledge of combustion control developed problems of distributing the required volumes of gas and air decreased and the narrow oven was readopted with advantage. It could



be applied to a wider range of coals than the beehive oven even though by the 1930s low volatile coals of high rank and high volatile coals of low rank were, with advantage, blended with greater swelling coals of intermediate rank.

Although the earliest methods of coke making by means of the coke heap and the beehive oven as well as the recovery of tar and gas from the process were first applied extensively in Britain, development of successors, the narrow retort oven and the by-product recovery oven, was left almost entirely to continental and American workers. Furthermore, adoption of the retort oven and of the recovery of by-products in this country was slower than it need have been.

There are several reasons for the slow progress. To some extent it was a penalty of early development for a coke making industry on a scale which was not enlarged appreciably between the wars, existed in this country before the retort oven was developed. The custom and practice of beehive coke making had become well established and it hindered the development of newer methods. Another reason for failure to take the initiative was the innate conservatism of the iron masters who preferred large finger coke, silver-grey in colour and resonant when dropped. Ironically people with little appreciation of statistical correlation attempted to relate appearance and resonance of coke to hardness - arguably this may have been due to overconfidence or perhaps simply a commercial ploy. Conservatism was the result of success in the iron industry because of almost exclusive use of empiricism and absence of detailed understanding of the technicalities of iron production.

It took a long time to convince the iron masters that coke of different colour, size and resonance could be equally suitable for use in the blast furnace. The conservatism of outlook, which slowly recognised that coke making in the by-product recovery oven required a new standing for those responsible for its management, hindered progress. (2) There was divided responsibility for the early by-product ovens, only rare discussion of technical problems and close collaboration between science and industry, so evident in Germany, received little encouragement in Britain. (3) There was little real knowledge of the reactions in a coke oven and documentation of the industry had become the domain of contracting companies who were not always impartial.

The vital importance of the by-product coking industry to the nation became abundantly clear during World War I and many changes ensued, some of which are shown in chapters IV, V and VI. It does not necessarily follow that changes came because of the war, the event simply accelerated the process. The formation of the Coke Oven Managers' Association in 1915 provided a forum for technical discussion and an exchange of information which has been invaluable to the industry. Since World War I organisations such as the British Sulphate of Ammonia Federation, the National Benzole Association and the British Road Tar Association were formed to control the sale of products and to fix standards for their manufacture. Success in their respective fields may be judged by the fact that they remained until the late 1950s when changes within the coking industry itself as well as related industries brought obsolescence. The systematic study of the main product of the industry, namely



coke, was encouraged by the Midland, Northern and Scottish Coke Research Committees in 1926-7. From simple beginnings emerged the British Coke Research Association in 1944, this in turn was unified with the establishment of the Coke Research Centre in 1958.

The first and in some respects the only major change in the industry, the demise of beehive ovens and replacement with waste heat ovens was long and hard. (4) The coking industry progressed and developed and unfortunately though not singularly, it started on the wrong course so that when change came and practical skills and expertise were everything, it had to restart its progression in a new direction. Much of the traditional knowledge of the art of coke making became worthless but the challenge of a fresh start was accepted with great enthusiasm.

Development of slot type waste heat ovens led naturally and relatively quickly to by-product ovens as the demand for town's gas increased early in the twentieth century. Initially the gas companies resisted the use of coke oven gas for town's use because they thought it might prejudice their own industry. A strong campaign for using coke oven gas by the Coke Oven Managers' Association contributed to the quicker adoption of this gas to the mutual benefit of both industries.

In principle at least the method of coke manufacture and by-product recovery established in the 1920s has remained unaltered to the present time. A variety of technical changes followed, perhaps the most important being the widespread use of silica for oven chamber construction, even though the material

was not fully understood. As a result higher operating temperatures gave rise to increased throughput for a given capital outlay and harder coke. Tests for hardness were insufficiently sensitive to produce reliable data - rate of throughput was the all important consideration. Improvements in manufacturing techniques, especially a reduction in tollerances as engineering skills progressed, has led to ovens becoming taller and longer as a means of increasing throughput though the width has remained unchanged for technical reasons. (5) It is highly significant that after early experimentation in the use of various chamber widths a width of 18 inches was established empirically and became universal by the late 1920s. With two slight exceptions to meet specific needs and regardless of the tremendous advances in scientific knowledge during the half century which followed, the chamber width has remained unaltered. This is indeed proof if any is necessary, of the sound practical expertise by devoted people with little education into the art of coke making. From its inception the coking industry, regardless of the method of carbonisation, had become intent on reducing production costs. This has so often been achieved by inoreasing throughput or rate of throughput or a combination of both.

Coke oven managers are optimists. It was not unusual for plants built in the 1920s and subsequently, to be arranged so that they could easily be extended, though in reality very few were able to take advantage of the facility. It is not that the coke market could not rise to inoreased availability but rather that in general the size of coking plants matched the size of the colliery or group of collieries. An inorease in the former could only become reality by an inorease in the



latter which was already meeting the market for large coal to the full. Advances on many fronts were necessary if collieries were to be increased in size and progress was retarded pending better knowledge of many scientific subjects relating to the technology of coal mining.

Bearing in mind the fact that coking plants were the only means of providing an outlet for small coking coal which was itself a side product to the main objective of mining large coal, the industry has been buoyant to say the least. It adequately met the demands of the blast furnace market in respect of quantity if not in terms of quality and it has supplied coke for use in foundries, for steam raising -- including locomotives, and for domestic purposes. The industry was able to create demand as well as to meet it. It is worthwhile to consider whether the industry could, or should have paid more attention to coke quality, and the following paragraphs go some way towards answering the question. The fundamental connection between coke making and the iron industry has been made in earlier sections so that it is sufficient to state that in 1973 the ratio of coke consumed by the iron and steel industry as a percentage of oven coke production had reached 68.6 per cent.(6) Of the coke used by the iron and steel industry by far the greater proportion is used in blast furnaces. It has been traditional to state that coke will always be needed for the production of iron but the trend has been for it to decrease in amount per ton of pig iron and in more recent times this view has been modified. Because the present route requires a high consumption of energy interest in alternatives has existed, but in recent times it has been intensified. The blast furnace route seems likely to remain the predominant approach, at least for the next decade

and beyond, although much depends on advances in technology. The traditional view that coke would always be necessary in a blast furnace, albeit in reduced amounts, is no longer accepted.

Since blast furnace coke is by far the most remunerative product of the coking industry it is worthwhile to consider some of the properties which have been aimed towards throughout the century. Moisture content has been recognised as a parameter of major importance almost from the outset and the goal of a low moisture content has been aimed for continuously since the end of World War II. It has also been the subject of much argument between the producer and user and became a major criterion in the blast furnace coke price structure developed in the 1950s to achieve equitable payment. Perhaps the fault lay with the blast furnace manager because insistence of such a low moisture content meant that under certain circumstances the value of moisture increased during rail transit. Coke oven managers and blast furnace men alike knew this and it is an unproven probability that coke moisture values at the point of production were artificially depressed. The objective has always been to produce coke with the lowest moisture content possible.

Other equally important properties which have figured prominently in the minds of producers and users are those of size and strength. The aim in coke production has always been to obtain as great a yield as possible within a defined size range and thereafter to accept the need to cut large coke to ensure the material meets the upper size specification.



The minimum size range has been met by screening. As far as strength is concerned the problem has been to control the resistance to breakage by impact and abrasion. The problem for the coke producers has been that until World War II the criteria for optimum size in a blast furnace and hardness has varied from one ironworks to another and the ability to achieve the criteria has varied from producer to producer. Another problem has been that until recent times the blast furnace operator has not been able to define the characteristics which would give optimum conditions in the furnace. The situation has been complicated further by the fact that throughout the century blast furnaces have increased in size and rate of throughput so the physical characteristics specified for the coke have had to change continually.

Coke which was unsuitable for metallurgical use was sold on the domestic and industrial market and coke oven managers were quick to take command of a situation which rightly belonged to science and technology. Mystique regarding the ideal quality of coke nuts was generated by customers who regarded the operation of small boiler plants as an art. They were helped by the fact that no two boiler plants were identical and differences could readily be <sup>wrongly ascribed</sup> to the fuel. Coke oven managers encouraged such attitudes when it was advantageous to do so. In the case of complaint regarding coke quality the easiest parameter to change was coke nut size and this remedy was usually accepted by the customer whether it was correct or not. Much folklore surrounded coke size and competing coking plants claimed slightly different nut sizes and used distinguishing names such as apples, pears, beans, nuts or peas. Screening was never very efficient so actual coke size

often bore little relation to the descriptive size. It was not until the late 1950s when a need to penetrate the domestic coke market caused the whole concept of screening to be re-examined and coke sizes to be controlled on a statistical basis. For the first time in the history of the industry sophistication was introduced and the arguable point arises - should it have come earlier?

A small number of plants claimed to produce a particularly reactive fuel but in reality it would not differ appreciably from any other domestic size of coke. Nunnery Handsworth was the only plant built between the wars specifically to produce domestic coke and Avenue Coke and Chemical Plant was the only one built after World War II for the same purpose. In contrast Barrow Barnsley, one of the very few independent plants remaining in the 1950s attempted to penetrate the domestic market with 'Burn Brite' - coke made from very clean coal and quenched with copper sulphate to give it a pale blue flame. The venture ended when the N.C.B. were no longer able to supply the appropriate quality coal. In some quarters it was believed that suitable coal was no longer available from the N.C.B. because of a need to preserve the domestic market but this cannot be proved. Undoubtedly the N.C.B. were attempting to produce their own brand of highly reactive smokeless fuel sold under the trade name 'Warmco' in competition with 'Burn Brite'. It is sufficient to say that the N.C.B. were monopolistic suppliers of coal and they may not have helped this independent plant. This unproven view has strong possibilities.



By-products, especially tar, benzole and ammonia have played a traditional part in supporting the economy of the coke making process but extent of the contribution has depended on local situations and the influence of world economics. The carbonisation industry was for the greater part of the present century by far the major supplier of ammonium sulphate, tar, benzole, motor spirit and nitration grade toluene. The advent of alternative sources of supply, particularly from or based upon the petrochemical industry after World War II, led to a period of diminishing returns. The situation became so serious that within the last decade consideration has been given to the introduction of partial and non-recovery systems. In the event such change failed to materialise because no reconstructions were in hand at the time and it remained clear that, having installed by-product plants, the economy was best served by operating them and taking whatever returns could be secured.

The most depressed of the coke oven by-product markets has been that for ammonium sulphate. After a long period of gradual decline in price since the end of World War II the price obtainable in 1972 reached a level lower than the cost of the acid required to produce it. The advent of synthetic ammonia started to control the price so the point had been reached when removal of ammonia had become little more than the first stage of liquid effluent treatment for which purpose it remains essential.

The value of tar and benzole have been related directly to the value of alternative fuels. The net result of the crude oil price increases since World War II was to substantially improve

the profitability of the refining of tar and benzole and in 1973-4 both tar and benzole products increased in value to such an extent that profit margins were considerably improved. Full by-product recovery was re-established as a valuable contributor to the economy of coke production. So far as benzene is concerned, the severe shortage which developed in 1974 gave renewed importance to crude benzole production.

The coking industry has been fortunate in that for the greater part of the first half of the present century at least, it has been complementary to the gas industry. The advent of gas lighting did more than anything else to provide a boost to a continuing industrial revolution. It transformed Britain from a cottage industry <sup>economy</sup> into an industrial nation so that the demand for iron goods and steam power increased and this in turn gave a boost to the coal and coking industries. Other factors such as the growth in size and number of the merchant fleet as well as the Royal Navy played their part. The gas industry and the coking industry had some complementary objectives although the gas industry was slow to appreciate the value of the coking industry. It is an unproven possibility that the gas industry was in fact self centred. Other objectives were in strict competition and the market place decided the relative merits of specific commodities and therefore controlled the price. Only acceptance of the use of coke oven gas for town's purposes enabled the regenerative oven to stay and become the universal means of producing high temperature coke.

Since the advent of by-product ovens it has been accepted as good practice to use part of the gas produced to heat the



ovens. Surplus coke oven gas constitutes an important part of the economy of coke production and it has generally been reckonable as equivalent to the cheapest available alternative fuel. It is not surprising that coke oven gas was so lucrative in the 1930s, to the extent that Blackwell coking plant in Derbyshire was the first plant attached to a colliery to use producer gas for underfiring purposes so that an equivalent amount of coke oven gas was available for town's use. The company were able to take advantage of increased gas sales without increasing the amount of coke production. The use of gas producers at merchant plants did not spread until the late 1950s when they were used at new and rebuilt plants to increase town's gas availability on an intermittent basis.

Advent of North Sea Gas as the source of town's gas and stoppage of carbonisation for gas making meant that surplus coke oven gas could no longer be sold for town's use. Consequently there was an important departure from a long established pattern with major diminution of the contribution of coke oven gas to the credit of coke making because the surplus gas could only be reckoned at the value of the cheaply available fuel oil which it could replace. Special arrangements have been made in some cases for supply by pipeline to suitable industrial outlets though even this has not eliminated the increased amount of gas which has had to be burned to atmosphere, especially at weekends, public holidays and holidays for consumer industries involved with the scheme.

It is worthwhile to consider the interaction between the coking industry and industrial society in general. Perhaps the coking industry contributed most early in the century when it assumed the role of innovator and entrepreneur in an

environment fraught by competition. Because of the complex nature of the coking process and the inadequate education of many of those involved in the industry its early beginnings started as an art rather than a science and the fact that so many coking plants came into being is some measure of its success. Unquestionably the industry would have benefited from a better understanding of science and technology but this can also be said about many other industries. Science was used as a convenience and ignored when it conflicted with short term financial reward. Perhaps the best illustration of indifference towards science in the face of hard commercial reality was the existence of Brewer's producer at Rotherham Main. This comprised a movable slide on the gas main before the exhauster which was opened or closed to alter the amount of dilution air added in order to maximise the volume of sales gas without it falling below the contractual calorific value of 500 Btu/cu.ft. The fact that high oxygen content in the gas favoured corrosion of the gas mains and reacted with other constituents to form gum compounds in the long term was conveniently ignored. Rotherham Gas Works were always at a loss to understand why the gas from this plant should be so near the 2 per cent limit for oxygen content when coke oven gas from other plants carbonising similar coals contained only half as much. The industry was carried forward as an integral part of industrial society and it in turn provided several essential components for that society to progress.

Chapter VI describing Rotherham Main contains detailed illustrations of the influence of coal mining and related activities on the local environment. Prior to the establishment



of these activities at the turn of the century the villages of Canklow and Brinsworth were both sparsely inhabited farming communities. The advent of coal mining, town's gas production and coal carbonisation transformed both districts not least with an influx of one thousand miners and coke oven workers into purpose built property provided by the company. Quite typically the colliery company accepted responsibility for education until it was transferred to the local authority when a new purpose built school was opened. The spiritual and social needs were looked after by the company who extensively funded the parish church, a public house and a miners' welfare building.

These developments would not have been undertaken so readily, if at all, without co-operation from the neighbouring town which was ripe for expansion. The town councillors saw merit in the growth of a district close to the town and they were prepared to lay a water main to the district. The colliery financed the sewage works soon afterwards to allay fears of the Rivers Board who were concerned about the polluted condition of the local stream. With the establishment of the colliery followed by a gas works, gas lighting of streets and houses spread. Advent of the first coking plant very early in the present century provided impetus for expansion of gas utilisation, another boost came with the sale of gas to Rotherham Corporation for re-distribution when the modern ovens were built a quarter of a century later.

It should not be thought that co-operation between a local authority and a colliery company was the sole requirement for creating what in effect became a conurbation. The pace of the progressive event was influenced by superimposition of wider

aspects of development, or sometimes lack of them on the local situation early in the century. The effect of the national economy for example was a prime factor and other influences bearing on the district included local industries. The gradual awakening to the idea that standards ought to change and the growth of science and technology to bring this about was just as important. Increased use of electricity for social purposes, growth of road and rail transport, changing standards of education together with satisfaction derived from employment as a means of financial support and as a contribution towards the prosperity of the nation, were all requirements for industrial and social evolution.

Without doubt the most important single social happening in the coking industry was the passing of the Coal Industry Act of 1946 and the implementation thereof on 1st January 1947. Many of the coal mines were in a parlous state from the General Strike onwards and nationalisation, late though it was, provided the only reasonable solution. (9) The coking industry was not able to flourish and prosper on its own during the first half of the century. It has perhaps more than some single product industries, been dependent on a buoyant economy and this has frequently been absent. Indeed the economy was depressed throughout most of the twenties and thirties and the industry was only able to get by in some cases by withholding modernisation, solely because the coal owners faced grave problems and their first loyalty was necessarily to the mines. The deferment of capital expenditure in this way was aided by virtue of the fact that coke oven batteries, which are capital intensive, have a life span of some twenty five years. The end of the useful life of a battery of ovens is largely arbitrary



and can be adjusted to take into account external influences.

Hitherto the coal mining industry and the coking industry survived because the products were in demand and they were able to attract prices in the market place which overall must have been satisfactory. Nationalisation of the industry may be considered as a Government ploy to inject capital into the industry so that it could be modernised and produce raw materials more cheaply. If nationalisation hadn't taken place capital would have had to be found by a massive increase in the price of coal and other products. Such action would have brought about increases across the board and contributed towards inflation which was low at that time. The fact that vast sums of money provided by the Treasury, initially to compensate the former coal owners, and then to modernise the industry with intermittent loans was also contributory towards inflation. Indeed, after a massive modernisation programme, changed world events meant that the industry borrowed progressively more money from the Treasury until interest charges exceeded any possible income. The only solution was for the Government to intervene again and discard a large part of the debt but in doing so it stipulated conditions for future operation of the industry. Nationalisation of the Coal Industry in 1947 was a controversial issue then and it has remained so intermittently according to the aims and objectives of successive Governments.

Colliery companies have an excellent record for helping the communities they created to develop in many ways and their generosity was second to none. It is through such companies that social amenities were created and they often provided basic education. Why then did the collieries fail to

appreciate that adequate washing and changing facilities and canteen facilities were of mutual benefit to them and the community until the 1950s? If this question is answerable it will inevitably be open to conjecture and it may well tie up with a similar question about the apparent disregard for safety. (8)

The Miners were accustomed to Government intervention during World War II so that State ownership was a logical step if the capital necessary for complete modernisation of the industry was to be forthcoming. Those coking plants attached to collieries which were nationalised themselves vested. The coal industry was the first British industry to be nationalised and the Act allowed for it to gain in experience and stature. Nevertheless the industry started badly because the workforce initially believed it would literally own the vested assets and realisation that nationalisation simply meant transference of ownership did not dawn immediately. It was unfortunate that awakening to the reality coincided with an awareness that many people in the industry were being taken away from the immediate task of producing coal to accept appointments in a three tier management structure which appeared remote to say the least. The situation in the nationalised coking industry was very similar to the organisation in the mining Divisions and the attitude of miners and coke workers alike was the same towards the bureaucratic regime. Dissatisfaction with the extent of distant supervision, realisation of the tendency towards authority without responsibility and some awareness of its cost is understandable because nothing like it had ever been seen before. Perhaps the Government would have been wise to introduce a publicity programme before



implementation of the Act so that employees and the public would have had a better understanding of the significance of the Nationalisation of the Coal Industry.

The unfortunate start brought a reminder of the bad old days to employees in the industry and they became resolute in their desire to see that conditions would improve by reducing the working week, improving wages and changing fringe benefits in various combinations according to whatever seemed most acceptable at the time.

Undeterred by its poor image the newly formed National Coal Board set about re-shaping an industry so that within ten years it became the envy of the world - the nationalised coking industry formed an important part of that programme. Because of major underground reconstruction a few very large coking plants, some of which were almost totally self sufficient in everything except coal, were built. Nationalisation provided two elements which the coking industry had hitherto lacked, a large single supply of coking smalls and sufficient capital to develop accordingly. It is worthwhile to examine some of the new options which were now available to the industry, in fact some were simply well tried remedies in a different setting.

The predominant factor in determining the cost of coke is the cost of coal used. For practical purposes the cost per ton of coke can often be taken as the cost of the coal, the capital labour and other operating costs are approximately offset by the credits from coke breeze, nuts, surplus gas and by-products. There are however, a number of other factors which have a beneficial effect on the economy. One example

has been the trend towards the reduced machine cycle times and hence the greater number of ovens per unit. (9)

Another approach towards increasing productivity has been the increase in oven chamber dimensions. The effect of this and the change mentioned in the previous paragraph has been to reduce capital expenditure per annual tonne of coke and thereby to reduce the capital cost per tonne of coke produced, or to reduce other costs such as labour per tonne of coke produced, or both.

The most obvious way of increasing oven productivity is to increase the useful chamber capacity by increasing the height and length, bearing in mind the width is determined within fairly narrow limits by the nature of the process. The general trend to increase these dimensions has always existed but it was given a new meaning after nationalisation. The use of tall ovens is not without practical problems similar to those experienced by the pioneers. Traditionally it is more difficult to heat the oven walls evenly and it is harder to push the coke from the oven and provide tight oven door seals. These problems have given rise to the well known phenomenon of carbon formation, changes in coke quality, and high water content of the tar as well as other by-product difficulties.

Another method of increasing productivity which has been frequently tried is that of increasing the rate of carbonisation. To this end there has been a trend towards the use of higher flue temperatures due to the use of better refractories, or particularly in the late 1960s to erode temperature safety margins. The result is that flue temperatures of 1350°C or even 1400°C are



quite common. The extent to which flue temperatures can be raised depends upon the current working level and the safe working limit of the chamber refractories. Very high flue temperatures are associated with high density refractories and in some instances high density silica has been used as a method of improving thermal conductivity of the chamber walls, thereby increasing the coking rate at normal flue temperatures. The use of high density silica has always had implications which go beyond the benefit achievable from increased flue temperatures alone though they have not always been appreciated. The implications derive from increased strength and relate to thinner chamber walls which contribute to a higher carbonisation rate.

All these factors meant that charge weights increased rapidly from 8, 10 or 12 tons to 18.5 tons due to economic circumstances rather than to any specific advance in technology. Increasing the throughput per oven had gone a long way towards reducing costs of the new plants but it was not enough. Batteries containing up to the maximum of 56 ovens per unit were built and each new plant had several batteries. The intentions were good but there was too much importance attached to sheer scale as a panacea for financial ills. The result was that Avenue on the one hand had two batteries, each containing 56 ovens served by one service bunker and two sets of machines - the theoretical ideal. In contrast Manvers was already in being so its size was increased in the best way possible but the result was a disaster. One group of five batteries of various sizes had a total of seventy one ovens and were served by two sets of machines and one service bunker. Two other batteries with a total of 66 ovens (10) were served by another

bunker and two sets of machines. The result was that some items of plant were duplicated, triplicated, quadrupled or increased five fold in the interests of plant size, and power and maintenance were increased pro-rata with similar increases in manpower. It may be said that ideals were ruined because of over enthusiasm. Manvers is not an isolated case but it is by far the worst example of how things can go wrong.

A more important feature is to see if the re-vitalised industry wholly owned by the National Coal Board was pitched correctly. Planning of industrial output for a quarter of a century ahead was never more difficult than after World War II even for a single product industry. It was even more difficult for a multi-product coking industry. The prime consideration was to produce blast furnace coke but it was later denied much of this market and perhaps the change ought to have been anticipated. In addition the traditional outlet for surplus coke oven gas disappeared completely but this could not have been foreseen. Changes in the social climate brought about a contraction in the domestic market and the importance of other by-products became insignificant. With so many variable factors it is impossible to tell whether the nationalised coking industry was set on the right course. It is however possible to say that if plant closures continue at the present rate the merchant coking plants will soon become extinct.

It must be said that the N.C.B. has shown outstanding awareness of its moral obligation to employees in the coking industry in many ways, particularly during the 1950s and later in the 1970s when plants became worn out and were not replaced. The significance of N.C.B. coking plants has declined since



nationalisation of the coal industry although in contrast to the national situation it has for a long time had a larger presence in South Yorkshire and Derbyshire than B.S.C.(Chemicals) Limited, although very recent changes make the area conform to the general pattern. It is therefore worthwhile to analyse the changes which have taken place in the industry in the second half of the present century.

There has been a general contraction in the size of the coking industry since the end of World War II. In the late 1940s there were 90 coking plants in Britain which produced in 1949 a total of 15.49 million tons of coke. The comparative figures for 1974, a quarter of a century later, are 36 plants producing 14.5 million tons of coke. The figures show that in a quarter of a century the number of coking plants has decreased by 60 per cent although coke production only decreased by 6 per cent and they clearly illustrate the cumulative outcome of many changes which have taken place in recent years.

Although the industry has contracted in terms of the number of coking plants it has only suffered a small reduction in output. (11) The demand for foundry coke has remained fairly steady at about 1 million tonnes for many years and also, in spite of the new availability of other fuels in recent years (12) oven coke still accounts for some 7 per cent of the total output.

What do these figures indicate? Incontrovertibly they prove that major demand continues to be for coke of blast furnace quality and that over a quarter of a century the amount of pig iron produced has increased by some 75 per cent above

the 1949 level from 9.4 to 16.8 tonnes while the coke rate per ton of pig iron has decreased by approximately 50 per cent from 1087 kg/tonne to 577 kg/tonne. This is a development in which blast furnace techniques and construction have been greatly involved and coke oven construction and operation have perhaps been involved to a lesser extent.

Undoubtedly there have been major developments in iron-making, including recognition of the importance of burden preparation, the desirability of uniformity or consistency in raw material quality and the engineering developments in the blast furnace itself. All these features combine to enable a much more efficient iron industry to evolve over the past twenty five years or more.

What developments in the coking industry are responsible for the improved efficiency of iron making? Can the areas where practice needs to be improved still further to attain a greater level of efficiency and productivity be identified? In order to answer the first question it is necessary to look further at the comparison of 1949 when 90 coking plants were working and the largest throughput of coal per oven was of the order of 8,500 tonnes per year at the newly commissioned plants or those rebuilt after the war. There were many older plants carbonising little more than 2,000 tonnes of coal per oven per year still working at the time. By 1974 there had been a culmination of developments in oven size which had gradually taken place so that plants having ovens more than 6 m. tall and chamber volumes of 37 or 38 m<sup>3</sup> were operating (13) each one carbonising about three times as much coal as the ovens operating in 1949. This explains the fact that coke production has been maintained at a similar level for many years but at a



smaller number of plants having larger capacity ovens.

If the output of iron and steel is to rise using in the main the traditional process (14) more coke will be needed though perhaps not in direct proportion to the amount of iron produced but bearing some relation to it.

An alternative to the traditional method of making coke is the formed coke process which, in certain instances can produce a solid carbonised artefact by processing coals which are not normally used in the conventional carbonisation process, thereby extending the range of coals available for the manufacture of blast furnace fuels. This subject is beyond the scope of the thesis and it is therefore only mentioned for completeness.

Initial research into preheating coal, together with gravity feeding was successful and it has been adopted at a full scale plant as a means of increasing coke production. (15) An interesting side effect has been that as a result of improved coke quality arising from the use of this technique, it has been possible to extend the use of coals available for coke production. If increased throughput is unnecessary, then a reduced number of ovens charging preheated coal will provide the necessary coke production at lower capital cost.

Coal quality, so feebly looked at by coke oven managers in the early days, has taken on a new significance. As a result the life of some merchant coking plants has been extended by the judicious blending of coals which, on their own, are unsuitable for coke production. Blending has not only resulted in the continuous production of a uniform quality fuel, it has been accompanied by important economic benefits extending the range of coals suitable for foundry coke

production.

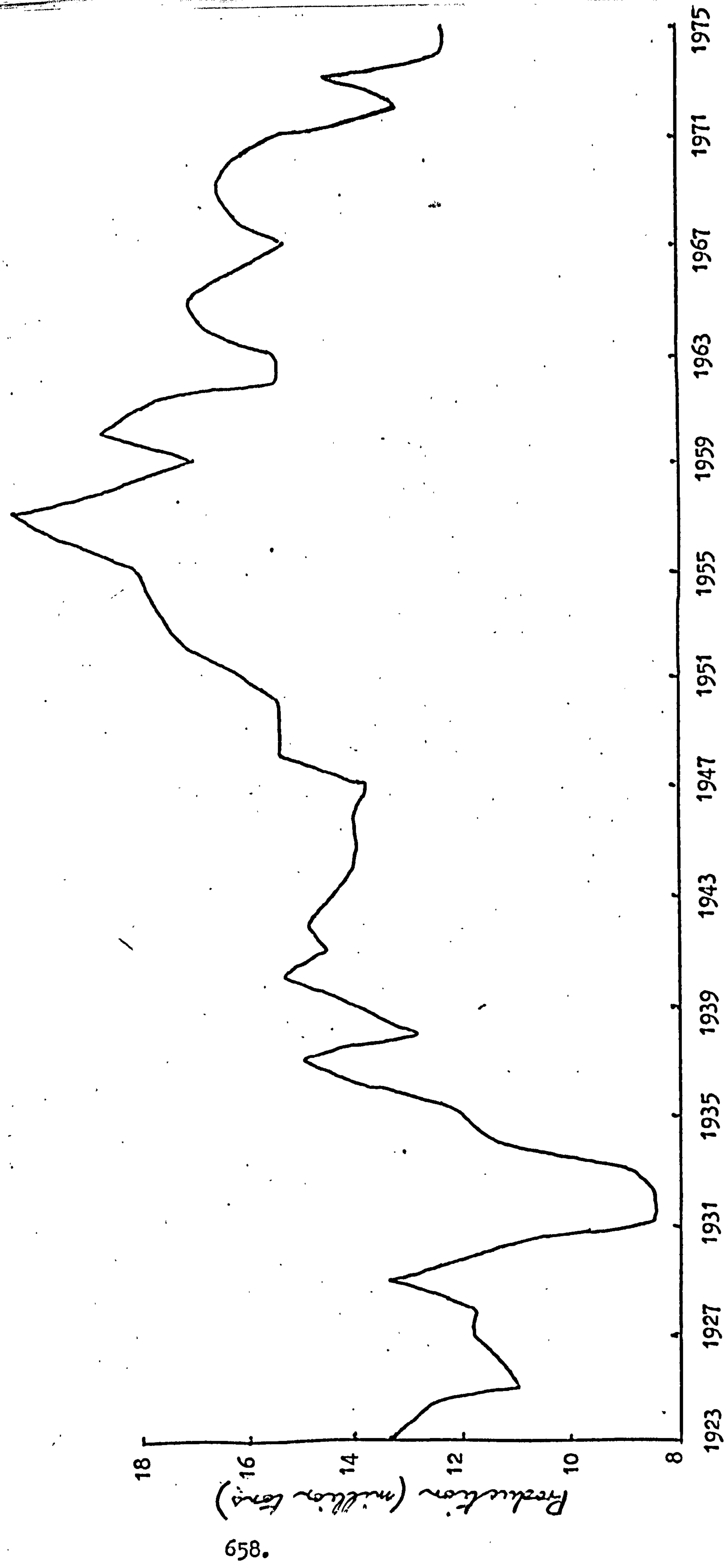
Another change which has taken place in recent years, and which is now regarded as an essential aspect of the industry, is the recognition of the need to drastically reduce the level of all types of pollution concomitant with coke manufacture. The adage 'where there's muck there's brass' has been true of the coking industry and many others in the past and it is perhaps true today but the pressures to improve the quality of life are now so great that it has become impossible to continue some of the industrial practices which have hitherto been tolerated. (16) Some progress towards reducing the emission of gaseous and liquid pollution from coking plants has been made but much more progress will be necessary if coke is to remain an integral part of the economy.

Figure 1 illustrates the fluctuations that have always been present because of external pressures but more important, it sums up the early growth, the halcyon days of the 1950s and 1960s and the decline thereafter. Production of coke in 1975 was less than in 1923!



**FIGURE 1**

Coke Produced at Coke Ovens (17)



## REFERENCES AND NOTES

1. N.C.B. Film Library, 'The Murton Plant'.
2. A.H. Middleton, Iron and Coal Trades Review (Diamond Jubilee Issue) 1927 p.74.
3. Chapter VI describing Rotherham Main Coking Plant shows how this attitude had changed by the late 1920s.
4. Other changes were simply part of continuing development whereas this one necessitated a radical movement in ideas.
5. The history of the coking industry is in considerable measure a story of the increase of rate of carbonisation mainly to improve capital and labour productivity, but also to permit the use of a wider range of coals for the manufacture of metallurgical coke.
6. Digest of United Kingdom Energy Statistics, 1979, table 30.
7. It is not intended to imply that the General Strike in 1926 created the situation but simply to indicate that it highlighted conditions under which coal miners were attempting to earn a living.
8. <sup>L</sup>Wigism should not be permitted to prejudice the answer against <sup>A</sup>the colliery owners.
9. A unit is the group of ovens normally operated with one set of machines and comprises one or more batteries.
10. The maximum number of ovens per set of machines was believed to be feasible in 1958, was 66. In the late 1970s part of Manvers was extended so that 91 ovens were operated from one service bunker and two sets of machines. There had been no other change in the relevant technology in the meanwhile - it was imply that economic pressures provided fresh impetus for increasing the work load of each unit.
11. In the same period gasworks declined rapidly.
12. The situation might have been different if the new solid smokeless fuel plant had not been bedevilled with technical and economic problems which prevented expansion of output.
13. None of these plants existed in Yorkshire or Derbyshire; they were confined to a few large steel making centres such as Shotton.
14. The blast furnace is likely to have a secure future for about 15 years.
15. Chapter VIII describing the British Carbonization Research Association contains further details on this subject.
16. The Clean Air Acts 1956 and 1968 and Rivers Pollution Acts have had a major effect on the coking industry.
17. Compiled from Ministry of Power Statistical Digest 1964, table 61, Annual Abstracts of Statistics 1973 and 1977, tables 176 and 8, 19, respectively.



## GLOSSARY

Acid. (i) B.O.V.	Brown oil of vitriol (77% $\text{H}_2\text{SO}_4$ ) used to produce sulphate of ammonia <sup>2</sup> in <sup>4</sup> the recovery of ammonia from coke oven gas.
(ii) D.O.V. (R.O.V.)	Distilled (rectified) oil of vitriol (95% $\text{H}_2\text{SO}_4$ ) used for the removal of sulphur and its compounds in the washing of benzole.
Acid Separator.	Vessel to intercept entrained acid in gas leaving the saturator (c.f.)
Acid tar.	Waste product from washing benzole with acid.
Ammonia liquor.	Solution of ammonium salts in water, collected as a condensed product from the gaseous products of carbonisation.
Ammonia Still.	Apparatus in which ammonia is recovered from ammonia liquor (c.f.) using steam and lime.
Ascension pipe valve. (Pullman valve)	Flap-type valve which when open allows gas from oven to pass through to the main; when closed it isolates the collecting main from the oven.
Ascension pipe. (stand pipe)	Vertical refractory-lined pipe which conveys gas from the coke oven to the collecting main.
Ash.	The solid residue from the combustion of solid fuel.
Battery.	A number of ovens operated as a unit.
Bench.	See 'wharf'.
Benzolized oil.	Wash oil rich in benzene, before passing through the crude still.
Black ends. (sponge)	That part of the coke in an oven which has been adjacent to the doors in an under-heated oven during the carbonisation cycle. It has an open-textured spongy appearance.
Blast furnace coke.	Metallurgical coke, screened to remove everything below a certain size.
Blast furnace gas.	A lean gas, usually with a calorific value of 90 - 110 Btu/ft <sup>3</sup> , derived from blast furnace operation, and used for such purposes as heating furnace stoves, coke ovens, and boiler firing.
Blending.	Intimate mixing of varying qualities of coal to produce a mixture which will give a metallurgical coke at the most economic price. A further function of blending is to conserve national resources of good metallurgical coal.

Breeze.	The smallest grade of coke produced in screening, usually below $\frac{3}{4}$ "
Buckstay.	The vertical steelwork which holds the oven brickwork and door frames in position.
Bunker.	Large storage bin, usually for coal or coke.
Buttress.	Supporting wall at the end of a battery of ovens.
By-products.	All those substances produced in the operation of coal carbonisation, with the exception of coke.
Carbonisation.	The heating of coal in the absence of air.
Carbonising time. (coking time)	Time that elapses between an oven being charged and pushed.
Chargehole.	Lidded hole on oven top through which charging takes place.
Charging.	Introducing coal in an oven.
Charging car. (larry car)	Machine with pans which line up with apertures at the bottom of the service bunker, and capable of travelling the length of the battery top to charge coal into the ovens.
Coke Car.	Sloping-bottomed tub to catch coke leaving the ovens.
Coke cutter. (breaker)	Device in which coke is reduced in size to a fixed top limit.
Coke side.	The end of the oven from which the coke is discharged.
Coking coal.	Coal which has certain characteristics which make it suitable for coke-making.
Collecting main.	Main which receives the gaseous products from a number of ovens.
Compressor. (booster)	Machine which draws in gas and delivers it at a higher pressure.
Cracking.	Thermal decomposition of volatile products of carbonisation.
Crude benzole.	Benzole as recovered from the gas stream by absorption in wash oil after separation from the wash oil but before rectification into pure products.
Crude tar. (coke oven)	Tar as collected from the crude gas, separated from liquor by settling.
Crusher. (coal)	Device in which coal is reduced to the desired size before charging.



Damper.	Adjustable plate restricting flow of gas or air.
Debenzolized oil. (D.B.O.)	Wash oil from the scrubbers after the absorbed benzole has been distilled off.
Debreezing.	Removal of dust from coke before loading.
Detarrer.	Vessel in which tar fog is removed from gas.
Door extractor.	Device for removing and replacing oven doors.
Ejector.	Part of system for removing sulphate of ammonia from the saturator.
Exhauster.	Compressor used for drawing gas from battery and overcoming back pressure exerted by gas treating plant.
Final Cooler.	Vessel in which the gas temperature is reduced prior to benzole removal.
Flue gas.	Products of combustion in oven heating.
Foundry coke.	Top quality metallurgical coke, with a high mechanical strength and low in sulphur content.
Gas Gallery.	Passages giving access to oven heating equipment.
Guide (coke)	Slat walled movable platform guiding coke from the oven across the coke side bench into a coke car.
Gum.	Nitrogenous sticky substance which sets on gas-governing appliances impairing their operation.
<i>Half and quarter wall reversal</i> Heating. (oven)	<i>Half wall or alternating quarter walls are on gas at any given time.</i> Distribution of burning and burnt gases within the oven walls in such a way as to ensure flue temperatures suitable for carbonisation.
Hydraulic main.	A type of collecting main with an ammoniacal liquor seal.
Lean Gas.	Gas with a low calorific value.
Leveller.	Mechanically operated bar which passes through a small door at the top of the pusher side door during the charging operation and which levels the coal along the length of the oven.
Liquor.	see Ammonia Liquor.
Longitudinal.	along the length of the battery (see Transverse)
Luting.	Sealing of apertures with a clay mix.
M.C.F.D.	<i>Million cubic feet per day</i>
Oven.	Tapered silica brick chamber in which carbonisation takes place.
<i>Producer gas</i> Purification. (gas)	<i>A fuel gas produced by the partial combustion of coke in a controlled supply of air.</i> Removal of hydrogen sulphide.

Pusher machine. (ram)	Machine which operates a ram for pushing coke out of an oven.
Pusher side. (ram side)	The side of the battery on which the pusher machine is situated.
Quencher.	Tower with sprays which discharge water on to coke for cooling purposes.
Reversal.	System whereby the direction of flow of heating gases is reversed at fixed time intervals, normally half-hour.
Regenerators.	Brick ducts where the sensible heat of flue gases is stored, later to be imparted to gas for combustion (preheat).
Rich gas.	• Coke oven gas.
Saturator.	Vessel in which ammonia in gas is removed by conversion to sulphate of ammonia, using a dilute solution of sulphuric acid.
Self-sealing doors.	Oven doors designed to seal themselves against smoke emission.
Service bunker. (bin)	Large storage bunker, holding more than a thousand tons of coal, from which the charging car is filled.
Smokeless charging.	Method of charging ovens to keep smoke emission to a minimum.
<i>Stamp charging</i> Stripping.	<i>Method of charging ovens by pre-forming the coal into a cake.</i> Removal of components of a mixture.
Tie rods.	Bars across the battery, tying the buckstays together.
Transverse. <i>Water gas</i> Wharf.	Across the width of the battery (see longitudinal). <i>A fuel gas obtained by the action of steam on red hot coke.</i> Sloping brickwork structure on which coke is deposited to cool before screening.



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