

This item was submitted to Loughborough's Research Repository by the author. Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Studies in industrial electric heating processes: high-intensity sources and electric discharges

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

Loughborough University of Technology

LICENCE

CC BY-NC 4.0

REPOSITORY RECORD

Harry, John E.. 2021. "Studies in Industrial Electric Heating Processes: High-intensity Sources and Electric Discharges". Loughborough University. https://doi.org/10.26174/thesis.lboro.14847483.v1.

STUDIES IN INDUSTRIAL ELECTRIC HEATING PROCESSES; HIGH INTENSITY SOURCES AND ELECTRIC DISCHARGES

John Ernest Harry

- Material submitted for the award of the Degree of Doctor of Science of Loughborough University of Technology.

CONTENTS

	Page
1. INTRODUCTION	1
2. COMMENTARY	4
2.1. High current arc studies.	4
2.1.1. The a.c. plasma torch.	7
2.2. High intensity sources.	9
2.3. Multiple discharges.	10
2.3.1. Applications for multiple discharges for	12
process heating.	
2.3.2. Application of multiple discharges to the	15
CO, laser.	
2.3.3. Other applications of multiple discharges.	17
2.4. Laser applications.	17
2.5. Control.	18
2.6. Education.	20
2.7. Safety.	21
3. LIST OF PUBLICATIONS	22
3.1. Refereed papers.	22
3.2. Books and contribution to books.	25
3.3. Patents.	26
3.4. Unrefereed papers.	27
3.5. Electricity Council publications.	27
3.6. Occasional papers.	28
4. BIOGRAPHY OF JOHN HARRY	29

5. PUBLICATIONS SUBMITTED

3. LIST OF PUBLICATIONS

3.1 Refereed papers.

- 1. Harry, J.E., Improvements in the operation of continuous working mains frequency plasma torches, Electrochem Soc. Electrothermics and Metallurgy Division Fall Meeting Pa, USA, 4, (2), Ab 219, pp. 54-56, 1966.
- 2. Harry, J.E., Measurement of the stability of an electric arc, Proc. IEE., 133, (12), pp. 2114-2115, 1966.
- 3. Harry, J.E., Rayner, P.J.W., A high current mains frequency synchronous switch, J. Sci. Inst., 1, (5), pp. 570-572, 1968.
- 4. Harry, J.E., Factors affecting the design and performance of a mains frequency plasma torch for industrial process heating, Paper N123, 6th Int. Cong. on Electroheat, Brighton, England, pp. 1-4, 1968.
- 5. Harry, J.E., Guile, A.E., Constricted or diffuse arcs rotating in high magnetic fields in air at atmospheric pressure, Proc. IEE., 115, (7), pp. 1019-1023, 1968.
- 6. Harry, J.E., The measurement of the erosion rate at the electrodes of an arc rotated by a transverse magnetic field, J. Appl. Phys., 40, (1), pp. 265-270, 1969.
- 7. Harry, J.E., A power frequency plasma torch for industrial heating, IEEE Conference Record of 9th Biennial Conf. on Process Heating in Industry, Pa, USA, pp. 85-92, 1969 (subsequently published in IEEE Trans. Industry and General Applications, 6, (1), pp. 36-42, 1970).
- 8. Harry, J.E., Measurement of the electrical parameters of a.c. arcs, IEE Trans. Industry and General Applications, 5, (5), pp. 594-599, 1969.
- Harry, J.E., Design of air cored solenoids, Proc. IEE., <u>117</u>,
 (1), pp. 241-242, 1970.
- 10. Harry, J.E., Characteristics of a magnetic arc operating continuously at atmospheric pressure, AIAA Journal, 9, (8), pp. 1660-1661, 1971.
- 11. Harry, J.E., Measurement of the persistence of luminosity of an arc after interruption, Proc. 10th Conference on Ionisation in Gases, Oxford, p. 211, 1971.
- 12. Harry, J.E., Lunau, F.W., Electrothermal cutting processes using a CO laser, IEEE-IGA Biennial Conf. on Electrothermal Processes in Industry, 1971 (subsequently published in Electrothermal cutting processes using a CO laser, IEEE Trans. Industry Applications, 1A-8, (4), pp. 418-424, 1972).

- 13. Harry, J.E., Lunau, F.W., Measurement of the intensity distribution in a CO laser beam, IEEE J-Quantum Electronics, 7, (6), p. 276, 1971.
- 14. Harry, J.E., Lunau, F.W., Lasers for industrial electroheating processes, Paper N125, 7th Int. Cong. on Electroheat, Warsaw, pp. 1-4, 1972.
- 15. Harry, J.E., Fox, T.J., The intensity distribution of high intensity heat sources, Proc. 10th University Power Engineering Conference, University of Aston, C6, pp. 1-2, 1975.
- 16. Harry, J.E., Wallington, R., Closed loop temperature control of high intensity heat sources, Proc. 10th University Power Engineering Conference, University of Aston, C5, pp. 1-6, 1975.
- 17. Harry, J.E., Hobson, L., The interaction of an induction coupled discharge with a d.c. arc, Proc. International Union of Pure and Applied Chemistry, Conference on Plasma Processes, Odeillo, France, I-7, 1-10, 1975.
- 18. Harry, J.E., Plasma furnaces, Session report Section 1b, 8th Int. Cong. on Electroheat, Liege, pp. 1-5, 1974.
- 19. Fox,T.J., Harry,J.E., Surface heat treatment using a plasma torch with a rectangular jet, IEE Conference, Electricity for Materials Processing pp. 21-23, 1977.
- 20. Goodwin, D., Harry, J.E., Surface heat treatment using a plasma torch with a magnetically traversed arc, Proc. 14th International Conference on Advances in Welding Processes, Harrogate, pp. 181-184, 1978.
- 21. Harry, J.E., Knight, R., A system for the production of a large volume of ionised gas for chemical and metallurgical synthesis, Proc. 14th Universities Power Engineering Conference, Paper 5B, pp. 1.1-1.4, 1979.
- 22. Harry, J.E., Barber, H., Electroheat: Electric power for industrial heating processes, Proc. IEE., 126, (11R), pp. 1126-1148, 1979.
- 23. Harry, J.E., Hobson, L., A multiple-arc system, J. Phys. E. 12, pp. 357-258, 1979.
- 24. Harry, J.E., Hobson, L., Production of a large volume discharge using a multiple arc system, IEEE Trans. on Plasma Science, <u>PS-7</u>, (3), pp. 157-162, 1979.
- 25. Harry, J.E., Magnetically scanned plasma surface heating, IEE Colloquium on Plasma Processing and Heating Applications, 4/1-4/3, 1979.

- 26. Harry, J.E., The use of plasma and d.c. arcs in electric steelmaking, Institution of Metallurgists Conference Report Series 3, (15), pp. 22-27, 1979.
- 27. Harry, J.E., Michalski, L., Examples of applications in electroheat made viable by virtue of their control, International Bulletin of Electroheat, 29, p. 14, 1980.
- 28. Barber, H., Harry, J.E., Greenslade, A.B., Surface heat treatment with a plasma torch using a magnetically traversed arc, Paper VB 6, 9th Int. Congress on Electroheat, Cannes, pp.1-6, 1980.
- 29. Harry, J.E., Hegewaldt, F., Drees, G.W., Gitgarz, D.A., Lobodzinski, W., Steurung von Elektrowarmeanlagen durch Mikroprozessoren, Paper II Cc5, 9th Int. Congress on Electroheat, Cannes, pp. 1-12, 1980.
- 30. Harry, J.E., Knight, R., Simultaneous operation of electric arcs from the same supply, IEEE Trans. Plasma Science, PS.9, (4), pp. 248-254, 1981.
- 31. Automatic Control Study Committee, Handbook of characteristic values, International Union of Electroheat, Paris, pp. 1-48, 1981 (subsequently published in Elecktrowarme International, 40, (B5), pp. 257-267, 1982).
- 32. Harry, J.E., Plasma furnaces for metal reduction; melting and chemical synthesis, IEE Colloquium, pp. 1-6, 1981.
- 33. Hobson, L., Harry, J.E., The production of a large volume electric discharge, 5th International Symposium on Plasma Chemistry, International Union of Pure and Applied Chemistry, 1, pp. 221-229, Edinburgh, 1981.
- 34. Harry, J.E., Saleh, S.N., Multiple electrode system for high power CO₂ laser excitation, Appl. Phys. Letters, 40, (5), pp. 359-361, 1982.
- 35. Harry, J.E., Temperature control of an electric furnace using a micro-processor, Elecktrowarme International, 40, (B6), pp. 303-305, 1982.
- 36. Harry, J.E., Revesz, G., CO laser with multiple discharge excitation for industrial processes, 16th Israel Conference on Mechanical Engineering, Haifa, 2.4, p. 6, 1982.
- 37. Harry, J.E., Electric discharge lamps with multiple electrodes, 3rd International Symposium on the Science and Technology of Light Sources, 18-21 April, Toulouse, France, pp. 86-87, 1983.
- 38. Harry, J.E., Laboratory tests in electric heating processes, International Journal of Electrical Eng. Education, <u>20</u>, (3), pp. 197-213, 1983.

- 39. Harry, J.E., Knight, R., Power supply design for multiple discharge arc processes, 6th International Symposium on Plasma Chemistry, International Union of Pure and Applied Chemistry, Montreal, 1, pp. 150-155, 1983.
- 40. Harry, J.E., Knight, R., Multiple arc discharges for metallurgical reduction or metal melting, Plasma Processing and Synthesis of Materials, Materials Research Society Symposium, Boston, 1983 subsequently published by North Holland, New York, pp. 245-253, 1984.
- 41. Harry, J.E., Knight, R., Investigation of the intensity distribution of large volume multiple discharges, J. Phys. D., 17, pp. 343-350, 1984.
- 42. Harry, J.E., Knight, R., High current multiple electrodes for use in arc furnaces, Paper 2.2.2, pp. 1-10, 10th International Congress on Electroheat, Stockholm, 1984, (subsequently published in Steel Times 213, (10), pp 486-487, 1985).
- 43. Barber, H., Harry, J.E., Report on UIE Study Committee on Education, Research Laboratories, 10th International Congress on Electroheat, Stockholm, Paper N.1.7, pp. 1-6, 1984.
- 44. Harry, J.E., Power supply design for plasma processes, IEE Colloquium Digest 1985/86, Thermal Plasma Industrial Processes pp. 3/1-3/2, 1985.
- 45. Harry, J.E., Knight, R., A multiple arc discharge reactor for materials processing, 7th International Symposium on Plasma Chemistry, 4, pp. 1192-1195, Eindhoven 1985.
- 46. Hodge, D., Harry, J.E., Knight, R., A plasma furnace system for chemical and metallurgical processes, 7th International Symposium on Plasma Chemistry, Workshop pp. 40-44, Eindhoven 1985.
- 47. Harry, J.E., Knight, R., Multiple electric discharges, Proc. IEE, 133A, (1), pp. 50-57, 1986.
- 3.2. Books and contributions to books (title and contents pages only submitted except for 49 and 50 which are also submitted separately).
- 48. Harry, J.E. et al., Furnace design, pp. 207-214, High Temperature Chemical Reaction Engineering, Ed. Roberts, F., Taylor, R.F., Jenkins, T.R., Inst. Chem. Eng., London, 1971.
- 49. Harry, J.E., Plastics Fabrication and Electrotechnology, Heyden, London, pp 1-141, 1971 (submitted separately).
- 50. Harry, J.E., Industrial Lasers and their Applications, McGraw-Hill, London, pp. 1-189, 1974 (Translated into Hungarian 1979) (English edition submitted separately).

- 51. Harry, J.E., Automation control and measurement, C24, pp. 1-33, Electronic Engineers Reference Book, 4th Edition, Ed. Turner, L.W., Butterworth, London, 1975.
- 52. Barber, H., Harry, J.E., Resistance heating, C7, pp. 95-97, The Efficient Use of Energy, 5th Edition, IPC Science and Technology Press, London, Ed. Dryden, I.G.C., 1975.
- 53. Harry, J.E., Indirect resistance heating, pp. 3.1-3.54, Industrial Process Heating and Electroheat, IEE Continuing Education Service, 1979.
- 54. Harry, J.E., High intensity sources (Plasma torches and lasers), pp. 11.1-11.14, 11.30-11.32, Industrial Process Heating and Electroheat. IEE Continuing Education Service, 1979.
- 55. Harry, J.E., Barber, H., Electroheat, pp. 21/1-21/20, Electrical Engineers Reference Book, 14th Edition, Ed. Laughton, M.A., Say, M.G., Butterworth, London, 1983.
- 56. Harry, J.E., Control, C35, pp. 1-12, Transducers, C48, pp. 1-9 Electronics Engineers Reference Book, 5th Edition, Ed. Mazda, F., Butterworth, London 1983.
- 57. Harry, J.E., Barber, H., Electroheat, G3, pp. 1-37, Kempe's Engineers Yearbook 88th Edition, Ed Quayle, J.P., Morgan-Grampian, London, 1983.
- 58. Harry, J.E., Non-Ionizing radiation, Section 7B, pp. 1-38, Dangerous Substances, Wolters Samson, (London), 1983.
- 59. Electroheat worked examples, International Union of Electroheat, Paris, pp. 1-161, 1985.
- 3.3 Patents
 (title pages only submitted except for 68)
 - 60. Emmerson, D., Harry, J.E., Modification of fibres by electrical discharge treatment, UK Patent 1,300,088, 1972.
 - 61. Wijetunga, S.P., Harry, J.E., Cutting materials, UK Patent 1,365,673, 1974.
 - 62. Blake, P.D., Lunau, F.W., Harry, J.E., Welding electrodes, UK Patent 1,374,577, 1974.
 - 63. Harry, J.E., Fox, T.J., Plasma Torches, UK Patent 1,543,164, 1979.
 - 64. Burnham, R.F., Gibbon, A., Harry, J.E., Plasma arc furnaces, European Patent Application 0,096,493, 1983 (also USA).
 - 65. Harry, J.E., Improvements in or relating to plasma torches, UK Patent 2,145,310B, 1985.
 - 66. Harry, J.E., Improvements in or relating to lasers and methods of operating lasers, UK Patent 2,145,589B, 1985 (also Canada and USA).

- 67. Harry, J.E., Improvements in or relating to lasers and methods of operating lasers, UK Patent 2,145,591B, 1985 (also Canada and USA).
- 68. Harry, J.E., Evans, D.R., Gas lasers, European Patent Application 85.307913.5, 1985 (also Canada, Israel, Japan, Korea and USA). Full patent application submitted.
- 69. Harry, J.E., Evans, D.R., Electric discharge apparatus, UK Patent Application 2,167,928A, 1986 (also foreign applications).
- 3.4 Unrefereed Papers.
 - 70. Harry, J.E., Plasma torches, Electrical Times, 154, (9), pp. 14-16 (Supplement), 1968.
 - 71. Harry, J.E., Developments in electrical process heating, Electrical Times, 155, (23), pp. 46-47, 1969.
 - 72. Harry, J.E., Laser cutting in the sheet metal industry, Sheet Metal Industries and Steel Times Stockholding Issue, pp. 69-70, 1970.
 - 73. Harry, J.E., Lasers for cutting and piercing, Welding in the World, 10, (7/8), p. 226, 1972.
 - 74. McMillin, C.W., Harry, J.E., Laser machining of southern pine, Forest Products Journal, 21, 10, pp. 35-37, 1972.
 - 75. Barber, H., Harry, J.E., Electroheat Warsaw 1972, Industrial Process Heating, 12, (12), pp. 9-11, 1972.
 - 76. Harry, J.E., Air and water uprate plasma torch, Electrical Times, Aug. 15/22, p.15, 1974.
 - 77. Harry, J.E., Deep welds in thick steel make C.E.G.B. look hard at lasers, The Engineer, 19/26, p. 25, 1974.
 - 78. Harry, J.E., Plasma techniques boosted by energy and resource scarcities, Electrical Review, 208, (8), pp. 25-26, 1981.
- 3.5. Electricity Council Publications (not submitted).
 - 79. Harry, J.E., Laboratory notes on electroheat 1976 Electroheat Teaching Workshop Notes, Ed. Harry, J.E., British National Committee for Electroheat, 1980.
 - 80. Harry, J.E., Laboratory work in electroheat, ibid (also published in International Journal of Electrical Engineering Education, 38).

- 81. Electricity Council Notes on Electroheat.
 - 1. Solution of electromagnetic, electrical and thermal conduction fields, pp. 63-85.
 - 2. Heat transfer temperature measurement and control, pp. 1-99.
 - 3. Heat treatment of metallic materials; electric ovens and furnaces, pp. 1-89.
 - 4. Heating of non-metallic materials, pp. 1-42.
 - 5. Metal melting; electric metal melting, refining and smelting, pp. 1-34.
- 82. Barber, H., Harry, J.E., Hobson, L., Electric heating elements, Electroproduction Teaching Information, Note 3, 1985.
- 3.6. Occasional Publications (not submitted).
 - 83. Harry, J.E., Electric power for industrial process heating, Association for Science Education Annual Meeting, Kent, 1982.
- 84. Safety in electroheat installations Part 5: Specifications for Safety in plasma installations, IEC Standard 519-15, pp. 1-18, 1980.
- 85. Harry, J.E., Knight, R., The application of large volume plasmas produced by multiple arcs to high temperature material processing, Gordon Research Conference, Tilton USA, August 1984.