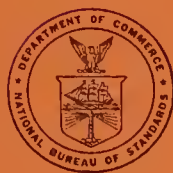


Bibliography on Ignition and Spark-Ignition Systems



U.S. Department of Commerce

National Bureau of Standards

Miscellaneous Publication 251

THE NATIONAL BUREAU OF STANDARDS

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The functions of the National Bureau of Standards include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications, including assistance to industry, business and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on page 26.

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UNITED STATES DEPARTMENT OF COMMERCE • Luther H. Hodges, Secretary
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Bibliography on Ignition and Spark-Ignition Systems

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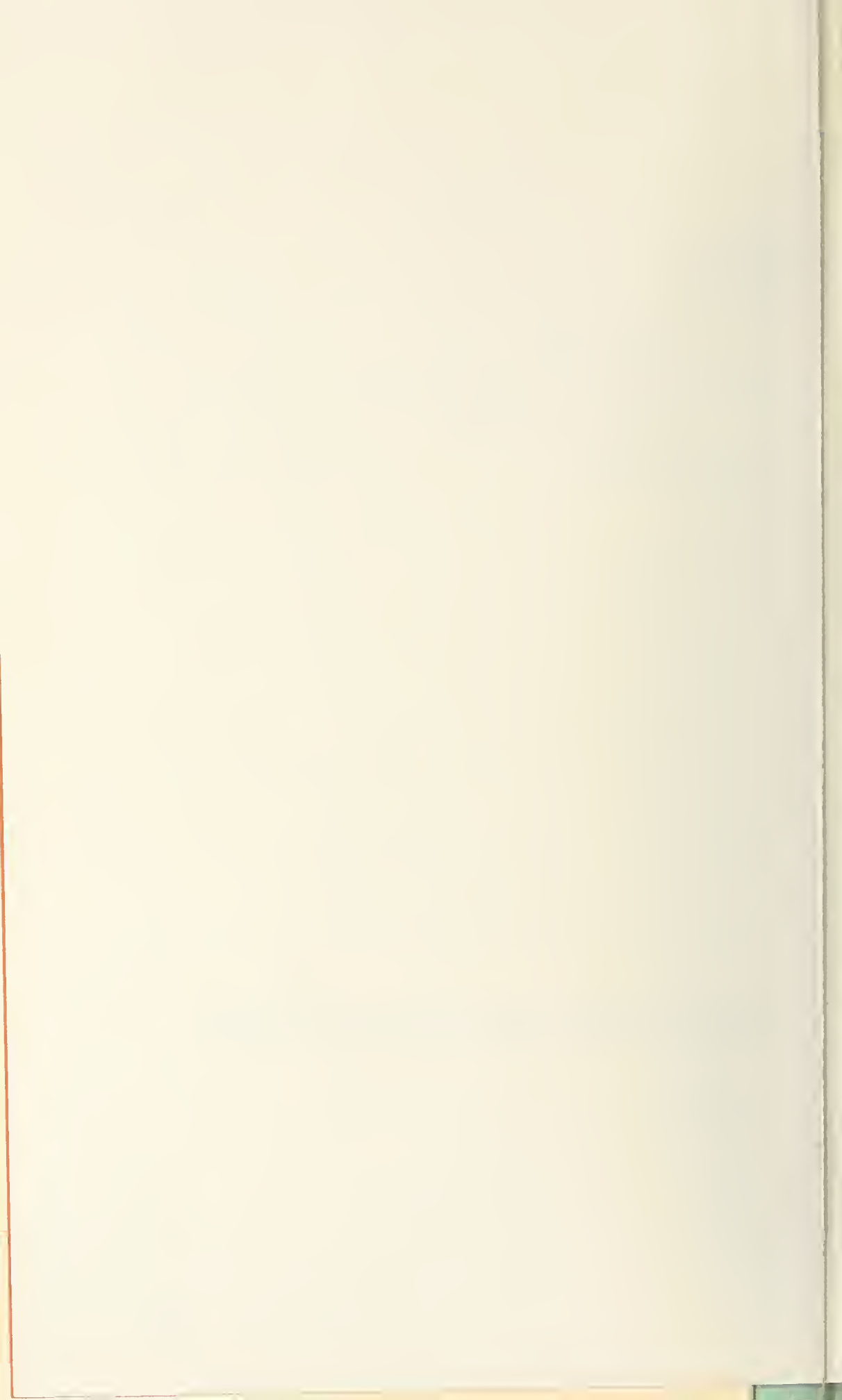
(Supersedes NBS Circular 580)



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Bibliography on Ignition and Spark-Ignition Systems

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Approximately 730 references to books, papers, and reports are listed on ignition of combustible gaseous mixtures and ignition apparatus. The ignition of gases includes ignition by electric sparks and arcs and by hot surfaces. The references on ignition apparatus are for the most part on ignition systems and components for internal-combustion engines, with spark plugs listed separately from other components.

1. Introduction

This publication supersedes National Bureau of Standards Circular 580. It covers the initiation of combustion in explosive gaseous mixtures by means other than compression ignition, as well as electric equipment for spark-ignition engines.

Part 2.1 lists books in which ignition or ignition equipment is either the main topic or is given fairly extensive treatment.

The references to other publications are presented under three main heads. The first concerns ignition of combustible mixtures of gases and vapors, and is subdivided into two parts, according to whether ignition is effected by an electric spark or arc or by a heated surface. Part 2.2.a includes references to work on measuring spark energy. Part 2.2.b covers both fundamental investigations of ignition by heated surfaces and ignition by hot spots in internal-combustion engines.

Although ignition is an essential stage in the combustion process, papers dealing primarily with the kinetics of combustion, flame propagation, and detonation, or with the flammability limits of composition, temperature, and pressure of gases, have not been included in this bibliography unless they were found to contribute also to an understanding of ignition phenomena.

Part 2.3 lists references on spark-ignition systems for internal-combustion engines, and their components. It includes work on testing and test equipment. Because there are so many references to spark plugs, these are listed separately as part 2.3.b.

Part 2.4 contains miscellaneous references on ignition that do not fall within the category of part 2.2. Included are a number of papers and reports concerning explosion hazards and ignition of fuels used in rocket propulsion.

Within each topical subdivision the references are given in chronological order, and within each chronological subdivision, alphabetically by author, followed by anonymous references.

The journal abbreviations used are those employed in Chemical Abstracts, except that the abbreviation NACA is used for the National Advisory Committee for Aeronautics and SAE J. for the Journal of the Society of Automotive Engineers. An unpublished paper presented before a technical or professional society is designated by the abbreviation M. P. for Meeting Paper. Volume numbers are in boldface, and the date of issue is given in cases where page numbers do not run consecutively through a given volume.

In general, the reports and papers listed are available only in libraries, and none can be supplied by the Bureau. The Federal Specification for Spark Plugs, W-S-506(2) (listed in part 2.3.b), may be obtained for 10 cents from the Business Service Center, Federal Supply Service, General Services Administration Regional Office, Washington D.C. 20407. The sources of translation of several articles in foreign languages are given. Some of these are available from the Office of Technical Services (OTS), U.S. Department of Commerce, Washington D.C. 20230. That agency can usually furnish information as to the availability of translations of other foreign-language articles. Information as to the availability of other reports should be obtained from the author or from the sponsoring organization.

2. Bibliography

2.1. Books

- Consoliver, E. L., and G. S. Mitchell, *Automotive ignition systems* (McGraw-Hill Book Co., New York, 1920).
- Consoliver, E. L., *Automotive electricity* (McGraw-Hill Book Co., New York, 1925).
- Bone, W. A., and D. T. A. Townend, *Flame and combustion in gases* (Longmans, Green and Co., London, 1927).
- Kirkby, W. A., *Flame* (Methuen and Co., Ltd., London, 1936).
- Automotive electricity* (Technical Manual No. 10-580, War Department, Washington, 1941).
- Morgan, J. D., *The principles of ignition* (Sir Isaac Pitman and Sons, Ltd., London, 1944).
- Kuns, R. F., and T. C. Plumridge, *Automobile ignition and electrical equipment* (American Technical Society, Chicago, 1945).
- Packer, A. H., *Electrical trouble shooting on the motor car*, 5th ed. (Battery Man Publishing Co., Terre Haute, Ind., 1945).
- Jost, W., *Explosion and combustion processes in gases* (McGraw-Hill Book Co., New York, 1946).
- Third symposium on combustion, flame and explosion phenomena* (The Williams and Wilkins Co., Baltimore, 1949).
- Bowden, F. P., and A. D. Yoffe, *Initiation and growth of explosion in liquids and solids* (Cambridge University Press, 1952).
- Gaydon, A. G., and H. G. Wolfhard, *Flames—their structure, radiation and temperature* (Chapman and Hall, Ltd., London, 1953).
- Fourth symposium on combustion* (The Williams and Wilkins Co., Baltimore, 1953).
- Spreadbury, F., *Electrical ignition equipment* (Constable and Co., Ltd., London, 1954).
- Advisory Group for Aeronautical Research and Development (AGARD), North Atlantic Treaty Organization, *Selected combustion problems I. Fundamentals and aeronautical applications* (Butterworths Scientific Publications, London, 1954).
- Rao, N. N. N., *The high-tension spark plug, its evolution, present state of development and manufacture* (Indian Institute of Science, Bangalore, 1955).
- Fifth symposium on combustion: combustion in engines and combustion kinetics* (Reinhold Publishing Corp., New York, 1955).
- Balkevich, V. L., *Insulators for internal combustion engine spark plugs* (Gos. izd-vo lit-ry po stroit, Moscow, 1956).
- Gatti, M., *Ignition of explosive engines: the magneto, the coil, and the flywheel magneto* (G. Lavagnolo, Turin, 1956).
- Advisory Group for Aeronautical Research and Development (AGARD), North Atlantic Treaty Organization, *Selected combustion problems II. Transport phenomena; ignition; altitude behaviour and scaling of aero engines* (Butterworths Scientific Publications, London, 1956).
- Kolychev, N., *Marine internal combustion engines* (State Publishing House for the Shipbuilding Industry, Leningrad, 1957).
- Sixth symposium on combustion* (Reinhold Publishing Corp., New York, 1957).

- Klinkenberg, A., and J. L. van der Minne, *Electrostatics in the petroleum industry—the prevention of explosion hazards* (Elsevier Publishing Co., Amsterdam, 1958).
- Mullins, B. P., and S. S. Penner, *Explosion, detonation, flammability and ignition*, AGARDograph No. 31 (Pergamon Press, Oxford, 1959).
- Seventh symposium on combustion (Butterworths Scientific Publications, London, 1959).
- Electrical safety abstracts and references (Instrument Society of America, Pittsburgh, 1960).
- Lewis, B., and G. von Elbe, *Combustion, flames and explosions of gases* (Academic Press, New York, 1961).
- Tune-up manual (Ignition Manufacturers Institute, Cleveland, 1961).

2.2. Ignition of Combustible Mixtures

a. Electric Ignition

- Kirkby, P. J., The effect of the passage of electricity through a mixture of oxygen and hydrogen at low pressures, *Phil. Mag.* (6) 7, 223 (1904).
- Kirkby, P. J., The union of hydrogen and oxygen at low pressures through the passage of electricity, *Phil. Mag.* (6) 9, 171 (1905).
- Kirkby, P. J., Chemical effects of the electric discharge in rarefied hydrogen and oxygen, *Phil. Mag.* (6) 13, 289 (1909).
- Kirkby, P. J. A theory of the chemical action of the electric discharge in electrolytic gas, *Proc. Roy. Soc. (London)* [A] 85, 151 (1911).
- Coward, H. F., C. Cooper, and C. H. Warburton, The ignition of electrolytic gas by the electric discharge, *J. Chem. Soc.* 101, 2278 (1912).
- Thornton, W. M., Ignition of coal gas and methane by momentary electric arcs, *Trans. Inst. Mining Engr. (London)* 44-1, 145 (1912).
- Thornton, W. M., The ignition of gaseous mixtures by momentary electric arcs, *Brit. Assoc. Advan. Sci. Rept. 82d Meeting*, 564 (1912).
- Coward, H. F., C. Cooper, and J. Jacobs, The ignition of some gaseous mixtures by the electric discharge, *J. Chem. Soc.* 105, 1069 (1914).
- Thornton, W. M., Electric ignition of gaseous mixtures, *Proc. Roy. Soc. (London)* [A] 90, 272 (1914).
- Thornton, W. M., Ignition of gases by condenser discharge sparks, *Proc. Roy. Soc. (London)* [A] 91, 17 (1914).
- Thornton, W. M., Least energy required to start a gaseous explosion, *Phil. Mag.* 28, 734 (1914).
- Morgan, J. D., The ignition of explosive gases by electric sparks, *J. Inst. Elec. Engr. (London)* 54, 196 (1916); *J. Am. Soc. Mech. Engr.* 39, 86 (1917); *J. Chem. Soc.* 115, 94 (1919).
- Sastry, S. G., The ignition of mixtures of methane and air and hydrogen and air by means of impulsive electric discharge, *J. Chem. Soc.* 109, 523 (1916).
- Thornton, W. M., Ignition of gases by impulsive electrical discharge, *Proc. Roy. Soc. (London)* [A] 92, 381 (1916).
- Thornton, W. M., Reaction between gas and pole in electrical ignition of gaseous mixtures, *Proc. Roy. Soc. (London)* [A] 92, 9 (1916).
- Wheeler, R. V., "Stepped" ignition, *J. Chem. Soc.* 111, 130 (1917).
- Wheeler, R. V., Influence of pressure on the ignition of a mixture of methane and air by the impulsive electric discharge, *J. Chem. Soc.* 111, 411 (1917).
- Wright, R., Spark length in various gases and vapors, *J. Chem. Soc.* 111, 643 (1917).
- Campbell, N. R., The influence of the electrode on the ignition of explosive mixtures by sparks, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 27* (1918).
- Paterson, C. C., and N. R. Campbell, Experiments on the ignition of explosive mixtures by sparks, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 43* (1918).
- Paterson, C. C., and N. R. Campbell, The characteristics of the spark discharge and its effect in igniting explosive mixtures, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 23* (1918).
- Paterson, C. C., and N. R. Campbell, The expenditure of current and energy required for ignition in an explosion engine, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 25* (1918).
- Baird, G. E., and J. A. Hughes, On the spark energy of electrical ignition systems, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 51* (1919).

- Paterson, C. C., and N. R. Campbell, Some characteristics of the spark discharge and its effect in igniting explosive mixtures, *Proc. Phys. Soc. (London)* 31, 168 (1919).
- Silsbee, F. B., L. B. Loeb, and E. L. Fonseca, Heat energy of various ignition sparks, *NACA Rept.* 56 (1919).
- Thornton, W. M., Ignition of gases at reduced pressures by impulsive electric sparks, *Phil. Mag.* (6) 40, 345 (1920).
- Thornton, W. M., Ignition of gases at reduced pressures by transient arcs, *Phil. Mag.* (6) 40, 450 (1920).
- Wheeler, R. V., The ignition of gases: Part I. Ignition by the impulsive electric discharge—mixtures of methane and air, *J. Chem. Soc.* 117, 903 (1920).
- Young, A. P., and H. Warren, The process of ignition, *Automobile Engr.* 10, 115 (1920).
- Bailey, B. F., Underlying principles of electrical ignition, *SAE J.* 8, 570 (1921).
- Morgan, J. D., and R. V. Wheeler, Phenomena of the ignition of gaseous mixtures by induction coil sparks, *J. Chem. Soc.* 119, 239 (1921).
- Thornburgh, H. A., and E. B. Weaver, A calorimeter for determining the heat of ignition sparks, *Automotive Ind.* 45, 523 (1921).
- Kratz, A. P., and C. Z. Rosecrans, Study of explosions of gaseous mixtures, *Univ. Illinois Eng. Expt. Sta. Bull.* 133 (1922).
- Taylor-Jones, E., J. D. Morgan, and R. V. Wheeler, On the form of temperature wave spreading from point and spherical sources, with a suggested application to the problem of spark ignition, *Phil. Mag.* (6) 43, 359 (1922).
- Morgan, J. D., Some observations on the ignition of combustible gases by electric sparks, *Phil. Mag.* (6) 45, 968 (1923).
- Thornton, W. M., The mechanism of gas ignition, *Brit. Assoc. Advan. Sci. Rept.*, 91st Meeting, 469 (1923).
- Randolph, D. W., and F. B. Silsbee, Flame speed and spark intensity, *NACA Rept.* 187 (1924).
- Wheeler, R. V., The ignition of gases, III. Ignition by the impulsive electric discharge, Mixtures of the paraffins and air, *J. Chem. Soc.* 125, 1858 (1924).
- Morgan, J. D., The thermal theory of gas ignition by electric sparks, *Phil. Mag.* 49, 323 (1925).
- Wheeler, R. V., The ignition of gases, V. Ignition by inductance sparks, Mixtures of the paraffins with air, *J. Chem. Soc.* 127, 14 (1925).
- Finch, G. I., L. G. Cowen, D. L. Hodge, H. H. Thompson, and W. T. Patrick, Gaseous combustion in electric discharges, *Proc. Roy. Soc. (London)* [A] 111, 257 (1926); [A] 116, 529 (1927); [A] 124, 303 (1929); [A] 129, 314, 656, and 672 (1930).
- Wheeler, R. V., The electric ignition of firedamp: alternating and continuous current compared, *Gt. Brit. Safety in Mines Res. Board*, Paper 20 (1926).
- Bone, W. A., The initial stages of gaseous explosions, III. The behavior of an equi-molecular methane-oxygen mixture when fired with sparks of varying intensities, *Proc. Roy. Soc. (London)* [A] 114, 442 (1927).
- Coward, H. F., and E. G. Meiter, Chemical action in the electric spark discharge, The ignition of methane, *J. Am. Chem. Soc.* 49, 396 (1927).
- Taylor-Jones, E., Spark ignition, *Phil. Mag.* (7) 6, 1090 (1928).
- Peters, M. F., W. Summerville, and M. Davis, An investigation of the effectiveness of ignition sparks, *NACA Rept.* 359 (1930).
- Finch, G. I., and H. H. Thompson, The effect of frequency on the condensed discharge ignition of carbonic oxide-air detonating gas, *Proc. Roy. Soc. (London)* [A] 134, 343 (1931).
- Morgan, J. D., Some further experiments on the combustion of inflammable gases by electric sparks, *Phil. Mag.* (7) 11, 158 (1931).
- Bradford, B. W., G. I. Finch, and A. M. Prior, The coil ignition of some explosive gaseous mixtures, *J. Chem. Soc.* 1933, 227.
- Kontorova, T. A., Ignition of mixtures of hydrogen and oxygen by electric sparks, *Zh. Fiz. Khim.* 4, 64 (1933).
- Lewis, B., and C. D. Kreutz, Influence of ionization on the ignition temperature of combustible gases, *J. Chem. Phys.* 1, 89 (1933).
- Bradford, B. W., G. I. Finch, and A. M. Prior, The ignition of some explosive mixtures by modified coil discharges, *J. Chem. Soc.* 1934, 75.
- Finch, G. I., and G. Mole, The mechanism of electrical ignition, *Proc. Inst. Automobile Engr. (London)* 29, 71 (1934).
- Morgan, J. D., Experiment relating to the thermal and electrical theories of spark ignition, *Phil. Mag.* (7) 18, 827 (1934).
- Tchang, Te-Lou, A new method of ignition in internal combustion engines, *Compt. Rend.* 198, 542 (1934).

- Browne, K. A., Aircraft spark-ignition versus compression-ignition engines, SAE J. 37, 342 (1935).
- Wheeler, R. V., Ignition of turbulent explosive mixtures by electric sparks, Fuel 14, 147 (1935).
- Mole, G., The ignition of explosive gases, Proc. Phys. Soc. (London) 48, 857 (1936).
- Bradford, B. W., and G. I. Finch, The mechanism of ignition by electric discharges, Chem. Rev. 21, 221 (1937).
- Landau, H. G., The ignition of gases by local sources, Chem. Rev. 21, 245 (1937).
- Viallard, R., Ignition of explosive mixtures by electric sparks, Compt. Rend. 207, 1045 (1938); J. Chem. Phys. 40, 54 and 101 (1943); J. Chem. Phys. 16, 555 (1948).
- Zeise, H., The physical-chemical problem of the ignition of gas mixtures in engines, Z. Elektrochem. 47, 238 (1941).
- Goto, R., and K. Urakubo, The explosive reactions of gases: the pressure effect of spark ignition of oxy-hydrogen gas, Rev. Phys. Chem. (Japan) 16, 28 (1942).
- Toriyama, V., and S. Saito, Ignition of flammable gases, Inst. Elec. Engr. (Japan) 62, 427 (1942).
- Guest, P. G., Apparatus for determining minimum energies for electric-spark ignition of flammable gases and vapors, U.S. Bur. Mines Rept. Invest. 3753 (1944).
- Linnett, J. W., E. J. Raynor, and W. E. Frost, The mechanism of spark ignition, Trans. Faraday Soc. 41, 487 (1945); 44, 416 and 421 (1948).
- Blanc, M. V., P. G. Guest, G. von Elbe, and B. Lewis, Ignition of explosive gas mixtures by electric sparks, I. Minimum ignition energies and quenching distances of mixtures of methane, oxygen and inert gases, J. Chem. Phys. 15, 798 (1947).
- Boyle, A. R., and F. J. Llewellyn, The electrostatic ignitability of various solvent vapor-air mixtures, J. Soc. Chem. Ind. (London) 66, 99 (1947).
- Hoerl, Jr., A. E., Ignition of gases and vapors by sparks, Gas 23, 60 (1947).
- Lewis, B., and G. von Elbe, Ignition of explosive gas mixtures by electric sparks, II. Theory of the propagation of flame from an instantaneous point source of ignition, J. Chem. Phys. 15, 803 (1947).
- Lewis, B., and G. von Elbe, Minimum spark energy for ignition of explosive gases and its significance in flame propagation, Proc. Eleventh Intern. Congr. Pure and Appl. Chem. (London) 4, 523 (1947).
- Mache, H., Increasing ignition power of electric sparks by locally changing the gas mixture, Oesterr. Ingr.-Arch. 1, 273 (1947).
- Rehfisch, T. J., and W. Nethercot, Determination of energy dissipated in capacitive discharges across small gaps by means of the high-speed oscillograph, Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T197 (1947).
- Cipriani, C., and L. H. Middleton, A modern approach to ignition, SAE J. 56, 47 (Oct. 1948).
- Lewis, B., and G. von Elbe, Ignition and flame stabilization in gases, Trans. Am. Soc. Mech. Engr. 70, 307 (1948).
- Nethercot, W., and T. J. Rehfisch, The oscillographic study of the spark arising from the interruption of a current in an inductive circuit with particular reference to intrinsic safety, Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T217 (1948).
- Swett, Jr., C. C., Investigation of spark gaps subjected to altitude and air-velocity conditions, NACA Res. Mem. E8117 (Nov. 1948).
- Allsop, G., and E. M. Guenault, The incendivity of electric sparks in relation to the characteristics of the circuit, Third symposium on combustion, flame and explosion phenomena, 341, Williams and Wilkins, Baltimore (1949).
- Blanc, M. V., P. G. Guest, G. von Elbe, and B. Lewis, Ignition of explosive gas mixtures by electric sparks, III. Minimum ignition energies and quenching distances of mixtures of hydrocarbons and ether with oxygen and inert gases, Third symposium on combustion, flame and explosion phenomena, 363, Williams and Wilkins, Baltimore (1949).
- Friedman, R., and E. Burke, Spark ignition of gas mixtures, J. Chem. Phys. 17, 667 (1949).
- Linnett, J. W., and D. M. Nutbourne, The spark ignition of nitrous-oxide hydrogen mixtures, Third symposium on combustion, flame and explosion phenomena, 336, Williams and Wilkins, Baltimore (1949).
- Morris, H., Ignition of gas mixtures by electric sparks, Third symposium on combustion, flame and explosion phenomena, 361, Williams and Wilkins, Baltimore (1949).

- Swett, Jr., C. C., Effect of gas stream parameters on the energy and power dissipated in a spark and on ignition, Third symposium on combustion, flame and explosion phenomena, 353, Williams and Wilkins, Baltimore (1949).
- Swett, Jr., C. C., and R. H. Donlon, Spark ignition in flowing gases, NACA Res. Mem. E9E17 (Aug. 1949); E51J12 (Dec. 1951); E52J28 (Jan. 1953); E54F29a (June 1954); E55I16 (Nov. 1955).
- von Elbe, G., and B. Lewis, Theory of ignition, quenching and stabilization of flames of non-turbulent gas mixtures, Third symposium on combustion, flame and explosion phenomena, 68, Williams and Wilkins, Baltimore (1949).
- von Elbe, G., and B. Lewis, Theory of inflammation, extinction and stabilization of flames, Rev. Inst. Franc. Petrole 4, 374 (1949).
- Zel'dovich, Y. B., and N. N. Simonov, Theory of the spark ignition of explosive gas mixtures, Zh. Fiz. Khim. 23, 1361 (1949).
- Bechert, K., The theory of ignition limits and the ignition of combustible gas mixtures, Ann. Phys. 7, 113 (1950); Chem. Zentr. 1950, II, 1669.
- Jost, W., Theory of flame velocity, III. Elementary considerations on spark ignition, Z. Phys. Chem. 196, 298 (1950).
- Fenn, J. G. Lean flammability limit and minimum spark ignition energy, Ind. Eng. Chem. 43, 2865 (1951).
- Jost, W., and L. Sieg, Investigations of flames, IV. Investigation of ignition of explosive gas mixtures by sparks, Z. Elektrochem. 55, 13 (1951).
- Jost, W., Investigations of flame velocity, V. Broader discussion of spark ignition. Z. Elektrochem. 55, 17 (1951).
- Lötsch, H., Ignition of flowing propane-air mixture by an electric spark, Monatsh. Chem. 82, 714 (1951).
- Roth, W., P. G. Guest, G. von Elbe, and B. Lewis, Heat generation by electric sparks, and rate of heat loss to the spark electrodes, J. Chem. Phys. 19, 1530 (1951).
- Calcote, H. F., C. A. Gregory, C. M. Barnett, and R. B. Gilmer, Spark ignition: effect of molecular structure, Ind. Eng. Chem. 44, 2656 (1952).
- Metzler, A. J., Minimum ignition energies of six pure hydrocarbon fuels of the C₂ and C₆ series, NACA Res. Mem. E52F27 (Aug. 1952).
- Olsen, H. L., R. H. Edmonson, and E. L. Gayhart, Microchronometric schlieren study of gaseous expansion from an electric spark, J. Appl. Phys. 23, 1157 (1952).
- Sims, M. W., and A. M. Krakower, Simple calorimeter for measurement of spark energy, Automotive Ind. 107, 65 (Oct. 1, 1952).
- Arnold, J. S., and R. K. Sherburne, Observations of the ignition and incipient flame growth in hydrocarbon-air mixtures, Fourth symposium on combustion, 139, Williams and Wilkins, Baltimore (1953).
- Krawtschenko, W. S., The igniting ability of electric sparks, Deut. Elektrotech. 7, 153 (1953).
- Kumagai, S., T. Sakai, and I. Kimura, Effect of ultrasonic waves on flame propagation and spark ignition, Fourth symposium on combustion, 148, Williams and Wilkins, Baltimore (1953).
- Laffitte, P., and R. Delbourgo, Ignition by condenser sparks: regions of flammability of ethane, propane, n-butane and n-pentane, Fourth symposium on combustion, 114, Williams and Wilkins, Baltimore (1953).
- Metzler, A. J., Minimum spark-ignition energies of 12 pure fuels at atmospheric and reduced pressure, NACA Res. Mem. E53H31 (Oct. 1953).
- Olsen, H. L., E. L. Gayhart, and R. B. Edmonson, Propagation of incipient spark-ignited flames in hydrogen-air and propane-air mixtures, Fourth symposium on combustion, 144, Williams and Wilkins, Baltimore (1953).
- Richmond, J. K., and A. L. Furno, Production and measurement of surge ignition sparks, Rev. Sci. Inst. 24, 1107 (1953).
- von Elbe, G., The problem of ignition, Fourth symposium on combustion, 13, Williams and Wilkins, Baltimore (1953).
- Relative burning velocities, ignition energies and quenching distances for 12 fuels, SAE and Am. Petrol. Inst., Coordinating Research Council Rept. (1953).
- Edmonson, R. B., H. L. Olsen, and E. L. Gayhart, Application of ideal gas theory to the gaseous expansion from an electric spark, J. Appl. Phys. 25, 1008 (1954).
- Fushimi, K., and T. Kutsuwada, Ignition of methane-air mixtures of sparks of contact opening, Bull. Electrotech. Lab. Japan 18, 43 (1954).
- Gibbons, L. C., H. C. Barnett, and M. Gerstein, Effect of molecular structure on combustion behavior, Ind. Eng. Chem. 46, 2150 (1954).
- Lloyd, P., and B. P. Mullins, The problem of combustion at high altitude, AGARD Selected combustion problems I, 405, Butterworths, London (1954).

- Marble, F. E., and T. C. Adamson, Jr., Ignition and combustion in a laminar mixing zone, AGARD Selected combustion problems I, 111, Butterworths, London (1954).
- Mullins, B. P., Combustion in vitiated air, AGARD Selected combustion problems I, 447, Butterworths, London (1954).
- Flame and ignition phenomena: minimum spark energy, Semiannual progress report on Project Squid, Princeton Univ. (Oct. 1954).
- Itin, A. V., Experimental investigation of the ignition of mine gas by sparks which arise in electrical circuits at various frequencies, Izv. Dnepropetr. Gorn. Inst. 23, 191 (1955); Referat. Zh. Elektrotekh. No. 34 (1956).
- Krug, I. R., and H. F. Calcote, Effect of initial temperature on minimum spark-ignition energy, J. Chem. Phys. 23, 2444 (1955).
- Cristea, P., Preignition, autoignition and post ignition, Rev. Transport. 3, 176 (1956).
- Gershman, I. I., and M. N. Kukharev, Investigation of ignition and fuel combustion in a motorless laboratory device, Avtomob. i Trakt. Prom., 9 (April 1956).
- Hughes, E. C., P. S. Fay, L. S. Szabo, and R. C. Tupa, Effect of boron compounds on combustion processes, Ind. Eng. Chem. 48, 1858 (1956).
- Kimura, I., and S. Kumagai, Spark ignition of flowing gases, J. Phys. Soc. Japan 11, 599 (1956).
- Moser, C. F., and R. K. Sherburne, Studies of the ignition of gaseous hydrocarbons, Proc. Gas Dyn. Symp. Aerothermochem., 159, Northwestern Univ., Evanston (1956).
- Parlin, R. B., and J. C. Giddings, Explosive-ignition phenomena, J. Chem. Phys. 25, 1161 (1956).
- Vasilescu, A., and V. Pimsner, The influence of poor dosages on the characteristics of power of motors with liquid fuel and spark ignition, transformed to operate with natural gas, Studii Cercetari Energetica 6, 243 (1956).
- Wigg, L. D., The ignition of flowing gases, AGARD Selected combustion problems II, 73, Butterworths, London (1956).
- Brokaw, R. S., and M. Gerstein, Correlation of burning velocity, quenching distances and minimum ignition energies for hydrocarbon-oxygen-nitrogen systems, Sixth symposium on combustion, 66, Reinhold, New York (1957).
- Kubin, P., The ignition spark and engine performance, Automobil (Czechoslovakia) 1, 342 (1957).
- Swett, Jr., C. C., Spark ignition of flowing gases using long-duration discharges, Sixth symposium on combustion, 523, Reinhold, New York (1957).
- Viculin, J., The electric spark and explosive mixture in the ignition system, Vojno Tehnicki Glasnik 5, 500 (1957).
- Wolf, I. W., and V. T. Burkett, A method for determining minimum ignition energies: results for a neopentane-air mixture, Combust. Flame 1, 330 (1957).
- Bowden, F. P., and R. D. Lewis, Ignition of firedamp by stationary metal particles and frictional sparks, Engineering 186, 241 (1958).
- Khitrin, L. N., The theory of combustion of gas mixture flow and the critical characteristics of its ignition, Teoriya i Praktika Szhiganiya Gaza, Gostoptekhizdat, Leningrad, 94-115 (1958); Transl.: MCL 1331 of Foreign Tech. Div., Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.
- Khitrin, L. N., and S. A. Gol'denberg, On the ignition of gas mixtures and critical characteristics, Akad. Nauk SSSR Issled. Protsssoy Goreniya. (Sb. Statei), 5 (1958).
- Sale, B., Contribution to the study of normal combustion in controlled ignition engines, Rev. Inst. Franc. Petrole Ann. Combust. 13, 1040 (1958); Transl.: 68L31F of Associated Technical Services, East Orange, New Jersey.
- Wyatt, R. H. M., P. W. J. Moore, G. K. Adams, and J. F. Sumner, The ignition of primary explosives by electric discharges, Proc. Roy. Soc. (London) A246, 189 (1958).
- Berz, I., On inductive break sparks of high incendive power, Combust. Flame 3, 131 (1959).
- Khitrin, L. N., Regularities of ignition of gas mixtures in a rapid flow, Inzh.-Fiz. Zh. Akad. Nauk Belorus, SSR 2, No. 5, 110 (1959).
- Kinasiewicz, J., Analysis of thermal conditions of the course of combustion, Part I. Ignition, Energ. Przemyslowa 7, 259 (1959).
- Lintin, D. R., and E. R. Wooding, Investigation of the ignition of a gas by an electric spark, Brit. J. Appl. Phys. 10, 159 (1959).
- Rose, H. E., and T. Priede, Ignition phenomena in hydrogen-air mixtures, Seventh symposium on combustion, 436, Butterworths, London (1959).

- Rose, H. E., and T. Priede, An investigation of the characteristics of spark discharges as employed in ignition experiments, Seventh symposium on combustion, 454, Butterworths, London (1959).
- Results of investigations on pre-combustion chamber flame ignition in automobile engines, *Vestn. Akad. Nauk SSSR* 29, 122 (1959).
- Grunwald, B., New procedure for the combustion of poor mixtures in engines with spark ignition, *Met. Constructia Masini* 12, 780 (1961).
- Gutovskii, M. V., The temperature field of a discharge in an electrical ignition system, *Izv. Vysshikh Uchebn. Zavendenii, Energ.* 4, 37 (1961); *Transl.*: OTS 62-32315.
- Kogarko, S. M., V. V. Mikheev, and V. Ya. Basevich, Effect of active particles of products of combustion on the limits of ignition in turbulent flow, *Zh. Fiz. Khim.* 35, 2341 (1961); *Transl.*: OTS 62-24349.
- Kototii, V. A., and D. S. Gerchikov, Effect of electrode materials on the ignition of explosive gas mixtures by spark discharge, *Inzh.-Fiz. Zh. Akad. Nauk Belorus, SSR* 4, No. 10, 97 (1961).
- Litchfield, E. L., Chronology and topography of sparks at minimum energy for ignition, *Combust. Flame* 5, 235 (1961).
- Salooja, K. C., Effect of temperature on the ignition characteristics of hydrocarbons, *Combust. Flame* 5, 243 (1961).
- Bollinger, L. E., and others, Effect of ignition method on detonation induction distances in hydrogen-oxygen mixtures, *ARS J.* 32, 428 (1962).
- Grishin, A. M., Some problems of the ignition theory, *Zh. Prikl. Mekhan. i Tekhn. Fiz.* No. 5, 74 (Sept.-Oct. 1962).
- Laderman, A. J., P. A. Urtiew, and A. K. Oppenheim, Effect of ignition geometry on initial flame acceleration in a spark ignited explosive gas, *Combust. Flame* 6, 325 (1962).
- McKinney, A. H., Electrical ignition of combustible atmospheres, *ISA Trans.* 1, 1 (1962).
- Rogulski, W., Ignition of gas mixtures by electric discharges between a heated and a cold electrode, *Nature* 194, 858 (1962).
- Yang, C. H., Theory of ignition and auto-ignition, *Combust. Flame* 6, 215 (1962).
- Laszlo, A., A. Nemeth, and L. Fay, Relation of ignition parameters of a flowing gas, *Acta Chim. Acad. Sci. Hung.* 35, 233, 351 (1963).

b. Ignition by Hot Surfaces

- Couriot, H., and J. Meunier, Research on the explosion of firedamp by electric current, *Compt. Rend.* 126, 750 (1898).
- Bone, W. A., and R. V. Wheeler, The combination of hydrogen and oxygen in contact with hot surfaces, *Phil. Trans.* A206, 1, (1906).
- Couriot, H., and J. Meunier, Action of an incandescent electric conductor on the surrounding gas, *Compt. Rend.* 145, 1161 (1907).
- Thornton, W. M., The ignition of gases by hot wires, *Phil. Mag.* (6) 38, 613 (1919).
- White, A. S., and T. W. Price, The ignition of ether-alcohol-air and acetone-air mixtures in contact with heated surfaces, *J. Chem. Soc.* 115, 1462 (1919).
- Mason, W., and R. V. Wheeler, The ignition of gases, II. Ignition by a heated surface: Mixtures of methane and air, *J. Chem. Soc.* 121, 2079 (1922).
- Mason, W., and R. V. Wheeler, The ignition of gases, IV. Ignition by a heated surface. Mixtures of the paraffins with air, *J. Chem. Soc.* 125, 1869 (1924).
- Coward, H. F., and P. G. Guest, Ignition of natural gas-air mixtures by heated metal bars, *J. Am. Chem. Soc.* 49, 2479 (1927).
- Shepherd, W. C. F., and R. V. Wheeler, The ignition of gases by hot wires, *Gt. Brit. Safety in Mines Res. Board Paper* 36 (1927).
- Guest, P. G., Ignition of natural gas-air mixtures by heated surfaces, *U.S. Bur. Mines Tech. Paper* 475 (1930).
- Naylor, C. A., and R. V. Wheeler, The ignition of gases, VII. Ignition by a heated surface. Mixtures of methane with oxygen, nitrogen, argon or helium, *J. Chem. Soc.* 1931, 2456.
- Allsop, G., and T. S. E. Thomas, The ignition of firedamp by the filaments of broken electric lamp bulbs, *Gt. Brit. Safety in Mines Res. Board Paper* 80 (1933).
- Morgan, J. D., An experiment on the combustion of an inflammable gas mixture by a hot wire, *Phil. Mag.* 15, 440 (1933).
- Naylor, C. A., and R. V. Wheeler, The ignition of gases, VIII. Ignition by a heated surface, Ethane, propane, butane, ethylene, propylene, butylene, with air, *J. Chem. Soc.* 1933, 1240.

- Naylor, C. A. and R. V. Wheeler, The ignition of gases, IX. Ignition by a heated surface, Mixtures of methane and air at reduced pressure, J. Chem. Soc. 1935, 1426.
- Serruys, M., Experimental study of ignition by hot spot in internal combustion engines, Publ. Sci. Tech. Min. Air (France), Bull. Tech. 115 (1937); NACA Tech. Mem. 873 (1938).
- Silver, R. S., The ignition of gaseous mixtures by hot particles, Phil. Mag. (7) 23, 633 (1937).
- Paterson, S., The ignition of inflammable gases by hot moving particles, Phil. Mag. (7) 28, 1 (1939); 30, 437 (1940).
- Spencer, R. C., Preignition characteristics of several fuels under simulated engine conditions, NACA Rept. 710 (1941).
- Davies, W., The ignition of methane by hot wires, Fuel 22, 72 (1943).
- Alquist, H. E., and D. W. Male, Trends in surface-ignition temperatures, NACA Wartime Rept. E-94 (1944).
- Sokolik, A., and S. Yantovskii, Kinetic conditions of knock and preignition in internal combustion engines, Acta Physicochim. URSS 19, 329 (1944); Transl.: OTS 61-18191.
- Hundere, A., and J. A. Bert, Preignition and its deleterious effects in aircraft engines, SAE Quart. Trans. 2, 546 (1948).
- Mullen II, J. W., J. B. Fenn, and M. R. Irby, The ignition of high velocity gas streams of combustible gases by heated cylindrical rods, Third symposium on combustion, flame and explosion phenomena, 317, Williams and Wilkins, Baltimore (1949).
- Stout, H. P., and E. Jones, The ignition of gaseous explosive media by hot wires, Third symposium on combustion, flame and explosion phenomena, 329, Williams and Wilkins, Baltimore (1949).
- Downs, D., and J. H. Pigneguy, An experimental investigation into preignition in the spark-ignition engine, Proc. Inst. Mech. Engr. (London), Automobile Div., 125 (1950-51).
- Hundere, A., No harmful preignition from lead deposits, Automotive Ind. 103, 50 (Sept. 1, 1950).
- Bernard, M. L. J., Influence of surface phenomena on the kinetics of ignition of liquid propellants, Compt. Rend. 235, 1646 (1952).
- Withrow, L. L., and F. W. Bowditch, Flame photographs of auto-ignition induced by combustion chamber deposits, SAE Quart. Trans. 6, 724 (1952).
- Jones, E., Heat transfer in hot wire ignition, Fourth symposium on combustion, 151, Williams and Wilkins, Baltimore (1953).
- Sabina, J. R., J. J. Mikita, and M. H. Campbell, Preignition in automotive engines, Proc. Am. Petrol. Inst., Sect. III 33, 137 (1953).
- Winch, R. F., and F. M. Mayes, A method for identifying preignition, SAE Trans. 61, 453 (1953).
- Bowers, R. C., and A. R. Isitt, Observation of automotive preignition and knock, SAE M.P., Atlantic City (June 1954); Abstract: SAE J. 63, 178 (Feb. 1955).
- Bowditch, F. W., R. E. Wilson, and G. J. Nebel, Some aspects of particle ignition, Proc. Am. Petrol. Inst., Sect. III 34, 242 (1954).
- Burk, F. C., L. J. Test, and H. R. Jackson, How effective are gasoline additives? Petrol. Refiner 33, 97 (Aug. 1954).
- Fleming, Jr., C. L., N. V. Hakala, and L. E. Mody, Combustion chamber deposit control, Petrol. Refiner 33, 88 (Aug. 1954).
- Heron, S. D., Uncontrolled combustion in spark-ignition engines, SAE Trans. 62, 24 (1954).
- Hincamp, J. B., H. A. Toulmin, Jr., and J. S. Wintringham, The measurement and chemical control of preignition in engines, Proc. Am. Petrol. Inst., Sect. III 34, 278 (1954).
- Hirschler, D. A., J. D. McCullough, and C. A. Hall, Deposit-induced ignition-evaluation in a laboratory engine, SAE Trans. 62, 40 (1954).
- Jeffrey, R. E., L. W. Griffith, E. Dunning, and R. S. Baldwin, Improve fuel with phosphorous additives, Petrol. Refiner 33, 92 (Aug. 1954).
- Landis, J. R., Detection of abnormal flame-fronts in road tests with an engine using independent ionization gaps, SAE M.P., Atlantic City (June 1954).
- Melby, A. O., D. R. Diggs, and B. M. Sturgis, An investigation of preignition in engines, SAE Trans. 62, 32 (1954).
- Shore, L. B., and J. F. Kunc, Jr., The effect of simulated surface ignition on engine performance, SAE M.P., Atlantic City (June 1954); Abstract: SAE J. 62, 58 (Dec. 1954).
- Sigworth, H. W., and R. K. Stone, Controlling preignition by deposit removal, SAE M.P., Atlantic City (June 1954); Abstract: SAE J. 62, 85 (Dec. 1954).

- Sturgis, B. M., E. N. Cantwell, W. E. Morris, and D. L. Schultz, The preignition resistance of fuels, *Proc. Am. Petrol. Inst., Sect. III* 34, 256 (1954).
- Weber, G., Let's take a good hard look at this preignition problem and at the study being directed at its solution, *Oil Gas J.* 53, No. 16, 114 (1954).
- Williams, R. K., and J. R. Landis, Some effects of fuels and lubricants on auto-ignition in cars on the road, *SAE Trans.* 62, 57 (1954).
- Winch, R. F., Occurrence of preignition in present-day cars in normal service, *SAE Trans.* 62, 50 (1954).
- Combustion terms defined by CRC, *SAE J.* 62, 46 (Oct. 1954).
- Researchers marshal combustion study weapons to arrest power-robbing pre-ignition, *SAE J.* 62, 17 (Oct. 1954).
- Burnham, H. D., Role of tritolyl phosphate in gasoline for the control of ignition and combustion problems, *Am. Chem. Soc., Div. Petrol. Chem., Symp.* 36, 39 (1955).
- Hall, C. A., J. A. Warren, and J. D. McCullough, Practical yardsticks for deposit effects, *SAE Trans.* 63, 53 (1955); Abstract: *SAE J.* 63, 98 (Jan. 1955).
- Khitrin, L. N., and S. A. Gol'denberg, Ignition of gaseous mixtures in a flow by a hot body, *Dokl. Akad. Nauk USSR* 103, 277 (1955).
- Meagher, R., R. L. Johnson, and K. G. Parthemore, Correlation of engine noises with combustion phenomena, *SAE Trans.* 63, 481 (1955); Abstract: *SAE J.* 63, 29 (March 1955).
- Chambre, P. L., On the ignition of a moving combustible gas stream, *J. Chem. Phys.* 25, 417 (1956).
- Reiman, M., Autoignition in repaired engines, *Motoryzacja* 11, 266 (1956).
- Warren, J. A., and J. B. Hinkamp, New instrumentation for engine combustion studies, *SAE Trans.* 64, 665 (1956).
- Wimmer, D. B., Some factors involved in surface ignition in spark-ignition engines, *SAE M.P.*, Tulsa (Nov. 1956); Abstract: *SAE J.* 65, 112 (Jan. 1957).
- Anderson, J., Preignition in aircraft reciprocating engines, *SAE Trans.* 65, 19 (1957).
- Kumagai, S., and I. Kimura, Ignition of flowing gases by heated wires, Sixth symposium on combustion, 554, Reinhold, New York (1957).
- Palmer, K. N., and P. S. Tonkin, The ignition of dust layers on a hot surface, *Combust. Flame* 1, 14 (1957).
- Rozlovskii, A. I., Critical conditions for the ignition of combustible gas mixtures by heated solid bodies, *Dokl. Akad. Nauk SSSR* 117, 651 (1957).
- Toong, Tau-Yi, Ignition and combustion in a laminar boundary layer over a hot surface, Sixth symposium on combustion, 532, Reinhold, New York (1957).
- Voinov, A. N., A study of ignition by hot surfaces in an engine, *Dokl. Akad. Nauk SSSR* 113, 1259 (1957).
- Voinov, A. N., Kinetic relations in the case of hot-surface ignition within an engine, *Dokl. Akad. Nauk SSSR* 114, 135 (1957).
- Bowditch, F. W., and R. F. Steber, Autoignition associated with hot starting, *SAE Trans.* 66, 179 (1958).
- Courtney, W. G., Ignition by flow over hot surfaces, *Jet Propulsion* 28, 836 (1958).
- Hincamp, J. B., and J. A. Warren, Surface ignition control by phosphorus fuel additives, *Ind. Eng. Chem.* 50, 251 (1958).
- Kaesche-Krischer, B., and H. G. Wagner, Ignition of fuel-air mixtures on hot surfaces, *Brennstoff-Chem.* 39, 33 (1958).
- Sale, B., and R. Vichnievsky, Study of combustion in a single-cylinder IFP Renault CNRS, *J. Soc. Ingr. Automobile* 31, 53 (Oct. 1958).
- High compression ratios bring a new problem—rumble, *SAE J.* 66, 72 (Sept. 1958).
- Bame, J. L., and R. G. Tuell, Engine pounding—its causes and control, *SAE Trans.* 67, 158 (1959).
- Felt, A. E., J. A. Warren, and C. A. Hall, Rumble—a deposit effect at high compression ratios, *SAE Trans.* 67, 138 (1959).
- Hopkins, S., R. J. Pecora, and N. Alpert, Surface ignition as influenced by engine configuration and fuels—consumer type study in vehicles, *SAE M.P.* 78V (June 1959); Abstract: *SAE J.* 67, 58 (Oct. 1959).
- Hostetler, H. F., and W. R. Tuuri, Knock, rumble and ping, *SAE Trans.* 67, 152 (1959).
- Hyatt, K., V. J. Tomsic, and C. A. Mellinger, Surface ignition—new look with new instrument, *SAE M.P.* 78U (June 1959); Abstracts: *SAE J.* 67, 56 (Oct. 1959); *Automotive Ind.* 121, 94 (July 15, 1959).
- Khitrin, L. N., On some consequences of the thermal theory of ignition in a fast flow, Seventh symposium on combustion, 470, Butterworths, London (1959).

- Massa, V. F., New combustion problems—starting and stopping modern engines, SAE Trans. 67, 125 (1959).
- Perry, Jr., R. H., and H. V. Lowther, Knock-knock: spark knock, wild ping or rumble? SAE Trans. 67, 145 (1959).
- Robison, J. A., M. D. Behrens, and R. G. Mosher, Investigating rumble in single-cylinder engines, SAE Trans. 67, 169 (1959).
- Rozlovskii, A. I., I. S. Roizen, and P. G. Sushchev, Ignition of combustible gaseous mixtures by heated solid bodies, and problems of technical safety, *Izv. Vysshikh Uchebn. Zavendenii, Khim. i Khim. Tekhnol.* 2, 962 (1959).
- Sage, J. A., and F. J. Weinberg, An attempt at measuring homogeneous ignition temperatures, Seventh symposium on combustion, 464, Butterworths, London (1959).
- Tupa, R. C., New light on combustion noise and vibration, SAE J. 67, 80 (Oct. 1959).
- Wiese, W. M., If you squeeze them, must they scream? SAE Trans. 67, 175 (1959).
- Buckley, D. H., M. A. Swikert, and R. L. Johnson, Ignition of a combustible atmosphere by incandescent carbon wear particles, NASA Tech. Note D-289 (1960).
- Goodger, E. M., Abnormal combustion: operation of spark-ignition engines with high compression ratios, *Automobile Engr.* 50, 94 (1960).
- Koenig, E. F., J. R. McLean, and E. J. Buchanan, Jr., Surface ignition survey of new passenger cars, SAE M.P. 260C (Nov. 1960); Abstract: SAE J. 69, 77 (Mar. 1961).
- Preston, J., and L. E. Ashman, Temperature-regulated ignition source, *Rev. Sci. Instr.* 31, 53 (1960).
- Rossenbeck, M., On the interaction between fuel and motor, *Automobiltech.* Z. 62, 266 (1960).
- Starkman, E. S., and W. E. Sytz, The identification and characterization of rumble and thud, SAE Trans. 68, 93 (1960).
- Stear, R. F., W. M. Wiese, and R. L. Everett, Engine rumble—a barrier to higher compression ratios? SAE Trans. 68, 206 (1960); Abstracts: SAE J. 67, 34 (Oct. 1959); *Automotive Ind.* 122, 365 (Mar. 15, 1960).
- Ashman, L. E., and A. Buchler, The ignition of gases by electrically heated wires, *Combust. Flame* 5, 113 (1961).
- Bowditch, F. W., and T. C. Yu, A consideration of the deposit ignition mechanism, SAE Trans. 69, 435 (1961).
- Goldenberg, S. A., Ignition in a flow by hot bodies, *ARS J.* 31, 691 (1961).
- Goodger, E. M., Fuel additives: the surface ignition problem and its solution by the use of chemical agents, *Automobile Engr.* 51, 98 (1961).
- Massa, V. F., What makes engines rumble? SAE J. 69, 96 (May 1961).
- Novotny, M., and F. Lebr, Ignition of mixtures of powdered explosives with air on hot surfaces, *Sb. Ved. Praci, Vysoka Stola Chem.-Technol., Pardubice*, Pt. 1, 203 (1961).
- Tomsic, V. J., Surface ignition behavior of fuels, SAE Preprint 293E (1961).
- Bowes, P. C., and S. E. Townsend, Ignition of combustible dusts on hot surfaces, *Brit. J. Appl. Phys.* 13, 105 (1962).
- Scott, L. B., J. G. Ryan, and J. B. Baker, Deposit—induced runaway surface ignition, SAE M.P. 544B (1962).
- Steinke, R. E., and R. K. Stone, Fragile deposits make rumble hard to measure, SAE J. 70, 90 (Mar. 1962).

2.3. Spark-Ignition Systems and Components

a. Exclusive of Spark Plugs

- Armagnat, H., Magneto for electric ignition, *Rev. Elec.* 23, 321 (1915).
- Henderson, J. F., Magneto ignition, *Automobile Engr.* 5, 51 (1915).
- Campbell, A., and D. W. Dye, Summary of researches on magnetos at the National Physical Laboratory, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept.* 1 (1916).
- Griffiths, E. A., Tests on high-tension magnetos, *Gt. Brit. Advisory Comm. Aeron., Repts. and Mem.* 275 (1916).
- Baird, G. E., A method of intensifying the spark of a defective spark plug by the use of an additional spark gap in series with the plug, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept.* 17 (1917).

- Bairsto, G. E., Magneto faults, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 18* (1917).
- Bairsto, G. E., On the synchronism of the spark of a magneto as affected by the method of coupling, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 21* (1917).
- Paterson, C. C., and N. R. Campbell, An investigation of certain spark gaps for magnetos for the Air Board, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 14* (1917).
- Watson, E. A., The magneto: its functions, design and construction, *Automobile Engr. 7*, 137 (1917).
- Williams, J. A., Magneto vs battery ignition, *SAE J. 1*, 375 (1917).
- Young, A. P., The high-tension magneto, *Automobile Engr. 7*, 191 (1917).
- Young, A. P., Safety spark gap in magnetos for super-compression engines at high altitudes, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 7* (1917).
- Bairsto, G. E., On the rate of rise of secondary potential of an ignition system, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 31* (1918).
- Bairsto, G. E., On the effect of shunted resistance or plug leakage on the sparking performance of an ignition system, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 34* (1918).
- Bairsto, G. E., Notes on the relation between the output of a magneto and its size and weight, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 42* (1918).
- Campbell, N. R., The theory of the magneto, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 40* (1918).
- Campbell, N. R., The potential waveform of a magneto, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 47* (1918).
- Campbell, N. R., Notes on the "break" of a magneto, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 49* (1918).
- Paterson, C. C., and N. R. Campbell, Notes on the sparking of two gaps in series, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 28* (1918).
- Van Deventer, H. R., Ignition magneto construction, *SAE J. 3*, 257 (1918).
- Zimmerman, J. G., Magneto ignition for farm tractors, *SAE J. 2*, 419 (1918).
- Bairsto, G. E., On the relation between the number of secondary turns on a magneto armature and the secondary voltage with shunted resistance, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 52* (1919).
- Gorton, W. S., The subsidiary gap as a means for improving ignition, *NACA Rept. 57* (1919).
- Heldt, P. M., Tests of ignition apparatus, *Automotive Ind. 40*, 578 (1919).
- McLachlan, N. W., On the effective inductance, effective resistance and self-capacity of magneto windings, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 45* (1919).
- Paterson, C. C., and N. R. Campbell, The effect of capacity and shunt resistance on the peak voltage of a magneto, *Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Repts. 29 and 30* (1919).
- Silsbee, F. B., Characteristics of high-tension magnetos, *NACA Rept. 58* (1919).
- Silsbee, F. B., Ignition work at the Bureau of Standards, *Automotive Ind. 40*, 1294 (1919).
- Bairsto, G. E., The relationship between the number of secondary turns on a magneto armature and the secondary voltage with shunt resistance, *Measurements on a rotary armature magneto, Gt. Brit. Aeron. Res. Comm. Rept. and Mem. 724* (1920).
- Libby, A. D. T., Advantages of magneto ignition, *SAE J. 7*, 277 (1920).
- Young, A. P., Magneto testing and the choice of spark gap, *Engineering 110*, 729 (1920).
- Silsbee, F. B., Simplified theory of the magneto, *NACA Rept. 123* (1921).
- Watson, E. A., Magnetos for ignition purposes in internal-combustion engines, *J. Inst. Elec. Engr. 59*, 445 (1921).
- Silsbee, F. B., Mathematical theory of induced voltage in the high-tension magneto, *Bur. Std. (U.S.) Sci. Paper 17*, 407 (1922) S424.
- Brode, R. B., D. W. Randolph, and F. B. Silsbee, Electrical characteristics of spark generators for automotive ignition, *NACA Rept. 241* (1926).
- Haushalter, F. L., Corona tests of ignition cable, *SAE J. 19*, 361 (1926).
- Silsbee, F. B., and D. W. Randolph, Linkage-current diagram for representing magneto operation, *Bur. Std. (U.S.) Sci. Paper 21*, 647 (1926-27) S543.

- Shoemaker, F. G., Recent developments in aircraft ignition systems, SAE J. 21, 28 (1927).
- Young, A. P., and L. Griffith, The high-tension magneto, Automobile Engr. 17, 188 (1927).
- Lanchester, F. W., Coil ignition, Proc. Inst. Automobile Engr. (London) 23, 214 (1928).
- Watson, E. A., Effect of hydrocarbon vapors on contact points of ignition apparatus, Automobile Engr. 18, 347 (1928).
- Fitzsimmons, J. T., Ignition requirements for high-compression engines, SAE J. 24, 306 (1929).
- Robertson, E. A., and L. M. Hull, Suppressing ignition interference on radio equipment of aircraft, SAE J. 27, 78 (1930).
- Darnell, T. H., The automotive ignition coil, NACA Rept. 374 (1931).
- Watson, E. A., Coil ignition systems, J. Inst. Elec. Engr. (London) 70, 105 (1932).
- Finch, G. I., and R. W. Sutton, Control of ignition coil discharge characteristics, Proc. Phys. Soc. (London) 45, 288 (1933).
- Coil ignition at 10,000 rpm, Automobile Elec. 10, 6 (1934).
- Coil ignition testing, Automobile Elec. 10, 38 (1934).
- Temperature increase of ignition coils, Automobile Elec. 10, 68 (1934).
- Peters, M. F., G. F. Blackburn, and P. T. Hannen, Electrical character of the spark discharge of automotive ignition systems, J. Res. Natl. Bur. Std. (U.S.) 19, 401 (1937).
- Cook, J., The ignition coil, Automobile Elec. 14, 82 (1938).
- Critchfield, R. M., Effect of application on maintenance of automotive electrical equipment, SAE J. 43, 403 (1938).
- Keane, C. C., Ignition systems for internal combustion engines, Petrol. Engr. 9, 41 (Mar. 1938).
- Effect of the design and installation of high tension ignition cables on ignition system performance, Ethyl Gasoline Laboratories, Eng. Labs. Rept. 100 (1938).
- Turchiebash, P. E., Working of the magneto and spark plugs during high altitude flights (in Russian), Aeron. Engr. (Moscow) 1939, 39.
- Bairsto, G. E., Some factors controlling the development of electrical ignition of aero engines, J. Roy. Aeron. Soc. 44, 119 (1940).
- Hendry, N., Radio interference, Automobile Engr. 30, 167 (1940).
- Chaston, J. C., Materials for electrical contacts, J. Inst. Elec. Engr. (London) 88, 276 (1941).
- Kidder, C. P., Synthetics, Automobile Engr. 31, 455 (1941).
- Swanson, C. E., Supercharged aircraft ignition harnesses, SAE Trans. 48, 107 (1941).
- Fitzsimmons, J. T., The ignition system as influenced by fuel characteristics, SAE Trans. 50, 15 (1942).
- Randolph, D. W., Ignition shielding, Automotive Ind. 86, 24 (Apr. 1, 1942); SAE Trans. 50, 538 (1942).
- Alvino, A. V., Battery booster coils for airplane engine ignition systems, Trans. Am. Inst. Elec. Engr. 63, 672 (1944).
- Harkness, J. R., Design of an ignition system for an 18-cylinder aircraft engine, Trans. Am. Inst. Elec. Engr. 63, 1321 (1944).
- Peters, M. F., J. J. Philips, M. Kronstein, and H. B. Jealous, Cable used for transmitting electric energy in airplanes, Trans. Am. Inst. Elec. Engr. 63, 1271 (1944).
- Robinson, Jr., A. W., Analysis of high-frequency ignition circuits, Elec. Eng. 63, 916 (1944).
- Hartzell, H. L., Effect of post-war automotive practices on ignition performance, SAE Trans. 53, 427 (1945).
- Rohats, N., Testing magneto coils, General Electric Rev. 48, 49 (1945).
- Ross, D. M., Low-tension high-frequency ignition systems, Tech. Data Dig. 11, 53 (1945).
- Swett, Jr., C. C., and F. A. Rodgers, Effect of high-resistance ignition cable on the erosion of spark-plug electrodes, NACA Mem. Rept. E5I21 (Sept. 1945).
- Ignition testing unit, Flight 48, 47 (1945).
- Berkey, W. E., Electrical measurements on aircraft engine ignition circuits, Elec. Eng. 65, 49 (1946).
- Ignition problems, Automobile Engr. 36, 413 (1946).
- Hartzell, H. L., Coming car engine ignition, SAE J. 55, 69 (July 1947).
- Lindbergh, Jr., J. E., and C. Sackett, Engine troubleshooting in the air, SAE Quart. Trans. 1, 630 (1947).
- Poole, A. J., Electronic ignition, Automotive Ind. 96, 37 (Feb. 1, 1947).

- Rudd, J. K., Low tension whips plane ignition woes, SAE J. 55, 79 (Feb. 1947).
- Wall, A. C., Low tension system cures ignition ills, SAE J. 55, 73 (Jan. 1947).
- Welch, H. C., and J. V. McNulty, An ignition analyzer for internal-combustion engines, SAE Quart. Trans. 1, 662 (1947).
- Comber, M. M., Recent advances in aircraft ignition systems, Aircraft Eng. 20, 282 (1948).
- Keit, P. J., The automotive industry's participation in reduction of radio and television interference, SAE J. 57, 17 (Mar. 1949).
- Watters, C. J., The case for high frequency ignition systems, Aviation Week 50, 20 (Apr. 25, 1949).
- Bauer, W. M., and L. G. Sands, Aircraft ignition tester, Electronics 23, 87 (Oct. 1950).
- Rainey, C. W., Ford's new ignition system, SAE J. 58, 28 (Apr. 1950).
- Christian, G. L., Engine analyzers gain wider acceptance, Aviation Week 54, 34 (Apr. 2, 1951).
- Eaglesfield, C. C., Car ignition radiation, Wireless Engr. 28, 17 (Jan. 1951).
- Hartzell, H. L., Ignition systems for future high-compression engines, SAE J. 59, 45 (Nov. 1951).
- Hartzell, H. L., and B. H. Short, Ignition problems in damp weather, SAE Quart. Trans. 5, 207 (1951).
- Marchisio, M., Effect of temperature on the ignition vibrators of turbojet engines, Aerotechnica 31, 84 (1951).
- Peroutky, D. C., High frequency ignition needs no breaker points, Automotive Ind. 104, 34 (Jan. 1, 1951).
- Peters, M. F., and L. H. Middleton, Optimum rate of voltage rise for minimum energy loss in ignition systems, SAE Quart. Trans. 5, 309 (1951).
- Smits, W. Beye, and P. F. H. MacLan Pont, The Smitsvonk low-tension capacity ignition system, SAE J. 59, 61 (Apr. 1951).
- Zipkin, M. A., H. E. Sheets, and C. N. Scott, High energy multiple spark ignition systems for jet engines, SAE J. 59, 70 (Apr. 1951).
- Distributed resistance ignition cable, Electronics 24, 204 (Jan. 1, 1951).
- Elliott, L. J., Jet ignition systems, Aero. Dig. 64, 28 (Feb. 1952).
- Gregoire, S. E., Improvements in jet engine ignition systems, Automotive Ind. 107, 48 (Sept. 1, 1952).
- Klass, P., New ignition better, yet cheaper, Aviation Week 57, 47 (Sept. 22, 1952).
- MacNew, T., Analyzing ignition problems of piston and jet engines, Automotive Ind. 107, 46 (Sept. 1, 1952).
- Tognola, T., Analyzation of the creepage-gap ignition system, Automotive Ind. 107, 49 (Sept. 1, 1952).
- Bibliography and abstracts on electrical contacts, 1835-1951, Am. Soc. Testing Mater. Spec. Tech. Publ. 56-G (1952).
- High energy spark ignition units for gas turbines, Gas Oil Power 47, 314 (1952).
- Jet ignition, Aviation Week 57, 67 (Nov. 10, 1952).
- Christian, G. L., Comets use high-energy ignition, Aviation Week 59, 83 (Oct. 12, 1953).
- Moret, C., New ignition methods: electrostatic ignition, J. Soc. Ingr. Automobile 26, 284 (1953).
- Frederick, E., Electric ignition for high-compression engines, Diesel Power 32, 28 (June 1954).
- Martin, E. A., and J. H. Goffe, A new engine analyzer, SAE M.P., Atlantic City (June 1954); Abstract: SAE J. 62, 24 (Nov. 1954).
- Terry, S. M., 12 volts presents its case, SAE J. 62, 29 (Feb. 1954).
- New magneto uses battery current for starting, Automotive Ind. 111, 52 (Oct. 1, 1954).
- Balagyro, V. A., Heat calculations for automobile ignition coils, Avtomob. i Trakt. Prom., 13 (Dec. 1955).
- Boland, R. W., A fresh approach to ignition analysis, SAE M.P., St. Louis (Nov. 1955).
- Berezkin, V., and A. Zhernokov, Modernization of the ignition control instruments, Avtomob. Transp. 34, 29 (Dec. 1956).
- MacNew, T., Service problems discussed at Bendix Aircraft Ignition Conference, Automotive Ind. 115, 66 (Oct. 1, 1956).
- Pieslak, W., Electric ignition apparatus, Wiadomosci Elektrotechn. 16, 275 (1956).
- Vartanov, V., Restoring resistance in ignition coils, Avtomob. Transp. 34, 31 (March 1956).
- Gavrilov, A. K., Selecting optimum ignition timing for heating up the engine, Tr. Sibirsk. Avtomob.-Dor. Inst. No. 6, 41 (1957).

Koval, D., Stands used in studying the performance of ignition systems, *Avtomob. Transp.* 35, 28 (Nov. 1957).

Musienko, A., Starter ignition systems (for aircraft engines), *Grazhdanskaia Aviatsiia* 14, 32 (1957).

Shearer, A. W., Aircraft ignition problems studied at Fourth Annual Bendix Conference, *Automotive Ind.* 117, 66 (Sept. 15, 1957).

Uukkivi, V., V. Birivlev, and A. Zhernovkov, Stands used for checking ignition system devices, *Avtomob. Transp.* 35, 17 (June 1957).

Delco-Remy ignition distributor—notes on basic design and production, *Automobile Engr.* 47, 250 (1957).

Testing ignition distributors with electronic equipment, *Automotive Ind.* 116, 60 (April 1, 1957).

Altholz, E., Distributors for Detroit, *Machinery (N.Y.)* 65, 114 (Dec. 1958).

Temnov, V., Equipment for checking vacuum governors of ignition regulators, *Avtomob. Transp.* 36, 32 (Jan. 1958).

Urban, P., Basis of interference caused by automobile ignition systems, *Slaboproudny Obzor* 19, 385 (1958).

Ignition analyzer (DuMont Ignitionscope), *Electron. Ind.* 17, 84 (Feb. 1958).

Ignition uses transistors, *Electronics* 31, 20 (June 27, 1958).

Aleksandrov, E., Ignition system, *Za Rulem* 17, 16 (1959).

Campbell, E. L., Exit ignition noise! *QST* 43, 30 (May 1959).

Dasek, M., Ignition in two-stroke multi-cylinder engines, *Svet Motoru* 13, 664 (1959).

Dudic, R., Some problems of cables for spark plugs, *Vojno Tehnicki Glasnik* 7, 370 (1959).

Federov, S., Battery ignition, *Za Rulem* 17, 22 (1959).

Modly, J., Ignition of fast-working gasoline motors, *Tesla* 6, No. 4, 36 (1959).

Vaneev, A. I., and A. S. Skoblikov, Automatic vacuum-controlled advance ignition for all operating conditions, *Avtomob. Prom.*, 15 (May 1959).

Veverka, M., Magneto ignition or storage battery ignition for racing cars, *Svet Motoru* 13, 568 (1959).

Transistorized ignition system to take lid off engine design, *Prod. Eng.* 30, 25 (Mar. 2, 1959).

Transistors give new jolt to high-power auto engines, *Machine Design* 31, 25 (Mar. 19, 1959).

Transistors make cars run better, *Radio Electron.* 30, 43 (May 1959).

Geschelin, J., Second Ignition Performance Conference, *Automotive Ind.* 123, 80 (Nov. 15, 1960).

Spaulding, Jr., G. E., Transistor switched ignition systems, *SAE Trans.* 68, 611 (1960).

Electronics advances in ignition systems, *Electronics* 33, 82 (Mar. 25, 1960).

Piezoelectric ignition switch, *Engineer* 210, 973 (1960).

Ball, A. H., and W. Nethercot, Radio interference from ignition systems, *Proc. Inst. Elec. Engr. (London)* 108B, 273 (1961).

Becker, M. F., New truck ignition systems held promising, *SAE J.* 69, 123 (Feb. 1961).

Crankshaw, E., and R. Arnold, Piezoelectric ignition developed for small engines, *SAE J.* 69, 46 (Aug. 1961).

Gage, J. F., and C. J. Dunne, Service experience with transistorized ignition, *SAE J.* 69, 84 (Apr. 1961).

Lehr, W., The beginning of automobile electrical equipment: 1. the development of ignition systems, *Automobiltech. Z.* 63, 260 (1961).

Madland, G. R., Transistorized automotive ignition systems, *Automotive Ind.* 125, 70 (Aug. 15, 1961).

Martin, A. V. J., Electronic ignition systems designs, *Electron. Ind.* 20, 164 (July 1961).

Quinn, H. P., Gas tubes and a transistor for electronic ignition, *Electronics* 34, 62 (Dec. 15, 1961).

Scott, D., Lucas introduces electronic ignition system, *Automotive Ind.* 125, 52 (Aug. 1, 1961).

Smithey, T. E., Electronic ignition for your car, *Radio Electron.* 32, 34 (Sept. 1961).

Distributor mountings, *SAE Standard*, *SAE Handbook*, 642 (1961).

Electronically controlled ignition system for racing engines, *Engineer* 211, 426 (1961).

Electronic ignition—plastics parts used in improved system, *Plastics World* 19, 41 (July 1961).

Good start for two strokes with new ignition, *Engineering* 192, 569 (1961).

High tension ignition cable, SAE Standard, SAE Handbook, 649 (1961).
 Ignition coil mounting, SAE Standard, SAE Handbook, 637 (1961).
 Ignition system without coil or battery, Engineering 191, 21 (1961).
 London show review: electrical equipment, Automobile Engr. 51, 487 (1961).
 Low tension cable, SAE Standard, SAE Handbook, 650 (1961).
 Lucas electronic ignition system, Automobile Engr. 51, 140 (1961).
 Magister ignition system, Automobile Engr. 51, 240 (1961).
 Magneto mountings, SAE Standard, SAE Handbook, 642 (1961).
 Measurement of vehicle radio interference (30 to 400 megacycles), SAE Standard, SAE Handbook, 645 (1961).
 Piezoelectric ignition, Wireless World 67, 210 (1961).
 Pulse generator key to pointless ignition, Machine Design 33, 10 (Dec. 21, 1961).
 Radio noise suppressors, SAE Recommended Practice, SAE Handbook, 645 (1961).
 Brown, R. J., Low tension ignition on sewage gas engines, Public Works 93, 103 (1962).
 Butler, F., Electronic ignition, Wireless World 68, 29 (Jan. 1962).
 Lawson, H. W., Put electronic ignition in your car, Radio-Electron. 33, 34 (July 1962).
 Scholtz, A. M., Cheek auto ignition with an ohm-dwell tachometer, Radio-Electron. 33, 32 (June 1962).
 Shvetsov, A. G., Determination of the operating point of a magnet in the presence of magnetizing armature reaction in a magneto, Elektrichestvo, 6 (July 1962).
 Teasel, R. C., Ignition system development anticipates new engines, SAE J. 70, 38 (June 1962).
 Warner, R. S., Electronic breakerless ignition for large gas engines, Mech. Eng. 84, 58 (1962).
 Wass, C. A., An automatic wire-snapping machine for experiments on electrical ignition of gases, J. Sci Instr. 39, 229 (1962).
 Auto ignition has no breaker points, Electronics 35, 63 (Feb. 9, 1962).
 Compact unit cheeks out ignition system, Petrol. Eng. Management 34, 245 (June 1962).
 Electronic ignition arousing considerable interest for the future, Automobile Engr. 52, 482 (1962).
 Engine ignition, Automobile Engr. 52, 390 (1962).
 Ignition by electronics under trial, Am. Gas Assoc. Monthly 44, 13 (Dec. 1962).
 Silicon control rectifier slashes service needs (breakerless ignition system), Prod. Eng. 33, 64 (Aug. 20, 1962).
 S.T.E.A.M. automatic ignition control, Automobile Engr. 52, 54 (1962).
 Morgan, E. E., Oscilloscopes in the modern garage, Ind. Electron. 1, 349 (1963).
 Mayfield, M. R., Construction of high-performance transistorized ignition system, Electron. World 69, 30 (June 1963).

b. Spark Plugs

Fisher, J. O., Spark plugs, J. Am. Soc. Naval Engr. 28, 828 (1916).
 Cunningham, R. H., Resistance of hot spark plug insulators, Automotive Ind. 39, 907 (1918).
 Morgan, J. D., The effect of temperature on the resistance of spark plug insulations, Engineering 106, 513 (1918).
 Paterson, C. C., and N. R. Campbell, The sparking potential of spark plugs, Gt. Brit. Advisory Comm. Aeron., Internal Combustion Engine Sub-Comm. Rept. 48 (1918).
 Bleining, A. V., and F. H. Riddle, Special spark plug porcelains, J. Am. Ceram. Soc. 2, 564 (1919).
 Cragoe, C. S., Temperatures in spark plugs having steel and brass shells, NACA Rept. 52 (1919).
 Loeb, L. B., and F. B. Silsbee, Effect of temperature and pressure on the sparking voltage, NACA Rept. 54 (1919).
 Low, A. M., Spark plug efficiency, Autocar 42, 655 (1919).
 Silsbee, F. B., L. B. Loeb, L. G. Sawyer, E. L. Fonseca, H. C. Dickinson, and P. G. Agnew, Spark plug defects and tests, NACA Rept. 51 (1919).
 Silsbee, F. B., R. K. Honaman, E. L. Fonseca, A. V. Bleining, and H. F. Staley, Properties and preparation of ceramic insulators for spark plugs, NACA Rept. 53 (1919).

- Warren, H., The operation and design of sparking plugs, *Automobile Engr.* 9, 59 and 94 (1919).
- Rawdon, H. S., and A. I. Krynitsky, A study of the deterioration of nickel spark-plug electrodes in service, *Bur. Std. (U.S.) Technol. Paper* 13 (1920) T143.
- Sparrow, S. W., Preignition and spark plugs, *SAE J.* 6, 129 (1920).
- Staley, H. F., Cements for spark-plug electrodes, *Bur. Std. (U.S.) Technol. Paper* 13 (1920) T155.
- Manufacture of spark plugs, *Clay-Worker* 74, 324 (1920).
- Sparking plugs, *Automobile Engr.* 13, 10 (1922).
- Buckseth, W., Shock tester for porcelain insulators, *Elektrotech. Z.* 44, 943 (1923).
- Silsbee, F. B., The effect of electrode temperature on the sparking voltage of short spark gaps, *NACA Rept.* 179 (1923).
- Wikoff, A. G., Manufacture of spark plug porcelain, *Chem. Met. Eng.* 28, 150 (1923).
- Bowen, N. L., and J. W. Greig, The system $\text{Al}_2\text{O}_3\text{--SiO}_2$; a study of the equilibrium relations of pure alumina at high temperatures, *J. Am. Ceram. Soc.* 7, 238 (1924).
- Bowen, N. L., J. W. Greig, and E. G. Zies, Mullite, a silicate of alumina, *J. Wash. Acad. Sci.* 14, 183 (1924).
- Burgoine, A. C., Sparking plugs, *Automobile Engr.* 14, 301 (1924).
- Silsbee, F. B., The sparking voltage of spark plugs, *NACA Rept.* 202 (1924); *Automotive Ind.* 52, 539 (1925).
- Twells, Jr., R., Preparing and spraying a glaze slip with special reference to the control of the various operations, *J. Am. Chem. Soc.* 7, 465 (1924).
- Wataza, M., Spark plugs, *Rept. Osaka Ind. Res. Inst. (Japan)* 5, 1 (1924).
- Greig, J. W., Formation of mullite from cyanite, andalusite and sillimanite, *J. Am. Ceram. Soc.* 8, 465 (1925).
- Norton, J. T., An X-ray study of natural and artificial sillimanite, *J. Am. Ceram. Soc.* 8, 401 (1925).
- Peck, A. B., Changes in andalusite, cyanite and sillimanite at high temperatures, *J. Am. Ceram. Soc.* 8, 407 (1925).
- Watts, A. S., Spark plug insulation, *Ind. Eng. Chem.* 19, 1123 (1927).
- Rabazzana, H., Spark plug problems, *Automotive Ind.* 59, 900 (1928); *Aviation* 26, 798 (1929).
- Watson, E. A., The electrical characteristics of spark gaps and sparking plugs, *Automobile Engr.* 18, 140 (1928).
- Rabazzana, H., Spark plug examination, *Aero Dig.* 15, 152 (Nov. 1929).
- Rabazzana, H., and D. W. Randolph, Sparking plugs, *Automobile Engr.* 20, 224 (1930); *Automotive Ind.* 62, 83 (1930).
- Duffendack, O. S., R. A. Wolfe, and D. W. Randolph, The development of an electron emitting alloy, *Trans. Electrochem. Soc.* 59, 181 (1931).
- Production of sparking plugs, *Machinery (London)* 38, 339, 365, and 39, 1 (1931).
- Gavino, V., Profitable methods and equipment for salvaging and reconditioning used spark plugs, *Riv. Aeron.* 8, 61 (1932).
- Hall, R. M., Selection, care and maintenance of porcelain spark plugs, *Aviation Engr.* 6, 35 (1932).
- Seiler, E., Spark plug insulators for high compression and high-speed engines, *Brennstoff- u. Waermewirt.* 14, 21 and 43 (1932).
- Seiler, E., Effect of design and composition of spark plug electrodes on ignition process in spark ignition engines, *Brennstoff- u. Waermewirt.* 14, 100 and 113 (1932).
- Greene, C. F., Rapid firing of spark plug porcelain, *Ceram. Ind.* 23, 72 (1934).
- Testing spark plugs, *Automobile Elec.* 10, 276 (1934).
- Keeler, E. A., Procedure for rating spark plugs for resistance to fouling, *Automotive Ind.* 72, 604 (1935).
- Naviatiel, H., Spark plugs and their improvement, *Brennstoff- u. Waermewirt.* 17, 21 (1935).
- Rabazzana, H., Spark plug fouling analysis, *Automotive Ind.* 73, 754 (1935).
- Debenham, W. R., and F. G. Haydon, On the erosion of sparking plug electrodes and the variation of sparking plug voltage, *Brit. Air Min. Aeron. Res. Comm. Rept. and Mem.* 1744 (1936).
- Keeler, E. A., Simulated leakage gages ability of spark plugs, *Automotive Ind.* 75, 182 (1936).
- Electron device used in spark plug industry, *Electronics* 9, 44 (1936).
- Sparking plugs with platinum points, *Engineer* 161, 211 (1936).
- Arend, A. G., Sparking plugs and their manufacture, *Electrician* 118, 63 (1937).

- Banks, F. R., Sparking plugs, *J. Inst. Petrol. Technologists* 23, 84 (1937) ; *SAE J.* 45, 397 (1939).
- Boerlage, G. D., and A. C. Cattaneo, Thermocouple spark plug, *Automotive Ind.* 76, 114 (1937) ; *Automobile Engr.* 27, 64 (1937).
- Okazaki, S., Y. Hanawa, and B. Ichijo, Relation between gap length and missing pressure of spark plugs, *Bull. Inst. Phys. Chem. Res. (Tokyo)* 16, 519 (1937).
- Peters, M. F., H. K. King, and J. P. Boston, Government investigates mica spark plugs, *Automotive Ind.* 76, 777 (1937).
- Rabazzana, H., and H. Kalmar, Benefits from longer gaps in spark plugs, *Automotive Ind.* 76, 222 ; *Automobile Engr.* 27, 260 (1937).
- Beall, A. L., and L. M. Townsend, Hi-duty spark plug testing, *SAE J.* 43, 465 (1938).
- Ramsey, F. R., Sparking plugs in aero engines, *Flight* 33, 557 (1938).
- Spark plug endurance tests, *Automotive Ind.* 78, 87 (1938).
- Bibliography of spark plugs, *Works Progr. Admin. Bibliog. Aeron.*, Pt. 35, *Engine Parts and Accessories* (1939).
- Allen, A. H., Polonium spark plugs, *Steel* 106, 37 (Mar. 18, 1940) ; *Discussion* 106, 4 (Apr. 22, 1940).
- Bairsto, G. E., Some factors controlling the development of electrical ignition of aero engines, *J. Roy. Aeron. Soc.* 44, 119 (1940).
- Cronstedt, V., Shortcomings of mica insulation for aviation spark plugs, *SAE J.* 46, 233 (1940).
- Dillon, J. H., Polonium alloys for spark plug electrodes, *J. Appl. Phys.* 11, 291 (1940).
- Riddle, F. H., Ceramic insulators for spark plugs, *SAE J.* 46, 236 (1940).
- Chandler, H. C., Ceramic insulators for aviation spark plugs, *NACA OCR Rept.* 3 (1941).
- Method of determining rate of spark plug gas leakage during actual engine operation, *Ethyl Corp. Rept. A. R.* 67 (1943).
- Effect of spark plug design details on electrode erosion, *Ethyl Corp. Rept. A. R.* 76 (1943).
- Effect of low and high values of capacitance on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 100 (1943).
- Effect of internal resistors on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 101 (1943).
- Effect of ignition source on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 102 (1943).
- Effect of spark polarity on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 103 (1943).
- Method of measuring the resistance of spark plugs while the plugs are firing in an engine, *Ethyl Corp. Rept. A. R.* 104 (1944).
- Effect of electrode geometry on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 105 (1944).
- Effect of nose well ventilation on spark plug electrode erosion, *Ethyl Corp. Rept. A. R.* 106 (1944).
- Sloop, J. L., G. R. Kinney, and W. H. Rowe, Process of lead-deposit accumulations on aircraft engine spark plugs, *NACA Wartime Rept. E* 181 (1945).
- Effect of different center electrode materials on sparking voltage during actual engine operation, *Ethyl Corp. Rept. A. R.* 139 (1945).
- Effect of spark polarity on sparking voltage during actual engine operation, *Ethyl Corp. Rept. A. R.* 140 (1945).
- Effect of heat range on electrode erosion of spark plugs having identical electrode design, *Ethyl Corp. Rept. A. R.* 144 (1945).
- Test procedure for determining oil fouling characteristics of aircraft spark plugs in the SC 17.6 engine, *Ethyl Corp. Repts. A. R.* 145 and *A. R.* 146 (1945).
- Effect of varying load conditions on the sparking voltage requirements of current production ceramic spark plugs, *Ethyl Corp. Rept. A. R.* 148 (1945).
- Spark plugs, *War Department Tech. Bull. TB ORD* 313 (1945).
- Sparking plugs, *Automobile Engr.* 35, 208 (1945).
- Technical reports on spark plug electrode materials, *Battelle Memorial Institute* (1945).
- Bychinsky, W. A., Factors affecting the functioning of spark plugs, *SAE Quart. Trans.* 2, 254 (1948).
- Eitel, W., Ceramic spark plug insulators rich in alumina, *Ceram. Ind.* 50, 66 (1948).
- Pigneguy, P. G., and J. G. Dawson, Spark plug fouling and mixture distribution, *Shell Aviation News* 117, 14 (1948).
- Airline tests gage spark plug erosion, *SAE J.* 56, 70 (Apr. 1948).

Effect of tetraethyl lead content on preignition ratings of aviation spark plugs with platinum alloy electrodes, Ethyl Corp. Rept. A. R. 193 (1948).

Spark plug manufacture, Elec. Rev. (London) 142, 721 (1948).

Barlett, H. B., and K. Schwartzwalder, Trends in the chemical and mineralogical constitution of spark plug insulators, Bull. Am. Ceram. Soc. 28, 462 (1949).

Furman, G. R., and B. Corrigan, All-important spark plug, Aero Dig. 59, 20 and 92 (Oct. 1949).

Riddle, F. H., Ceramic spark plug insulators, J. Am. Ceram. Soc. 32, 333 (1949).

Schwartzwalder, K., and C. F. Schaefer, Internal sealing of spark plug insulators, Bull. Am. Ceram. Soc. 28, 455 (1949).

Cold tests with arctic oil at temperatures ranging to -40°F , Delco-Remy Division, General Motors Corp. Eng. Rept. 2918-B (Oct. 28, 1949).

Investigation of the effect of resistor-suppressors upon cold starting, Signal Corps Eng. Labs. Tech. Mem. M-1189 (Mar. 24, 1949).

Spark plugs for internal combustion engines, Lubrication 35, 61 (1949).

Christian, G. L., New trends at plug conference, Aviation Week 53, 19 (Sept. 18, 1950).

Cipriani, C., Modern spark plugs permit wider gaps, SAE J. 58, 65 (June 1950).

Griffin, A. R., and J. G. Dawson, The effect of fuel factors on spark plug performance, Shell Aviation News 143, 8 (May 1950).

Annular electrode spark plug, Aero Dig. 60, 58 (May 1950).

Comparative cold-starting characteristics of resistor and non-resistor type spark plugs, The Electric Auto-Lite Co., Eng. Rept. 3 (Jan. 19, 1950).

Spark plug competition keen, Aviation Week 53, 33 (Oct. 2, 1950).

Swanson, C. E., and J. W. Miller, How large can the gaps be? SAE Quart. Trans. 5, 283 (1951); Excerpts: SAE J. 59, 32 (Feb. 1951).

New anti-fouling spark plug, Aviation Week 55, 48 (Oct. 15, 1951).

Beaubier, R. C., H. J. Chalk, and M. M. Roensch, Spark plug problems in automotive service, SAE M.P., Detroit (Mar. 1952).

Griffin, A. R., Control of lead fouling in aero engines, Shell Aviation News 165, 17 (Mar. 1952).

Harris, D. N., F. R. Watson, and T. Frame-Thompson, Pre-planned tests exemplified by flight research, Shell Aviation News 168, 14 (June 1952).

Metzel, H. N., Spark plug fouling from a car manufacturer's viewpoint, SAE M.P., Detroit (Mar. 1952).

Vogel, H. H., Operation of spark plugs in present-day engines, SAE M.P., Detroit (Mar. 1952).

Yust, V. E., and E. A. Droegemueller, Aviation spark plug fouling—its cause and control, SAE J. 60, 65 (May) and 37 (June 1952); Shell Aviation News 164, 14 (Feb. 1952).

Four ways to combat auto spark plug fouling, SAE J. 60, 66 (July 1952).

Spark plug testing, Automobile Engr. 42, 113 (1952).

Greenshields, R. J., Spark plug fouling studies, SAE Trans. 61, 3 (1953).

Experts study misfiring, fouling; Champion's aircraft spark plug and ignition conference, Aviation Week 59, 58 (Oct. 26, 1953).

"De-glamorized" spark plug is big news at Champion conference, Am. Aviation 18, 58 (Nov. 8, 1954).

High-altitude spark plug, Aero Dig. 68, 48 (Apr. 1954).

Improved ceramic insulating material, Engineer 197, 289 (1954); Engineering 177, 253 (1954); Flight 65, 207 (1954).

Spark plug fouling and preignition, Petrol. Process. 9, 53 (1954).

Balkevich, V. L., Cast alumina spark plugs, Tr. Vses. Nauchn.-Issled. Inst. Stroit. Keram. No. 10, 187 (1955).

Delikladić, M., Selection of spark plugs for motor vehicles, Vojno Tehnicki Glasnik 3, 672 (1955).

New developments highlight spark plug conference, Am. Aviation 19, 34 (Nov. 7, 1955).

Temperature governs spark plug performance, SAE J. 63, 107 (Dec. 1955).

Vital spark (KLG's plug for jet engines), Elec. J. 154, 1856 (1955).

Lebedev, A., X-ray detection of faults in engine spark plugs, Grazhdanskaia Aviatsiia 13, No. 2, 28 (1956).

Vaneev, A. I., and A. S. Skeblikov, Increasing the spark gap of spark plugs and the requirements for automobile ignition systems, Avtomob. Trakt. Prom., 26 (Aug. 1956).

- Hall, C. A., R. C. Beaubier, E. C. Marckwardt, and R. L. Courtney, Phosphorus fuel additives reduce spark plug fouling, *SAE J.* 65, 60 (Aug. 1957).
- Modly, J., The spark plug and its maintenance, *Vojno Tehnicki Glasnik* 5, 49 (1957).
- Sergel, O. S., Piezoelectric spark plug indicators, *Tr. Aviatsionnii Inst.* No. 92, 129 (1957).
- Winogradow, L., and Z. Czeckowska, Preparing an insulating composition for the production of spark plugs for automobiles, *Szklo Ceram.* 8, 199, 250 (1957).
- How AC turns out top grade spark plugs, *Ceram. Ind.* 69, 84 (1957).
- Spark plug assembly (Crusota air-operated machine), *Automobile Engr.* 47, 314 (1957).
- Hudec, R., The heat range of spark plugs, *Avtomobil (Czechoslovakia)*, 2, 132 (1958).
- Lauer, J. L., P. J. Friel, and R. D. Miller, Fundamental studies related to spark plug deposits, *SAE M.P.*, 106B (Nov. 1958).
- Orlov, V., Instrument for cleaning and pressure testing of spark plugs, *Avtomob. Transp.* 36, 24 (Nov. 1958).
- Shakhovtsev, V. I., Improving spark plugs, *Avtomob. Prom.*, 10 (Sept. 1958).
- Usanov, A. D., A. A. Chapchaev, Effect of operating conditions of engines on spark plug performance, *Avtomob. Prom.*, 22 (July 1958).
- Can beta rays make better spark plugs? *Nucleonics* 16, 82 (1958).
- Dokkolsen, O. W., Plastic moulding of sparking plug insulators, *J. Inst. Production Engr.* 38, 614 (1959).
- Gumbleton, J. J., Engine voltage requirements using spark plugs preionized with radioactive gold, *SAE M.P.* 8T (Jan. 1959); Abstract: *SAE J.* 67, 125 (Feb. 1959).
- Haas, L. E., Wanted—better spark plugs for portable two-stroke engines, *SAE M.P.* 123U (1959); Abstract: *SAE J.* 68, 52 (Mar. 1960).
- Leutz, L. R., R. F. Nostrant, and R. J. Craver, Some problems of spark plug operation in two-cycle engines, *SAE M.P.* 123V (Oct. 1959); Abstract: *SAE J.* 67, 41 (Dec. 1959).
- Nagy, G., and S. Matisesak, Influence of correct working of spark plugs on the reduction of gasoline consumption, *Rev. Transport.* 6, 235 (1959).
- Popa, B., and L. Sandor, Stresses and testing of spark plugs, *Rev. Transport.* 6, 522 (1959).
- AC's hot tip for spark plugs, *Motor Ind.* 78, 96 (May 1959).
- Improved K. L. G. glow plugs, *Automobile Engr.* 49, 339 (1959).
- New AC sparking plugs, *Automobile Engr.* 49, 246 (1959).
- Sheathed element glow plugs, *Engineer* 207, 588 (1959).
- Sparking plug development (K.L.G. engine testing), *Automobile Engr.* 49, 103 (1959).
- Counts, W. E., and W. E. Hauth, Jr., Radioisotope techniques applied to fundamental corrosion studies of spark plug ceramics, *General Motors Eng. J.* 7, 31 (July–Sept. 1960).
- Julien, H. P., and R. F. Neblett, Spark plug misfiring—mechanism studies, *SAE Trans.* 68, 328 (1960).
- Petru, S., On the thermal value of plugs, *Met. Constructia Masini* 12, 409 (1960).
- Smith, L. E., How AC uses optical gauging for precision ceramics, *Ceram. Ind.* 74, 68 (Mar. 1960).
- Federal Specification for spark plugs, W-8-506(2) (1960).
- Fuchs, E. J., Single cylinder engine method for measurement of spark plug fouling, *SAE M.P.* 436B (1961).
- Preignition rating of spark plugs for ground vehicles, *SAE Recommended Practice*, *SAE Handbook*, 644 (1961).
- Spark plugs, *SAE Standard*, *SAE Handbook*, 642 (1961).
- Torque requirements for spark plug installation, *SAE Recommended Practice*, *SAE Handbook*, 644 (1961).
- Dudikov, N. K., Portable device for testing spark plugs, *Avtomob. Prom.*, 46 (1962).
- Gail, R. J., Type of fuel affects spark plug selection, *Oil Gas J.* 60, 96 (1962).
- Test, L. J., and B. L. Hurd, Simple apparatus measure plug fouling, *SAE J.* 70, 86 (Mar. 1962).
- A significant new controlled voltage high frequency plug, *Automobile Engr.* 52, 482, (1962).
- The Lodge "Golden" controlled voltage high-frequency plug, *Motor Ind.* 81, 36 (Oct. 17, 1962).

2.4. Miscellaneous

- Bairstow, L., E. F. Relf, and E. A. Griffiths, Tests on magnetos immersed in an explosive mixture of petrol and air, *Gt. Brit. Advisory Comm. for Aeron. Rept. and Mem.* 186 (1914).
- The prevention of fire in single-engined aeroplanes, *Rept. of the Fire Prevention Sub-Committee, Gt. Brit. Aeron. Res. Comm., Rept. and Mem.* 795 (1922).
- The possible causes of fire in an aeroplane crash and the means that can be taken to lessen the fire risk, *Rept. of the Fire Prevention Sub-Committee, Gt. Brit. Aeron. Res. Comm., Rept. and Mem.* 796 (1922).
- Walls, N. S., R. V. Wheeler, W. Rintoul, and A. G. White, The ignition of fire-damp by momentary flames, *Gt. Brit. Safety in Mines Res. Board, Paper* 24 (1926).
- Walls, N. S., and R. V. Wheeler, The ignition of gases, VI. Ignition by flames, Mixtures of the paraffins with air, *J. Chem. Soc.* 1927, 291.
- Blacktin, S. C., Spontaneous electrification in dust clouds, with special reference to coal dust clouds, *Gt. Brit. Safety in Mines Res. Board, Paper* 43 (1928).
- Burgess, M. J., and R. V. Wheeler, The ignition of firedamp by the heat of impact of rocks, *Gt. Brit. Safety in Mines Res. Board, Paper* 46 (1928).
- Burgess, M. J., and R. V. Wheeler, The ignition of firedamp by the heat of impact of metal against rock, *Gt. Brit. Safety in Mines Res. Board, Paper* 54 (1929).
- Coward, H. F., and R. V. Wheeler, The ignition of firedamp, *Gt. Brit. Safety in Mines Res. Board, Paper* 53 (1929).
- Burgess, M. J., and R. V. Wheeler, The ignition of firedamp by the heat impact of hand picks against rock, *Gt. Brit. Safety in Mines Res. Board, Paper* 62 (1930).
- Blacktin, S. C., and H. Robinson, Spontaneous electrification in coal-dust clouds, *Gt. Brit. Safety in Mines Res. Board, Paper* 71 (1931).
- Burgess, M. J., and R. V. Wheeler, The ignition of firedamp by the heat of impact of coal cutter picks against rocks, *Gt. Brit. Safety in Mines Res. Board, Paper* 70 (1931).
- Grimshaw, H. C., and W. Payman, The ignition of firedamp by coal-mining explosives, Part I. Gallery experiments, *Gt. Brit. Safety in Mines Res. Board, Paper* 69 (1931).
- Kirby, W. A., Ionization in gaseous explosions, *J. Chem. Soc.* 1931, 878.
- Burgess, M. J., and R. V. Wheeler, The prevention of ignition of firedamp by the heat of impact of coal-cutter picks against hard rocks, *Gt. Brit. Safety in Mines Res. Board, Paper* 81 (1933).
- Guest, P. G., Static electricity in nature and industry, *U.S. Bur. Mines Bull.* 368 (1933).
- King, R. O., and G. Mole, The explosions of mixtures of combustible gases with air by nuclear drops of water and other nuclei and by X-rays, *J. Inst. Petrol. Technologist* 20, 791 (1934); 21, 838 (1935).
- Cotte, E., Ignition of firedamp by portable incandescent electric lamps, *Rev. Ind. Minerale*, No. 367, 371 (1936).
- Greene, B. A., The hazard of fire and explosion in anesthesia, *Anesthesiology* 2, 138 (1941).
- Horton, J. W., Present status of the problem of preventing anesthetic explosions, *Anesthesiology* 2, 121 (1941).
- Jones, G. W., and G. J. Thomas, The prevention of cyclopropane-oxygen explosions by dilution with helium, *Anesthesiology* 2, 138 (1941).
- Thomas, G. J., and G. W. Jones, Clinical experiences in the prevention of cyclopropane-oxygen explosions by the addition of helium, *Current Researches Anesthesia Analgesia* 20, 121 (1941).
- Silsbee, F. B., Static electricity, *Natl. Bur. Std. (U.S.) Circ.* 438 (1942).
- Jones, G. W., R. E. Kennedy, and G. J. Thomas, Explosion hazards of combustible anesthetics, *U.S. Bur. Mines Tech. Paper* 653 (1943).
- A review of electrical research and testing with regard to flame-proof enclosure and intrinsic safety of electrical apparatus and circuits, *H. M. Stationery Office, London* (1944).
- Allsop, G., E. M. Guenalt, and A. D. J. Nicol, Intrinsic safety of electrical apparatus, *Gt. Brit. Safety in Mines Res. Board, Paper* 104 (1946).
- Bender, R. J., Use of ether as ignition agent, *Automotive and Aviation Ind.* 95, 40 (Sept. 1, 1946).
- Studies of explosives and explosions, *U.S. Bur. Mines Rept. Invest.* 4031 (1946).

- Allsop, G., F. J. Hartwell, E. M. Guenalt, and A. R. Baker, Intrinsic safety in electrical apparatus, Second Report, Gt. Brit. Safety in Mines Res. Board, Paper 106 (1947).
- King, R. O., The cause of detonation or combustion knock in engines, *Can. J. Res. [F]* 26, 228 (1948).
- King, R. O., W. A. Wallace, and B. Mahapatra, The hydrogen engine and the nuclear theory of ignition, *Can. J. Res. [F]* 26, 264 (1948).
- King, R. O., W. A. Wallace, and B. Mahapatra, The prevention of preignition and detonation in gas engines, *Can. J. Res. [F]* 26, 366 (1948).
- Jones, E., The ignition of solid explosive media by hot wires, *Proc. Roy. Soc. (London)* [A] 198, 523 (1949).
- King, R. O., and E. J. Durand, The cause of preignition (surface ignition)—undoped liquid fuel, *Can. J. Res. [F]* 27, 337 (1949).
- Boyle, A. R., and F. J. Llewellyn, Electrification of metal dusts, *J. Soc. Chem. Ind. (London)* 69, 45 (1950).
- Boyle, A. R., and F. J. Llewellyn, The electrostatic ignitability of dust clouds and powder, *J. Soc. Chem. Ind. (London)*, 69, 173, (1950).
- Broatch, J. D., An apparatus for the measurement of ignition delays of self-ignition, *Fuel* 29, 106 (1950).
- Guenalt, E. M., and E. Atherton, Intrinsically safe electrical apparatus: relation of igniting current to circuit inductance for inflammable mixture with air of the vapours of pentane, hexane, heptane and acetone, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T232* (1950).
- King, R. O., E. J. Durand, and A. B. Allan, The concentration of finely divided carbon in town gas-air mixtures required to induce severe knocking combustion, *Can. J. Res. [F]* 28, 177 (1950).
- Scull, W. E., Relation between inflammables and ignition sources in aircraft environments, *NACA Tech. Note* 2227 (Dec. 1950).
- Chukhanov, Z. F., Ignition of coke dust, *Dokl. Akad. Nauk SSSR* 81, 821 (1951); *Transl.: OTS* 61-17371.
- Guenalt, E. M., and E. Atherton, Intrinsically safe electrical apparatus: relation of igniting current to circuit inductance for inflammable mixtures of carbon, coal gas and hydrogen, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T257* (1951).
- Guenalt, E. M., and E. Atherton, Intrinsically safe electrical apparatus: relation of igniting current to circuit inductance for inflammable mixtures of blue water-gas with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T258* (1951).
- Horsley, J. A. B., Intrinsic safety of electrical circuits in relation to the explosion hazard in industry and relative ease of ignition by weak sparks of various gases and vapours, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T259* (1951).
- King, R. O., E. J. Durand, and A. B. Allan, The nuclear ignition of n-pentane in the CFR engine and the effect on performance, *Can. J. Technol.* 29, 52 (1951).
- Riddlestone, H. G., The effect of series resistance on the energy dissipated in capacitive spark discharges across small gaps, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T253* (1951).
- Barrere, M., General methods of measuring ignition lag in liquid propellants, *IV^o Congr. Intern. Chauffage Ind. (Paris)* (1952).
- Guenalt, E. M., and E. Atherton, Intrinsically safe electrical apparatus: relation of igniting current to circuit inductance for inflammable mixtures of benzene and of cyclohexane with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T268* (1952).
- Gunn, S. V., The effects of several variables upon the ignition lag of hypergolic fuels oxydized by nitric acid, *ARS J.* 22, 33 (1952).
- King, R. O., E. J. Durand, A. B. Allan, and E. J. T. Hansen, Optimum timing of compression or spark ignition as determined by compression ratio; acetaldehyde and diethyl ether as engine fuels, *Can. J. Technol.* 30, 29 (1952).
- King, R. O., and A. B. Allan, The adverse effect on thermal efficiency of the endothermic reaction required for nuclear ignition as shown by engine experiments with methanol, acetaldehyde and diethyl ether, *Can. J. Technol.* 30, 44 (1952).
- King, R. O., E. J. Durand, A. B. Allan, E. J. T. Hansen, and V. E. Bowen, Nuclear ignition as illustrated by the characteristics of compression and spark ignition, *Can. J. Technol.* 30, 222 (1952).
- Kingman, F. E. T., E. H. Coleman, and Z. W. Rogowski, The ignition of flammable gases by sparks from aluminum paint and rusty steel, *J. Appl. Chem. (London)* 2, 449 (1952).

- Altman, D., and A. F. Grant, Jr., Thermal theory of solid-propellant ignition by hot wires, Fourth symposium on combustion, 158, Williams and Wilkins, Baltimore (1953).
- Busch, A. M., Electrostatic spark ignition-source hazard in airplane crashes, NACA Tech. Note 3026 (1953).
- Bowden, F. P., The development of combustion and explosion in liquids and solids, Fourth symposium on combustion, 161, Williams and Wilkins, Baltimore (1953).
- Grice, C. S. W., Sparks from aluminum paint. The firedamp ignition hazard, *Prod. Finishing* (London) 6, No. 4, 58 (1953).
- Guenalt, E. M., E. Atherton, and F. Shaw, Intrinsically safe electrical apparatus: relation of igniting current to circuit inductance for inflammable mixtures of color gas (butane) and of cyclohexane with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T282* (1953).
- Margerson, S. N. A., H. Robinson, and H. A. Wilkins, The ignition hazard from sparks from magnesium-base alloys, *Gt. Brit. Safety in Mines Res. Estab. Res. Rept. 75* (1953).
- Mullins, B. P., Studies on the spontaneous ignition of fuels injected into a hot air stream, *Fuel* 32, 211, 234, 327, 343, 363, 451, 467, and 481 (1953).
- Riddlestone, H. G., The ignition of methane-air gas mixtures by capacitive spark discharges, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T278* (1953).
- Roston, B., Theoretical approach to the problem of determining the relationship between the constants of circuits and their intrinsic safety, *Nature* 171, 397 (1953).
- Holm, R., On the calculation of burning duration of switching arcs and the effect of capacitive quenching circuits, *Siemens Z.* 24, 1 (1954).
- King, R. O., and A. B. Allan, The characteristics of the ignition and combustion of benzene in a carburetor engine as affected by heat load, *Can. J. Technol.* 32, 22 (1954).
- Riddlestone, H. G., The effect of series resistance on the characteristics of capacitive spark discharges, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T293* (1954).
- Titman, H., Ignition hazard from sparks from cast aluminum alloys, *Gt. Brit. Safety in Mines Res. Estab. Res. Rept. 90* (1954).
- Wilke, R., Intrinsic safety, *Elektrotech. Z.* 75, 128 (1954).
- Wood, H. L., and D. A. Charvonia, The ignition of fuel droplets descending through an oxidizing atmosphere, *Jet Propulsion* 24, 162 (1954).
- Barrere, M., and A. Moutet, Study of ignition lag of liquid propellants, Fifth symposium on combustion, 170, Reinhold, New York (1955).
- Bernard, M. L. J., Surface properties of liquid bipropellants and their effects on the kinetics of ignition, Fifth symposium on combustion, 217, Reinhold, New York (1955).
- Grabowski, G., Developments in explosion- and fire-suppression techniques, *SAE Trans.* 63, 803 (1955).
- Hartman, I., Frictional ignition of gas by mining machines, *U.S. Bur. Mines, Inform. Circ. 7727* (1955).
- King, R. O., and A. B. Allan, The transition from spark to nuclear ignition as compression ratio is raised, *Can. J. Technol.* 33, 335 (1955).
- King, R. O. and M. Rand, The hydrogen engine, *Can. J. Technol.* 33, 445 (1955).
- Mullins, B. P., Spontaneous ignition of liquid fuels, *AGARDograph* 4, Butterworths, London (1955).
- Pino, M. A., A versatile ignition delay tester for self igniting rocket propellants, *ARS J.* 25, 463 (1955).
- Barrere, M., and A. Moutet, Inflammation and ignition in liquid-propellant rocket-motor, *AGARD selected combustion problems II*, 83, Butterworths, London (1956).
- Brokaw, R. S., Thermal ignition, with particular reference to high temperatures, *AGARD selected combustion problems II*, 115, Butterworths, London (1956).
- Lewis, B. and G. von Elbe, Fundamental principles of flammability and ignition, *AGARD selected combustion problems II*, 63, Butterworths, London (1956).
- Riddlestone, H. G., The effect of series resistance on the ignition of methane-air gas mixtures by capacitive spark discharges, *Brit. Elec. Allied Ind. Res. Assoc. Rept. G/T304* (1956).
- Bernstein, H., and G. C. Young, Sparking characteristics and safety hazards of metallic materials, *U.S. Naval Gun Factory Rept.* (April 1957).
- Khitrin, L. N., and S. A. Gol'denberg, Thermal theory of ignition of gas mixtures: limiting conditions, Sixth symposium on combustion, 545, Reinhold, New York (1957).

- Luk'yanov, F. N., and N. G. Drozdov, Minimum energy of the spark of static electricity required to initiate the explosion of petroleum products flowing into a tank, *Neft. Khoz.* 35, No. 3, 53 (1957).
- Muller, K., Intrinsically safe circuits, *Elektrotech. Z.* 78, 177 (1957).
- Riddlestone, H. G., The effect of circuit resistance on the discharge energy required for the ignition of methane-air mixtures, *Brit. Elec. Allied Ind. Res. Assoc. Rept. D/T105* (1957).
- Schultze-Rhonhof, H., German investigations of the danger of inflammation by sparks from aluminum, *Rev. Ind. Minerale* 39, 276 (1957).
- Wooding, E. R., Intrinsically safe electrical apparatus: relation of igniting current to inductance for a mixture of ethylene with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. D/T106* (1957).
- Wooding, E. R., and F. Shaw, Intrinsically safe electrical apparatus: relation of igniting current to inductance for a mixture of acetylene with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. D/T107* (1957).
- Wooding, E. R., and F. Shaw, Intrinsically safe electrical apparatus: relation of igniting current to inductance for a mixture of acetylene with air, *Brit. Elec. Allied Ind. Res. Assoc. Rept. D/T108* (1957).
- Bryan, G. J., and E. C. Noonan, Energy requirements for the ignition of seven solid explosives, *Proc. Roy. Soc. (London)* A246, 167 (1958).
- Carpenter, D. L., and D. R. Davies, Variation with temperature of explosibility characteristics of coal-dust clouds using electric spark ignition, *Combust. Flame* 2, 35 (1958).
- Evans, M. W., F. I. Given, and G. M. Muller, Ignition of electrolytic monopropellants by submerged electrical discharge, *Jet Propulsion* 28, 255 (1958).
- Griffiths, S. T., and R. R. Wilson, The spontaneous ignition of alkyl silanes, *Combust. Flame* 2, 244 (1958).
- Hashiguchi, Y., and T. Fujisaki, Electrostatic ignitability of high-pressure acetylene, *Kogyo Kagaku Zasshi* 61, 515 (1958).
- Whitney, W. B., Combustible industrial gases—possibilities of ignition by particles of light alloys heated by arcing or by frictional impact, An appraisal of published information, *Brit. Elec. Allied Ind. Res. Assoc. Rept. D/T104* (1958).
- Wolfhard, H. G., Ignition of combustible mixtures by hot gases, *Jet Propulsion* 28, 798 (1958).
- Wolfhard, H. G., and D. S. Burgess, The ignition of combustible gases by flames, *Combust. Flame* 2, 3 (1958).
- Chang, C. J., A. L. Thompson, and R. D. Winship, Ignition delay of propane in air between 725–880°C under isothermal conditions, Seventh symposium on combustion, 431, Butterworths, London (1959).
- Grey, P., and M. J. Harper, The thermal theory of induction periods and ignition delays, Seventh symposium on combustion, 425, Butterworths, London (1959).
- Hogan, V. D., and S. Gordon, Pre-ignition and ignition reactions of the propagatively reacting system magnesium-sodium nitrate-Laminac, *Combust. Flame* 3, 3 (1959).
- Kogarko, S. M., M. I. Devishev, and V. I. Basevich, A study of the ignition of gases in the reaction products of a flame, *Zh. Fiz. Khim.* 33, 2345 (1959).
- Marsel, J., and L. Kramer, Spontaneous ignition properties of metal alkyls, Seventh symposium on combustion, 906, Butterworths, London (1959).
- Miller, R. E., Some factors governing the ignition delay of a gaseous fuel, Seventh symposium on combustion, 417, Butterworths, London (1959).
- Vanpee, M., and H. G. Wolfhard, Comparison between hot gas ignition and limit flame temperatures, *ARS J.* 29, 517 (1959).
- Wolfhard, H. G., and M. Vanpee, Ignition of fuel-air mixtures by hot gases and its relationship to firedamp explosions, Seventh symposium on combustion, 446, Butterworths, London (1959).
- Beutler, J. A., and J. A. Clark, Minimum electrical energy for auto-ignition of gas mixtures in instrument cases, ISA M.P., Symp. on Safety for Electrical Instrumentation, Wilmington (1960).
- Cullis, C. F., and B. A. Khokhar, The spontaneous ignition of aliphatic amines, *Combust. Flame* 4, 265 (1960).
- Hickes, W. F., Intrinsic safety, ISA M.P., Symp. on Safety for Electrical Instrumentation, Wilmington (1960).
- Litchfield, E. L., Minimum ignition energy concept and its application to safety engineering, U.S. Bur. Mines Rept. Invest. 5671 (1960).
- Roeschenbleck, B., The ignition of explosive gas mixtures by metallic sparks, *Bergbau Arch.* 21, 61 (1960).

- Salooja, K. C., Studies of combustion processes leading to ignition in hydrocarbons, *Combust. Flame* 4, 117 (1960).
- Salooja, K. C., The pre-flame and ignition properties of fuels, *New Scientist* 8, 729 (1960).
- Wahl, H., Temperature and ignitability of grinding sparks in various gas mixtures, *Z. Angew. Phys.* 12, 60 (1960).
- Weaver, H. F., Analysis of the causes of mine fires and ignitions, *Coal Age* 65, 83 (1960).
- Electrical static discharges in aircraft fuel systems, SAE and Am. Petrol. Inst. Coordinating Research Council Rept. 346 (1960).
- Ciepluch, C. C., H. Allen, Jr., and E. A. Fletcher, Ignition of solid propellant rocket motors by injection of hypergolic fluids, *ARS J.* 31, 514 (1961).
- Keller, J. A., and N. W. Ryan, Measurement of heat flux from initiators for solid propellants, *ARS J.* 31, 1375 (1961).
- McAlvey, III, R. F., The ignition mechanism of composite solid propellants, Princeton Univ. Aeron. Eng. Lab. Rept. 557 (1961).
- Mitchell, R. C., J. A. Keller, and others, Ignition and combustion of solid propellants, Univ. of Utah Rept. (Sept. 30, 1961).
- Rae, D., A measurement of the temperature of some frictional sparks, *Combust. Flame* 5, 341 (1961).
- Courtney, W. G., Ignition of ethylene oxide vapor, *ARS J.* 32, 1530 (1962).
- Devlev, V. N., and S. A. Gol'denberg, Ignition from a flame source in the flow of homogeneous fuel-air mixtures, *Teplocnergetika* 9, 22 (1962).
- Kitmer, E. E., Energy requirement for the initiation of wire and carbon bridge primers connected electrically in parallel or series, U.S. Naval Ordnance Lab., Rept. NOLTR-61-171 (Feb. 1962).
- Knudson, L. I., and R. E. Forbess, Design concepts for an exploding bridge-wire electronic ignition system, *Elec. Eng.* 81, 523 (1962).
- Magison, E. G., Low voltage ignition of hazardous atmospheres, *ISA J.* 9, 29 (1962).
- McAlvey, III, R. F., and M. Summerfield, Ignition of double base solid rocket propellants, *ARS J.* 32, 270 (1962).
- Morinaga, K., Ignition of hydrogen-oxygen gas by silent electric discharge, *Bull. Chem. Soc. Japan* 35, 627 (1962).
- Nethercot, W., and H. G. Riddlestone, Criterion of intrinsic safety for inductive break-sparks, *Proc. Inst. Elec. Engr. (London)* 109, 543 (1962).
- Roth, J. F., and G. P. Wachtell, Heat transfer and chemical kinetics in the ignition of solid propellants, *Ind. Eng. Chem. Fundamentals* 1, 62 (1962).
- Schoen, G., Electrostatic charging processes and their dangers of ignition, *Chem. Ing. Tech.* 34, 432 (1962).
- Allen, Jr., H., and M. L. Pinns, Relative ignitability of typical solid propellants with chlorine trifluoride, NASA Tech. Note D-1533 (1963).

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The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

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Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

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Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction. Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics. Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics-NBS Group (Univ. of Colo.).

