AFCRL-62-1053
OCTOBER 1962

Research Report

A Bibliography of the Electrically Exploded Conductor Phenomenon

WILLIAM G. CHACE
ELEANOR M. WATSON

OPTICAL PHYSICS LABORATORY PROJECT 8608

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES, OFFICE OF AEROSPACE RESEARCH, UNITED STATES AIR FORCE, L. G. HANSCOM FIELD, MASS.

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Abstract

This bibliography includes abstracts of reports on the exploding conductor (previously called 'exploding wire') phenomenon published from 1774 through 1961. There is also some coverage of important papers in adjacent areas of spectroscopy and instrumentation. Arrangement is by subject group, alphabetically by authors.

Preface to the Third Edition

The accelerating interest in exploding wires, foils, and films and the resultant appearance of many publications, has made a third edition of the E. W. P. Bibliography highly desirable. The field has broadened to include exploding foils and films as well as wires, hence the new title.

No change has been made in the plan followed in previous editions. Coverage in areas other than exploding wires (Sec. E) and Exploding Foils and Films (Sec. U) is perhaps less thorough than originally planned. Most of these fields are covered by other good bibliographies, which should be consulted for more thorough coverage.

There has been, however, no relaxation of our original attempt to cover the major field completely. It is still our aim to include every publication on exploding conductors. This edition covers the literature through the year 1961.

The authors wish to thank those who have pointed out errors and omissions in previous editions. It is our earnest hope that any lapses in the present edition will be promptly reported to us. Only by this assistance from users can the number of errors and omissions be kept at a minimum.

It is unlikely that another full edition of this publication will be printed in the near future. Economy of effort points to supplements as a most reasonable method of keeping the bibliography up to date. Since distribution is handled by a number of offices and agencies, a card is attached which we request users fill out and return to us in order that supplements may be mailed to all interested parties upon publication.

Preface to the First Edition

In connection with a fundamental study of the Exploding Wire Phenomenon (E. W. P.) being conducted by this laboratory, a search of the literature was undertaken. It was originally intended purely as background for our work. However, conversations with others working on E. W. P. and related problems indicated so much interest, that arrangements were made for this informal publication of the bibliography before the research paper to which it would normally be an appendix.

At the time this work was started, no exhaustive bibliography of E. W. P. was available. Shortly before it was completed William M. Conn's paper in the Z. angew. Phys. (see reference E-40) appeared with its excellent bibliography. It was decided to go ahead with this publication, however, since no English bibliography was available, and it was hoped the annotations might prove valuable.

The abstracts are from various sources. Most are original, from reading of the articles, but some were taken from abstract journals, - Physics Abstracts, Transactions of IRE, Chemical Abstracts, etc. Unfortunately since publication of the notes was not originally planned, no record was kept of sources so credit cannot be given in individual cases.

A considerable part of the library work was done by Mr. Robert Deignan of the Lowell Technological Institute library staff under Contract No. AF 19(604)-1747.

The author wishes to express his appreciation to the library staff of the Geophysics library, AFCRC, particularly Miss Mary Quint for invaluable assistance. Thanks are also due to Mr. Robert Morgan for assistance in proof reading and layout. Of course, nothing could have been done without the patience and help of our secretary, Mrs. W. Watson, who did the many preliminary typings and cut the final stencil.

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A Bibliography of the Electrically Exploded Conductor Phenomenon

INTRODUCTION

The general bibliographic arrangement and the journal abbreviations are, as recommended by the American Institute of Physics, those of Chemical Abstracts.

The bibliography is arranged in subject groups, each with a characteristic letter. Within the group, arrangement is (1) alphabetical by authors, (2) inverse chronological for articles by any one author.

In order not to repeat the abstract, each article is assigned to a subject group and given a letter characteristic of the group. The abstract appears in this group. When the article refers to other subjects, the reference, but not the abstract is included in the regular sequence in all pertinent groups. Its code group (which of course, is the same as before) leads the user back to the abstract.

For example: SMITH, S., Astrophys. J. 61, 186-203 (1925) is assigned code E-107 since E is the E. W. P. section and the article is principally about E. W. P. However, Smith discusses apparatus hence E-107 appears in proper alphabetical sequence in the apparatus (A) section. Theory is considered so E-107 is in section S (theory). Spectroscopy is also an important topic in this paper hence E-107 is listed as well in the section on spectroscopy (P).

It is hoped this system of cross references will make it easy for the user to locate any article.

Titles are given in the original language, except Russian where typography made this impossible. A translation is also given for each title.

Where the journal reference is followed by a "T" it indicates that a translation of the article is on file at this laboratory. All of these translations are being placed on file in the Special Libraries Association Translation Pool at The John Crerar Library, 86 E. Randolph St., Chicago 1, Illinois. Copies may be obtained from them either as photostats or on microfilm.

(Authors' manuscript approved for publication, 4 October 1962)

APPARATUS - Section A

L-1 BARTELS, H. and EISELT, B., "Über ein einfaches Verfahren zur kinematographischen Aufnahme schnell verlaufender Vorgänge," Optik 6, 56-58 (1950) T (A Simple Method for Cinematographic Photography of Rapidly Occurring Processes)

A-1 BELLASCHI, P. L., "Heavy Surge Currents - Generation and Measurements," Trans. Am. Inst. Elec. Engrs. 53, 86-94 (1934)

A quantitative discussion of surge-current generators. Some recommendations for measurements on these generators. Formula for current necessary to fuse a conductor.

A-2 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," B. R. L. Memo Report 1199 (March 1959)

The authors offer an improvement in Bennett's mirror back-lighted method of rendering shock waves visible from an E.W. Mirror is replaced with an array of shiny wires. Used #16 tinned copper wires in side by side contact.

A-3 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," Phys. Fluids 2, 338-339 (1959)

(See A-2)

A-4 BENNETT, F. D., SHEAR, D. D. and BURDEN, H. S., "Streak Interferometry," B. R. L. Report 1080 (September 1959)

The fringe method of examining shock waves has been combined with a Mach-Zender interferometer to allow study of transient axisymmetric flow. Apparatus is described and results are illustrated and analyzed.

Section A

A-5 BENNETT, F. D., SHEAR, D. D. and BURDEN, H. S., "Streak Interferometry," J. Opt. Soc. Am. 50, 212-216 (1960)

(See A-4)

A-6 BREIDENBACH, H. I., Jr., "A Fractional Microsecond X-ray Pulse Generator for Studying High Explosive Phenomena," Rev. Sci. Instr. 20, 899-903 (1949)

Discussion of apparatus

Q-3 BROADBENT, T. E., "The Breakdown Mechanism of Certain Triggered Spark Gaps," Brit. J. Appl. Phys. 8, 37-40 (1957)

A-7 CHACE, W. G. and CULLINGTON, E. H., "Instrumentation for Studies of the Exploding Wire Phenomenon," Instrumentation for Geophysical Research No. 7, AFCRC-TR-57-235 (1957)

Discussion of the theory and problems of E.W.P. instrumentation with some data on solutions to problems. Detailed description of control methods and some measuring equipment.

A-8 CNARE, E. C., "An Exploding Wire as a Fuse for the LASL Capacitor Bank - Zeus," Sandia Corp. SC-4324 (TR), TID-4500 (14th Ed) (1959)

A study of the optimum wire for a capacitor bank fuse. By using a tube around the wire, better results are obtained. Copper wire proves to be better than lower resistivity wires. The theoretical study is from consideration of Sandia's "action" function.

Q-5 CULLINGTON, E. H., CHACE, W. G. and MORGAN, R. L., "Lovotron - A Low Voltage Triggered Switch Gap," Instrumentation for Geophysical Research No. 5, AFCRC-TR-55-227 (1955)

J-1 FAYOLLE, P. and NASLIN, P., "Photographie Instantanée et Cinematographie Ultra-Rapide," Revue d'Optique, Paris, (1950) (Instantaneous Photography and High Speed Cinematography)

A-9 FERRARI, G., "Condensatori a Carta 'Induttivi' e 'Anti-unduttivi'," Ducati-Divisione Recerche-Laboratorie, Condensattori a Carta - EC - 1 (no date) (Inductive and Non-inductive Paper Condensers)

Inductance of condensers as effected by type of construction.

A-10 FOITZIK, S., "Versuche mit grossen Stossstromen," Electrotech. Z. 60, 89-92, 128-133 (1939) T (Experiments with Heavy Surge Currents)

Discussion of the design of a surge current generator and experiments performed with it. Action on metal conductors discussed.

M-6 HALPIN, W. J. and HENDRICKS, R. E., "The Use of Pressure Bars and Plates for the Investigation of Shock Waves from Electrically Exploded Wires," Sandia Tech. Memo SCTM 39-60 (51) (1960)

A-11 JANES, G. S. and KORITZ, H., "High Power Pulse Steepening by Means of Exploding Wires," Rev. Sci. Instr. 30, 1032-1037 (1959) (Also AVCO Res. Lab. Res. Rep. 50 (1959))

Extremely fast rise time produced by charging the transmission lines thru the E. W.'s and then transferring this to the load when the wires blow. Details of the device and apparatus for preparing the multiple wire fuse elements are included.

A-12 KAPITZA, P., "Further Developments of the Method of Obtaining Strong Magnetic Fields," Proc. Roy. Soc. (London) A115, 658-683 (1927)

A rotating generator of special construction as a high current, pulsed energy source.

Section A

D-2 KAPITZA, P., "A Method of Producing Strong Magnetic Fields," Proc. Roy. Soc. (London) A105, 691-710 (1924)

A-13 MARSHAK, I. S., "On the Practical Application of Exploding Wires," Optika i Spectroskopia 10, 801-804 (1961) (Transl. in Optics and Spectroscopy 10, 424-426 (1961)

> Principle of E. W. P. briefly discussed. Apparatus for continuous loading of wire-fiberglass thread treated with enamel laquer and wound with 125 micron W wire. Thread passes from a reel between two tubular electrodes wound up on second reel. Passes through at approx. 30 cm/sec. Flash interval 1-5 sec.

X-4 McFARLANE, H. B., "A High-Voltage, Quick-Acting Fuse, to Protect Capacitor Banks," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 324-344

A-14 PARK, J. H., "Design Data for Coaxial Shunt and Coaxial Inductor," J. Research Natl. Bur. Standards 39, 191-212 (1947)

> Shunt for coaxial measurements of very high surge currents. Inductor to measure $\frac{di}{dt}$.

H-4 PARK, J. H. and CONES, H. N., "Puncture Tests on Porcelain Distribution Insulators Using Steep-front Voltage Surges," Trans. Am. Inst. Elec. Engrs. 72, 1 (1953)

A-15 PREUSS, L. E., "Image Formation of the Rapid Vaporization of Metal Filaments by the Sensitization and Autoradiographic Methods," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, (1959), p. 288-306

> Evaporation of metals may be studied by a "pin hole" evaporation camera. The deposit is intensified by depositing on it another metal or by including in the original sample a radioactive tag and using autoradiography.

A-16 REITHEL, R. J. and BLACKBURN, J. H., "Method of Terminating the Energy Input to an Electrically Exploded Wire," Rev. Sci. Instr. 31, 464 (1960)

Triggered gaps across coax lines to crowbar the circuit. Resistance was 0.32 ohm. Inductance 0.45 μh. Used on Au wire. Cold resistance 0.042 ohm.

E-104 SCHERRER, V. E., "The NRL - AFSWP Exploded Wire Research Program," Exploding Wires Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 118-134

T-4 SLACK, C. M. and DICKSON, D. C., "One-Millionth-Second Radiograph and Its Application," Proc. Inst. Radio Engrs. 35, 600-606 (1947)

E-107 SMITH, S., "A Study of Electrically Exploded Wires, Rotating Mirror Spectrograph," Astrophys. J. 61, 186-203 (1925)

A-17 TUCKER, T. J., "Square-Wave Generator for the Study of Exploding Wires," Rev. Sci. Instr. 31, 165-168 (1960)

Description of a coaxial cable energy storage system, 100 kv, 2000 amp, 3 μsec duration pulse, with square wave form. Allows many analyses to be algebraic rather than nonlinear. Current and voltage coaxial measuring systems are described. Storage cable is 1000 ft. of RG 17/u.

A-18 WALBRECHT, E. E., "A Reliable Three-Channel Delayed Wire Exploder Unit," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 315-322

A delay and control circuit particularly designed for use in connection with E. W.'s.

Section A

A-19 WURSTER, W. H., "High Speed Shutter for Spectrographs," Rev. Sci. Instr. 28, 1093-1094 (1957)

Uses exploding lead wire to blow a "flap" made of scotch tape over the opening. Closes in 5 μsec.

A-20 ZAREM, A. M. and MARSHALL, F. R., "A Method for Measuring Very High Speed Transient Currents," Rev. Sci. Instr. 20, 133-134 (1949)

Description of a one turn magnetic deflection coil of sheet copper placed directly on the neck of a cathode ray tube, and a current transformer to reduce current to suitable value. Formulas are given for calculation of the characteristics of the current transformer.

E-126 ZAREM, A. M., MARSHALL, F. R. and POOLE, F. L., "Transient Electrical Discharges: Disintegration of Small Wires," Phys. Rev. 72, 158 (1947)

ARCS - Section B

Q-1 Anon, "5,000,000 - Ampere Arc," Radio-Electronics Vol. 31, 45 (September 1960)

P-1 ANDERSON, J. A., "Spectral Energy-Distribution of the High-Current Vacuum Tube," Astrophys. J. 75, 394-406 (1932)

N-1 BLOXSOM, D. E., "Production of High Temperature, Moderate Pressure Gases by Means of Electric Spark Discharges," Arnold Eng. Dev. Cent. AEDC-TN-56-17 (1956)

B-1 COBINE, J. D. and BURGER, E. E., "Analysis of Electrode Phenomena in the High-Current Arc," J. Appl. Phys. 26, 895-900 (1955)

Analysis of 100 amp., 60 cps arcs from energy balance point of view. Major energy loss due to evaporation. Graphs: (1) rate of evaporation of metals vs. temperature, (2) heat flow from surface vs. temperature.

B-2 DIEKE, G. H., "Study of Variations in Light Sources as They Affect Spectroscopy," ASTM Tech. Pub. 76, 37 (1946)

A study of characteristics of various types of arcs used as light sources.

B-3 KING, A. S., "Spectroscopic Phenomena of the High Current Arc," Astrophys. J. 62, 238-264 (1925)

Studied high current arc and found spectrum similar to that of E. W. P.

S-1 KLUGE, W. and HOCKER, K. H., "Ohmic Heating of Fully Ionized Plasmas," Proceedings of the Fourth International Conference on Ionization Phenomena in Gases, Vol. II, N. R. Nilsson (ed), North-Holland Pub. Co., Amsterdam (1960)

Section B

E-67 KORNEFF, T., BOHN, J. L. and NADIG, F. H., "Exploding Wire Phenomena at Reduced Pressures," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 104-117

R-6 LOCHTE-HOLTGREVEN, W., "Production and Measurement of High Temperatures," Rep. Progr. Phys. 21, 312-383 (1958)

N-6 MARTIN, E. A., "The Underwater Spark: An Example of Gaseous Conduction at about 10,000 Atmospheres," Univ. of Michigan 2048-12-F (July 1956)

E-115 TUCKER, T. J., "Dependent Resistivity of Exploding Wires," J. Appl. Phys. 30, 1841-1842 (1959)

R-11 VANYUKOR, M. P. and MAK, A. A., "High-Intensity Pulsed Light Sources," Uspekhi Fiz. Nauk. 66, 301-329 (1958) Trans. in Soviet Phys. - Uspekhi 66, 137-155 (1958)

CURRENT - Section C

E-4 ANDERSON, G. W. and NEILSON, F. W., "Use of the 'Action Integral' in Exploding Wire Studies", Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 97-103

C-1 BELLASCHI, P. L., "Lightning Currents in Field and Laboratory," Elec. Eng. 54, 837-843 (1935)

Among other results, some data on the effects of lightning currents on conductors. A description of crushing (pinch effect) and "explosive effects."

K-3 BORODOVSKAYA, L. N. and LEBEDEV, S. V., "Dependence of the Electrical Conductivity and Electron Emission on the Energy of a Metal in the Process of its Heating by a Current of High Density," Zhur. Eksp. i Teoret. Fiz. 28, 96-110 (1955) Soviet Phys. - JETP 1, 71-83 (1956)

K-4 BOROVIK, E. S., "Electrical Conductivity of Metals at High Current Densities," Soviet Phys. - Doklady 91, 771-774 (1953)

E-32 CHACE, W. G., MORGAN, R. L., and SAARI, K. R., "Conductivity During the 'Dwell-Time' of a Wire Explosion," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p 59-72

C-2 HERING, C., "Revision of Some of the Electromagnetic Laws," J. Franklin Inst. 192, p. 599-622 (1921)

Discussion of magnetic pinch effect in liquid metals.

K-6 IGNATYEVA, L. A. and KALASHNIKOV, S. G., "Electric Resistance of Metals in the Case of Large, Pulsed Current Densities," Zhur. Eksp. i Teoret. Fiz. 22, 385-399 (1952)

Section C

C-3 MANINGER, R. C., "Radial Distribution of Current and Its Effect in an Exploding Wire," Exploding Wires Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 156-169

An analysis of short duration currents in a wire. Skin effect can cause time-dependent radial distribution of current in the wire. The effects of the current distribution on exploding wire phenomena are discussed.

ENERGY - Section D

R-1 BEHRENS, W., "Temperatur Bestimmung bei Elektrischen Draht Explosionen," Dis. Hannover 1935 Abs. in Physik Ber. 16, 1958 (1935) T (Temperature Determination in Electrical Wire Explosions)

E-16 BENNETT, F. D., "Energy Partition in Exploding Wire Phenomena," Phys. Fluids 1, 515-522 (1958) (See E-15)

E-15 BENNETT, F. D., "Energy Partition in the Exploding Wire Phenomenon," B. R. L. Rep. 1056 (Oct 1958)

K-3 BORODOVSKIA, L. N. and LEBEDEV, S. V., "Dependence of the Electrical Conductivity and Electron Emission on the Energy of a Metal in the Process of its Heating by a Current of High Density," Zhur. Eksp. i Teoret. Fiz. 28, 96-110 (1955) Soviet Phys. JETP 1, 71-83 (1956)

D-1 EARLY, H. C. and WALKER, R. C., "The Economics of Multi-million Watt-Second Inductive Energy Storage," Trans. Am. Inst. Elec. Engrs. Winter Conference Paper 56-333 (1956)

Discussion of economics of energy storage by condenser, coil, and battery. Describes University of Michigan inductance coil storage system.

E-55 FOURNET, M., "Phénomènes provoques par des implosions de courant intenses dans des conducteurs resistants," Comptes Rendu 252, 2084-2086 (1961) (Phenomena produced by implosions of heavy current in resistive conductors)

E-56 FÜNFER, E., KEILHACKER, M., and LEHNER, G., "Zum Mechanismus von Drahtexplosionen," Z. angew. Physik 10, 157-162 (1959) (On the Mechanism of Wire Explosions)

Section D

D-2 KAPITZA, P., "A Method of Producing Strong Magnetic Fields," Proc. Roy. Soc. (London) 105, 691-710 (1924)

A discussion of the methods of storing energy for large pulsed currents. Although the author discusses magnets, the ideas are applicable to E. W. P.

E-78 LEBEDEV, S. V., "Phenomena in Tungsten Wires Preceding Their Disintegration Under the Effects of Heavy Current," Zhur. Eksp. i Teoret. Fiz. 27, 605-614 (1954)

E-79 LEVINE, P. H., TOLLESTRUP, A. V. and WEBB, F. H. Jr., "Electrical Conduction in Rapidly Exploded Wires," Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, p. 2034-2053, H. Maecker (ed), North-Holland Pub. Co., Amsterdam (1962)

S-2 MEEKER, M. E., "Solid and Solid-Liquid Phases in Wires at High Current Densities," Sandia Tech. Memo SCTM 314-58 (51) (1958)

E-110 STARR, W. L. and NAFF, J. T., "Acceleration of Metal Derived Plasmas," Lockheed Tech. Memo LMSD-288240 (Dec 1959)

E-115 TUCKER, T. J., "Dependent Resistivity of Exploding Wires," J. Appl. Phys. 30, 1841-1842 (1959)

U-3 WUNSCH, D. C., SOAPES, T. D. and GUENTHER, A. H., "Acceleration of Thin Plates by Exploding Foil Techniques," A. F. Special Weapons Lab. Report AFSWC-TDR-61-75 (Jan 1962)

E-126 ZAREM, A. M., MARSHALL, F. R. and POOLE, F. L., "Transient Electrical Discharges: Disintegration of Small Wires," Phys. Rev. 72, 158 (1947)

EXPLODING WIRE - Section E

E-1 Anon - "Statement on Electro-Optical Systems Work for Army," Missile Design and Development 7, (March 1960), Exploding Wires

A study of possible uses of E. W. s.

E-2 ALLEN, W. A., HENDRICKS, C. H., MAYFIELD, E. B., and MILLER, F. M., "Electronic Shutter Photographs of Exploding Bridge Wires," Rev. Sci. Instr. 24, 1068-1069 (1953)

Photographs with Rapatronic shutter camera. The authors also studied electrical behavior by placing wire in arm of 3 cm microwave bridge and noting the unbalance. When the wire is exploded in an electrostatic field the rate of unbalance is shortened. Postulate space charge.

E-3 ALLISON, S. K. and HARKINS, W. D., "The Absence of Helium from Gases Left After the Passage of Electric Discharges," J. Am. Chem. Soc. 46, 814-824 (1926)

Repeated the Wendt and Irion experiment looking for helium from discharges. Used principally discharge between metallic points. Also tried a few E. W. P. experiments.

E-4 ANDERSON, G. W. and NEILSON, F. W., "Use of the 'Action Integral' in Exploding Wire Studies," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 97-103

Defines action integral as $I(t) = \int i^2 \, dt$ and shows that it is often more useful in E. W. study than is energy integral $U = \int i^2 r \, dt$.

Section E

E-5 ANDERSON, J. A., "Electrically Exploded Wires," International Critical Tables, Vol. 4, p. 434 (1934) McGraw-Hill, N. Y.

Bibliography and brief description of phenomenon. Development of spectra with time is discussed.

E-6 ANDERSON, J. A., "The Spectral Distribution and Opacity of Wire Explosion Vapors," Proc. Natl. Acad. Sci. U. S. 8, 231-232 (1922)

The author measured the spectral energy from the infrared to the ultraviolet. Found that the continuous spectrum is the same for all metals tested. Also tried to pass spectrum from a spark through an exploding wire plasma. Found plasma opaque, 4 cm being perfectly opaque.

E-7 ANDERSON, J. A., "Spectra of Explosions," Proc. Natl. Acad. Sci. U. S. 6, 42-43 (1920)

A study of the spectrum of exploding iron wires.

E-8 ANDERSON, J. A., "The Spectrum of Electrically Exploded Wires," Astrophys. J. 51, 37-48 (1920)

The author points out that E. W. P. produces a more nearly complete absorption spectrum than any other laboratory source. The continuous background extends into the extreme ultraviolet. Intrinsic brightness is greater than the sun. Believes continuous spectra come from gases at relatively low pressure. Plates of typical spectra are given.

E-9 ANDERSON, J. A. and SMITH, S., "General Characteristics of Electrically Exploded Wires," Astrophys. J. 64, 295-314 (1926)

The authors discuss mainly techniques for studying E. W. P. They discuss and analyze (1) the storage condenser and circuit, (2) rotating mirror camera and spectrograph, (3) other fast photographic methods, (4) methods of estimating temperature, (5) double gap method for studying early stages of the explosion. A few results are given and discussed.

M-1 BAIRD, K. M., "Shock Waves in Glass," Nature 160, 24-25 (1947)

E-10 BAKER, L., WARCHALL, R. L., VOGEL, R. C., and KILPATRICK, M., "Studies of Metal-Water Reactions at High Temperatures - I. The condenser discharge experiment. Preliminary results with zirconium," Argonne Natl. Lab. ANL-6257 (May 1961)

Condenser discharge i. e. exploding wire methods of producing heated metals in water were employed to study Zr-water reaction. Methods of measuring total energy delivered, and temperature are described. Results in terms of % reaction and H_2 evolved are given for temps from 1000° to 4000°.

E-11 BALK, O., "Zahlrohrmessungen an Drahtexplosionen," Naturwissenschaften 43, 511 (1956) (Counter Tube Measurements on Exploded Wires)

Repeated experiment of Conn (E-42). Negative results.

L-1 BARTELS, H. and EISELT, B., "Über ein einfaches Verfahren zur kinematographischen Aufnahme schnell verlaufender Vorgänge," Optik 6, 56-58 (1950) T (A Simple Method for Cinematographic Photography of Rapidly Occurring Processes)

Section E

E-12 BARTELS, H., BORTFELDT, J., BERG, K. -H., "Über den Zündungsprozess bei Drahtexplosionen," Proc. of the Fifth International Conference on Ionization Phenomena in Gases Vol. I, H. Maecker (ed), North-Holland Pub. Co., Amsterdam (1962), p. 1048-1051 (On the Ignition Process in Wire Explosions)

High speed photos and spectrograms of E. W.'s. At 100 mm and 200 mm in rare gas atmospheres, the gas surrounding the wire breaks down first. Only under special circumstances does the wire also explode and when it does the early spectrum is of the rare gas, not of Cu.

E-13 BAXTER, H. W., Electric Fuses, Edward Arnold, (ed), London (1950)

Theoretical as well as practical discussion of slow speed fusion of wires. Experimental results are given but very few original references.

R-1 BEHRENS, W., "Temperatur Bestimmung bei Elektrischen Draht Explosionen," Dis. Hannover, Abs. in Physik Ber. 16, 1958 (1935) T (Temperature Determination in Electrical Wire Explosion)

Q-2 BELLASCHI, P. L., "Laboratory Lightning - The Microsecond Switch," Elec. J. 33, 273-275 (1936)

H-2 BENNETT, F. D., "Transient Skin Effects in Exploding Wire Circuits," B. R. L. Report 1137, (August 1961)

M-4 BENNETT, F. D., "Flow Fields Produced by Exploding Wires," Exploding Wires Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 211-266

E-14 BENNETT, F. D., "Flow Fields Produced by Exploding Wires," B. R. L. Report 1075 (May 1959)

Further study of shock wave problems, using linear streak back-lighting with rotating mirror. Concludes, among other things that an E.W. acts as a transducer between electrical and fluid mechanical energy and hence that its apparent resistance in the circuit depends on density of surrounding medium. An attempt is made to relate flow to variable energy similarity flows. Shows experimentally that actual shock trajectories do not differ much for different ambient densities.

M-2 BENNETT, F. D., "Cylindrical Shock Waves from Exploded Wires of Hydrogen-Charged Palladium," B. R. L. Report 1063 (January 1959)

M-3 BENNETT, F. D., "Cylindrical Shock Waves from Exploded Wires of Hydrogen-Charged Palladium," Phys. Fluids 2, 470-471 (1959)

E-15 BENNETT, F. D., "Energy Partition in the Exploding Wire Phenomenon," B. R. L. Report 1056 (Oct 1958)

A study by streak camera and oscillograph of relation between shock wave energy and electrical and heat energy in E.W.P. Wire diameter (3 to 8 mils) is the principle parameter. Calculation of power dissipated in an E.W.circuit in appendix.

M-5 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Bull. Am. Phys. Soc. 3, 292 (1958)

E-16 BENNETT, F. D., "Energy Partition in Exploding Wire Phenomena," Phys. Fluids 1, 515-522 (1958)

(See E-15)

Section E

E-17 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Phys. Fluids 1, 347-352 (1958)

(See E-18)

E-18 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," B. R. L. Report 1038 (1958)

Rotating mirror camera modified with a stationary plane mirror placed to give coincident second reflection. This backlights nonluminous shocks and makes them visible. Also streak photographs. Shocks up to Mach 9 were produced by E.W.P.

E-19 BENNETT, F. D. and SHEAR, D. D., "Shock Waves from Exploding Wires at Low Ambient Densities," B. R. L. Report 1152 (Oct 1961)

Modification of the method of streak interferometry is described. A system of very narrow band filters replaces the monochrometer. Using this technique to study the explosion of 4 mil Cu wires at reduced pressures shows that at 1/16 atm the shock comes not only from the unconfined expansion of metal vapor but in the early stages from expansion of the plasma of the peripheral arc. Electron density in the annular region reaches as high as 10^{18}/cc.

E-20 BENNETT, F. D., BURDEN, H. S., and SHEAR, D. D., "Correlated Electrical and Optical Measurements of Exploding Wires," B. R. L. Report 1133 (June 1961)

By relating current, voltage, light, and streak photographs the authors develop a comprehensive picture of wire explosions, especially those with wires matched to the internal electrical circuit.

A-2 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," B. R. L. Memo Report 1199 (March 1959)

E-21 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," Phys. Fluids 2, 338-339 (1959)

(See A-3)

E-22 BETHGE, O., "Mechanische Verformungen durch elektrische Entladungen," Ann. Physik 8, 475-499 (1931) T (Mechanical Distortions due to Electrical Discharges)

An exhaustive quantitative discussion of bends formed in wires by surges of current just below the fusion point.

E-23 BEUCHELT, R. and BÖHM, E., "Über eine Temperatur - und Druckmessung im Plasma von Drahtexplosionen," Naturwissenschaften 44, 507 (1957) (Temperature and Pressure Measurement in the Plasma from Exploding Wires)

A discussion of temperature determination from line width measurement. A temperature of 63,000 °K ± 12% is found in discharge of a wire 0.03 mm dia. The pressure was 135 atm ± 10%.

E-24 BEY, P. P., FAUST, W. R., FULPER, R., JR., LEAVITT, G. E., SHIPMAN, J. D. JR., and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. Naval Research Lab. Progress Report (1 Nov 1961 to 1 Feb 1962)

Calculations supporting x-ray production from bremsstrahlung. Kinetic electron temperature is calculated to be 2.6 KeV from photo studies. Power measurements were attempted. A voltage measuring system was devised and tested. Studies were made of a mylar-oil capacitor. Details of the voltage divider are given.

T-1 BEY, P. P., FAUST, W. R., FULPER, R., JR., HARRINGTON, F. D., LEAVITT, G. E., SHIPMAN, J. D., and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. Naval Research Lab. Progress Report (1 Aug to 1 Nov 1961)

Section E

N-1 BLOXSOM, D. E., "Production of High Temperature, Moderate Pressure Gases by Means of Electric Spark Discharges," Arnold Eng. Dev. Cent. AEDC-TN-56-17 (1956)

P-2 BODSON, E. and DEHALU, F., "Neuvelles récherches sur les bandes de l'oxyde d'aluminium," Bull. Acad. Belg. 23, 408 - (1937) (New research on the bands of aluminum oxide)

K-2 BONDARENKO, V. V., KVARTSKHAVA, L. F., PLIUTTO, A. A. and CHERNOV, A. A., "Resistance of Metals at High Current Densities," Zhur. Eksp. i Teoret. Fiz. 28, 191-198 (1955); Soviet Phys. JETP 1, 221-226 (1955)

E-25 BONPAS, M., ERTAUD, A., LEGRAND, J. P. and MEUNIER, R., "Expériences Preliminaires sur les Radioactivités Consécutives a l'Explosion de Fils Contenant Deutérium," J. phys. radium 18, 585-589 (1957) (Preliminary Experiments on Radioactivity Resulting from the Explosion of Wires Containing Deuterium)

> The author tried to repeat Conn's radioactivity experiment (E-42). Results were negative. Used wires containing deuterium and tritium with positive results here. Elaborate precautions to overcome high background to sample ratio.

E-26 BRAUN, F., "Der Mechanismus der elektrischen Zerstaubung; Schmelzen von Kohlenstoff; Zerlegung von Metallegierungen," Ann. Physik 17, 359-363 (1905) T (The Mechanism of Electrical Sputtering; Fusion of Carbon; Segregation of Alloys)

> The author exploded wires and condensed the resulting vapor on glass plates. Studied effects produced. Concludes metal is deposited, not oxides.

E-27 BRISCOE, H. V. A., ROBINSON, P. L. and STEPHENSON, G. E., "The Electrical Explosion of Tungsten Wires," J. Chem. Soc. (London) 127, 240-247 (1925)

The authors repeated the Wendt and Irion experiment exploding tungsten wires in vacuum. No evidence of the formation of helium.

E-28 CHACE, W. G., "Observations in High Density Plasmas Produced by Exploding Wires," Proc. of the Fourth International Conference on Ionization Phenomena in Gases," Vol. II, pp. IVE 1191 - IVE 1195, N. R. Nilsson (ed), North-Holland Pub. Co., Amsterdam (1960)

Measurements of current during dwell showed density of 10^5 A/cm^2. High speed photographs and flash x-rays indicate mechanism of vaporization from highly superheated liquid. Density of resulting vapor is order of 10^2 atoms/cm^3 and its conductivity is intermediate between a "normal" gas and a plasma. Restrike results from onset of avalanching.

E-29 CHACE, W. G., "The Liquid Behavior of Exploding Wires," Phys. Fluids 2, 230-235 (1959)

A theory of explosion due to superheating, supported by high speed photographs. The role of unduloids in striation formation is also disputed.

E-30 CHACE, W. G., "A Brief Survey of Exploding Wire Research," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York, p. 7-13 (1959)

A very brief historical sketch, the author's view of the mechanism of the explosion, and a short statement about some of the uses to which E. W.'s have been put.

Section E

E-31 CHACE, W. G., "Details of Behavior of a Wire During Electrical Explosions," Paper delivered before Tenth Annual Gaseous Electronics Conference, M. I. T. (Oct 1957)

Presentation of superheat theory coupled with the unduloid theory. Dwell related to vaporization. Experimental proof presented. Equation for dwell time (empirical) offered.

A-7 CHACE, W. G. and CULLINGTON, E. H., "Instrumentation for Studies of the Exploding Wire Phenomenon," Instr. Geophys. Res. No. 7, AFCRC-TR-57-235 (1957)

E-32 CHACE, W. G., MORGAN, R. L., and SAARI, K. R., "Conductivity During the 'Dwell-Time' of a Wire Explosion," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 59-72

Current was measured during dwell and found to be not zero but from 500 to 2000 amps for 10 cm wires of various diameter (0.13 to 1 mm). Study of the current voltage relations during the period leads to theory that current is conducted by thermoions.

E-33 CHACE, W. G. and LEVINE, M. A., "Classification of Wire Explosions," J. Appl. Phys. 31, 1298 (1960)

Four classes proposed in each of which phenomena are claimed to be comparable, while not always so between classes.

Classes	
1. Melting	$\frac{1}{2} C V_0^2 < W_v + \int I^2 R_0 \, dt$
2. Slow	$t_v > \Psi$
3. Fast	$t_v < \Psi$
4. Ablative	$t_v < \tau$

t_v = time to vaporize; Ψ = time constant of instabilities; τ = electrothermal time constant.

E-34 CNARE, E. C., "Electrically Imploded-Exploded Aluminum Tube," J. Appl. Phys. 32, 1275-1278 (1961)

Al tubes 19.0 cm (7 $\frac{1}{2}$") long, 0.476 cm dia. and 0.01 cm wall were exploded with 141 Kj at 20 kV. Observations - X-rays, I(t), and framing camera. The tube collapses, then melts, then explodes like a wire. For 3.7 μsec no tube wall motion because pinch has not yet built up. Up to 10.5 μsec it seems that the tube collapses still as a solid. E.W. action takes place after 15 μsec. Graphs and photos are shown.

A-8 CNARE, E. C., "An Exploding Wire as a Fuse for the LASL Capacitor Bank - Zeus," Sandia Corp. SC-4324 (TR), TID-4500 (14th Ed) (1959)

E-35 CNARE, E. C. and NEILSON, F. W., "Large Exploding Wires - Correlation to Small Wires and Pause Time versus Length Dependency," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 83-96

Large (up to 62 mil and up to 18 in. long) wires of Cu, and Fe were exploded with 49.5 Kj. The results were correlated with small wires. Relation between length and dwell time is established as well as the effects of confinement on the length of dwell.

P-4 COHEUR, F. and ROSEN, B., "Le spectre des bandes de l'oxyde d'aluminium," Bull. Soc. Roy. Sc. Liege 10, 405-413 (1941) (The band spectrum of aluminum oxide)

E-36 CONN, W. M., "Über Drahtexplosionen mit unterbrochenem Draht," Z. Naturforsch. 13a, 355-356 (1958) (Wire explosions with Interrupted Wires)

The author describes E.W.P. where the wire is not continuous electrically, but comes near a vertical plate. The wire frequently breaks into sections, some of which weld themselves to the plate. It is claimed that the length of these sections is that of a secondary unduloid.

Section E

E-37 CONN, W. M., "Fenstermethode zur Beobachtung innerhalb von Metalldämpfen die bei kurzzeitigen Vorgängen auftreten. Beispiel: Drahtexplosionen," Naturwissenschaften 45, 6-7 (1958) (Window Methods for Observation within the Metal Vapors Produced in Short Time Events: Example: Exploding Wires)

Wires were exploded close to a transparent plastic-like Mylar and high speed photographs taken.

E-38 CONN, W. M., "Observation of Phenomena Inside the Vapor Cylinder Formed During Explosion of a Metallic Wire," Bull. Am. Phys. Soc. 2, 376 (1957)

Investigation of the physical shape of an E. W. during explosion by deposits of vapor on glass slides and by a nylon "window" to observe the interior of the vapor cloud.

E-39 CONN, W. M., "Studies of the Mechanism of Electrically Exploded Wires," Naturwissenschaften 42, 65-66 (1955)

States theory resulting from work discussed in reference E-40 (In English)

E-40 CONN, W. M., "Studien zum Mechanismus von elektrischen Drahtexplosionen (Metallniederschläge und Stosswellen)," Z. angew. Physik 7, 539-554 (1955) T (Studies of the Mechanism of Electrical Wire Explosions)

Very comprehensive article including an excellent bibliography. The author discusses experiment work leading to his theory of E. W. P. The theory postulates shock phenomena as the cause of reignition.

E-41 CONN, W. M., "Metallic Deposits and Shock Waves Due to Electrically Exploded Wires," Phys. Rev. 98, 1551 (1955)

Abstract of a meeting paper describing results of metal deposits on glass and a theory of E. W. P. resulting from this work. This theory is fully discussed in reference E-40.

E-42 CONN, W. M., "A New Effect Observed in Connection with Electrically 'Exploded' Wires," Nature 169, 150 (1952)

Report of ionizing radiation following explosion of copper wire. Measurement of total light energy.

E-43 CONN, W. M., "The Use of 'Exploding Wires' as a Light Source of Very High Intensity and Short Duration," J. Opt. Soc. Am. 41, 445-449 (1951)

Investigated E. W. P. as a light source. Found copper best for photographic work and silver best for visual.

E-44 CONN, W. M., "A Coating Method Based on the Use of Electrically Exploded Wires," Phys. Rev. 79, 213 (1950)

Discusses uses of E. W. P. for metallic coating.

E-45 CONN, W. M., "Note on the Polarization of Light Emitted by Electrically Exploded Wires," Phys. Rev. 58, 50-51 (1940)

Studied polarization to determine source of continuous spectrum. Light reflected or scattered should be polarized. Found no polarization, hence continuous spectrum not due to this cause.

R-3 CONN, W. M. and DEEG, E. W., "Use of the Solar Furnace as an Intermediate Imaging Source for Attaining Extreme Temperatures for a Short Time," Bull. Am. Phys. Soc. 3, 375 (1958)

E-46 DAVID, E., "Exploding Wires, Calculation of Heating," Exploding Wires, Vol. I, Chace and Moore (eds) Plenum Press, New York (1959) p. 271-279

In a wire explosion, only that energy added in the short interval after the wire has exceeded temperature of vaporization but before it begins to expand produces high temperatures. Formulas are developed for calculating wire resistance producing maximum temperature. Terms are converted to dimensionless form and graphs are given showing behavior of these terms.

Section E

E-47 DAVID, E., "Physikalische Vorgänge bei elektrischen Drahtexplosionen," Z. Physik 150, 162-171 (1958) T (Physical Processes in Electrical Wire Explosions)

Calculations of behavior at various stages of development, using data from Müller (E-83)

E-48 DAY, P. B., "The Radiant Intensity of Electrically Exploded Wires," J. Opt. Soc. Am. 43, 817 (1953)

A method of photographic photometry is described from which spectral energy composition curves, and brightness temperatures of exploding wires may be obtained.

E-49 DÉCHÈNE, R., "Étude des Spectres de Fils Explosés," J. phys. radium 7, 59-64 (1926) (Study of the Spectra of Exploded Wires)

Investigation of spectra of several metals, particularly with respect to reversals. Uses reversal of lines in E.W.P. as a method of classifying spectral lines.

N-2 EARLY, H. C. and MARTIN, E. A., "The Underwater Spark; A Photographic Light Source of High Intrinsic Brilliance," Trans. Am. Inst. Elec. Engrs., Pt 1, 44, 788-790 (1955)

E-50 ECKSTEIN, L. and FREEMAN, I. M., "Das Spektrum explodierender Lithiumdrähte," Z. Physik 64, 547-555 (1930) (The Explosion Spectrum of Lithium Wires)

An attempt to solve some of the problems of E.W.P. by studying one of the simpler (alkali) spectra.

E-51 EISELT, B., "Über den Ablauf von Drahtexplosionen," Z. Physik 132, 54-71 (1952) T (The Course of Wire Explosions)

Comprehensive study of the theory of E.W.P. concentrating on a discussion of "dark time" and reason for reignition.

E-52 EISELT, B, "Über den Ablauf von Drahtexplosionen," Physik Ber. 30, 768-769 (1951) T (On the Discharge from Wire Explosion)

Meeting report giving results written up in reference E-51.

E-53 ESCHENBACH, R. C., "Measuring Voltage in an Exploded Wire Discharge," Army Project 4A (July 1948)

Detailed discussion of methods of measuring voltage across an exploded wire. Describes many methods tried and the final satisfactory method.

E-54 FARADAY, M., "Division by the Leyden Deflagration," Proc. Roy. Instn 8, 356 (1857)

Mentions E. W. P. as a method of obtaining a very thin gold film.

N-3 FINKELNBURG, W., "Continuous Electron Radiation in Gas Discharges," Phys. Rev. 45, 341-342 (1934)

A-10 FOITZIK, S., "Versuche mit grossen Stossströmen," Electrotech. Z. 60, 89-92; 128-133 (1939) T (Experiments with Heavy Surge Currents

E-55 FOURNET, M., "Phénomenes provoqués par des implosions de courant intenses dans des conducteurs résistants," Comptes Rendu 252, 2084-2086 (1961) (Phenomena Produced by Implosions of Heavy Current in Resistive Conductors)

Particles ejected by E. W.'s in vacuum are collected on a target and deductions made about velocity and thence about temperature. Velocity is reported to be 50 km/sec, 150 - 800 ev or 2,000,000°K. Cu-Ni alloy and graphite were exploded with 2 μF and 5000v.

Section E

E-56 FÜNFER, E., KEILHACKER, M., and LEHNER, G., "Zum Mechanismus von Drahtexplosionen," Z. angew. Physik 10, 157-162 (1959) (On the Mechanism of Wire Explosions)

An investigation of energy-temperature relations in E.W.P. Parameters include length, cross-section of Cu, Ag. A consideration of energy balance and losses is included.

E-57 FUTAGAMI, T., "On the Electric Explosion Spectrum of Metals," Sci. Papers Inst. Phys. Chem. Research (Tokyo) 31, 1-29 (1937)

Description of equipment, electrical and photographic, used in many papers by author on E.W.P. Interest is primarily spectrographic. Tables and spectrographic plates are included.

E-58 HALLOWES, J. P., JR., "Generation of Fast Waveforms," Res. Labs., Quart. Res. Rev. 17, 88-97 (1958) Army Rocket and G. M. Agency

The author suggests E.W.P. to generate fast waveforms. Very general analysis of the mechanism attempted.

M-6 HALPIN, W. J., and HENDRICKS, R. E., "The Use of Pressure Bars and Plates for the Investigation of Shock Waves from Electrically Exploded Wires," Sandia Tech. Memo SCTM 39-60 (51) (1960)

E-59 HAUVER, G. E., "A Spectrograph with Space-time Resolution and Its Application to the Study of Exploding Tungsten Wires," B. R. L. Report 913 (July 1955)

Using framing rotating mirror camera as a spectrograph, changes in spectrum with time were studied. Early stages mostly air spectrum; later tungsten.

J-3 HEINE-GELDERN, R. V., "Photographie Ultra-Rapide au Moyen de Cellules de Kerr et de Fils Explosifs," Photographie and Cinématographie Ultra-Rapides, Actes du 2 ème Congres International de Photographie et Cinématographie Ultra-Rapides, Paris (1954) p. 238-243 (High-Speed Photography by Means of Kerr-cells and Exploding Wires)

J-4 HEINE-GELDERN, R. V., PUGH, E. M. and FONER, S., "Kerr Cell Photography of High Speed Phenomena-Detonation and Shock Phenomena," Phys. Rev. 79, 230 (1950)

E-60 HERZOG, A., "Influence of Short Time, High Velocity Impact on Materials Structures," Tech. Memo WCRT-56-93, Wright Air Development Center, Materials Laboratory (Aug 1956)

Use of E.W.P. to produce shock, temperature, and particle effects on Al, Cu, and an alloy of Mo-98/W-2. Discussion and metallographic photographs.

J-5 HOLTZWORTH, R. E. and HINZ, D. J., "Exploding Wire Backlighting for the Study of Detonation, Shock and Shaped Charges," B. R. L. Report 818 (May 1952)

E-61 HORI, T., "On the Absorption Spectra Produced by the Explosion of Various Elements, (Hg, Cu, Fe, etc.)," Sci Papers Inst. Phys. Chem. Research (Tokyo) 4, 59-78 (1926)

A study of absorption spectra of exploding wires.

E-62 v. HÜBL, A. and v. OBERMAYER, A., "Über einige elektrische Entladungserscheinungen und ihre photographische Fixierung," Sitzungber d. K. Akad. Wissensch. zu. Wein 98, Abth IIa, 419-430 (1889) (On the Appearance of Several Electrical Discharges, and their Photographic Recording)

Photographs and smoke plate recordings of E.W.P. and sparks. Recorded the "normal rays" which would now be called jets.

Section E

E-63 KATZENSTEIN, J., "The Exploding Wire as Fast Dynamic Pinch," Univ. of N. Mex. Final Tech. Report (July 1961)

> Explosions of 1 mil Cu, Li, Li-H, Li-H^2 - graphite coated polyethylene were studied by streak camera, framing camera, current, and neutron detector. Low Z materials act much differently from high Z. Photographic and neutron evidence of pinch appears with the low Z materials. An unexplained dark area appears in the pinch photos. This may be due to bremsstrahlung with guillotining. Temperatures of about 300 ev were estimated.

E-64 KATZENSTEIN, J., "The Pinch Effect in the Exploding Wire Phenomenon," Exploding Wires, Vol. 1, Chace and Moore (eds), Plenum Press, New York (1959) p 135-146

> Streak camera studies of 2 mil Cu wires in a coaxial system. A current oscillogram was synchronized with the photos.

E-65 KEILHACKER, M., "Über den Mechanismus der explosionsartigen Verdampfung von Kupferdrähten durch sehr intensive Stromstösse und das Verhalten des Kupfers bei den dabei auftrentenden hohen Drucken und Temperaturen," Z. angew Physik 12, 49-59 (1960) (On the Mechanism of Explosive Vaporization of Copper Wires by Very Large Current Pulses and the Behavior of Copper at the Resulting High Pressures and Temperatures)

> The author measures current, voltage, and light intensity output and compares the results with his calculations of temperature, pressure, energy absorbed. He uses Himpan's equation of state for copper and gets his critical data from David's estimates. He proposes a mechanism in which the Cu superheats and the superheat is broken by an inward progressing rarefaction wave.

B-3 KING, A. S., "Spectroscopic Phenomena of the High Current Arc," Astrophys. J. 62, 238-264 (1925)

E-66 KLEEN, W., "Über den Durchgang der Elektrizität durch metallische Haardrähte," Ann. Physik 11, 579-605 (1931) (On the Passage of Electricity thru Fine Metal Wires)

A detailed study of E.W.P.with capacity as the principal variable, photography - including rotating mirror - the principal instrument. Explains vapor stria by prior formation of unduloids in the liquid phase.

E-67 KORNEFF, T., BOHN, J. L. and NADIG, F. H., "Exploding Wire Phenomena at Reduced Pressures," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p 104-117

A study of E. W. particularly during dwell by framing camera. Wires of Cu, B+S No. 24 and 40, were exploded in a vacuum and at atmospheric pressure. Differences in manner of restrike were noted for 24 and 40. At reduced pressures, arc over around wire is the important feature; down to 1 mm arc over is in the air; below this in the vapors produced by the heated wire.

E-68 KVARTSKHAVA, I. F., "Concerning Papers of E. S. Khaikin, S. V. Lebedev and B. N. Borodovskia Published in the Zhur. Eksp. i Teoret. Fiz. (USSR) in 1954-1955," Zhur. Eksp. i Teoret. Fiz. 30, 621 (1957); Soviet Phys. JETP 3, 787 (1956)

Kvartskhava feels that the anomalous state postulated by Lebedev, Khaikin and Borodovskia is not sufficiently supported by experimental evidence. Also he doubts Lebedev's measurements on E.W.P. especially voltage measurements. Kvartskhava thinks abnormality may be accounted for by motion of the wire.

Section E

E-69 KVARTSKHAVA, I. F., BONDARENKO, V. V., MELADZE, P. D. and SULADZE, K. V., "Electric Explosion of Spiral Wires in Vacuum," Zhur. Eksp. i Teoret. Fiz. 35, 911-916 (1958), transl. in Soviet Phys. JETP 35, 634-638 (1959)

Various bent wires were exploded and photographed. Action of explosion products were noted and the result analyzed. Radial ejection of explosion products confirmed. Current tubes formerly seen are reconfirmed and used to explain bent wire action.

E-70 KVARTSKHAVA, I. F., BONDARENKO, V. V., MELADZE, P. D. and SULADZE, K. V., "Electrical Explosion of Wires in Vacuum," Zhur. Eksp. i Teoret. Fiz. 31, 737-744 (1956), Soviet Phys. JETP 4, 637-644 (1957)

Studies were made from time integrated photographs and vapor deposits. The authors find explosion in vacuum is a combination of a real E.W.P. and an arc around the wire. Magnetic pinch is discussed.

E-71 KVARTSKHAVA, I. F., BONDARENKO, V. V., PLIUTTO, A. A. and CHERNOV, A. A., "Oscillographic Determination of Energy of Electric Explosion of Wires," Zhur. Eksp. i Teoret. Fiz. 31, 745-751 (1956); Soviet Phys. JETP 4, 623-629 (1957)

Studies resistance changes and proposes "energy leakage" and relates this to material expelled in the radial jets. Measures velocities of 10^6 cm/sec.

E-72 KVARTSKHAVA, I. F., PLIUTTO, A. A., CHERNOV, A. A., and BONDARENKO, V. V., "Electrical Explosion of Metal Wires," Zhur. Eksp. i Teoret. Fiz. 30, 42-53 (1956); Soviet Phys. JETP 3, 40-51 (1956)

Shadow photography, oscillography of current and voltage, also photometry are used to study E.W.P. Theory developed postulates pressure developed in wire due to heating and little time to expand. Interruption of current flow due to shock waves along the wire which cause cavitation and open the circuit. Melting is in beads. Evaporation starts between the beads.

E-73 LANDER, J. J. and GERMER, L. H., "The Bridge Erosion of Electrical Contacts - Part I," J. Appl. Phys. 19, 910-928 (1948)

Used E.W.P. to study melting phenomena. Important because of melted metal bridges formed on opening contacts.

E-74 LANGWORTHY, J. B., O'ROURKE, R. C., SHULER, M. P., VITKOVITSKY, I. M., DOBBIE, C. B., VEITH, R. J. and HANSEN, D. F., "Electrically Exploded Wires - Experiments and Theory," Progress Rept. I/III/58 to 30/VI/60. NRL Rept. 5489 (1961)

The report discusses: 1. the design, construction, and operation of the three capacitor systems for use on exploding wires; 2. an elementary theory of the processes which might occur in an exploding wire and, where possible, numerical examples; 3. electronic instrumentation which includes traveling-wave scope techniques for measuring current and power in exploding wires with 10^{-9} sec resolution; 4. optical instrumentation which involves a streak camera, an ultra-high-speed streak spectrograph, and a grating streak spectrograph which has high spectral resolution. Included are some preliminary experimental results.

E-75 LAPPLE, H., Electric Fuses, A Critical Review of Published Information, Butterworth, London (1952)

A qualitative discussion of fuses from European point of view. A fully annotated bibliography including several references to E.W.P.

Section E

E-76 LEBEDEV, S. V., "Reply to Critical Remarks of I. F. Kvartskhava Concerning our Papers," Zhur. Eksp. i Teoret. Fiz. 32, 144-145 (1957) Soviet Phys. JETP 5, 126-127 (1957)

As indicated, an answer to the criticism printed in Zhur. Eksp. i Teoret. Fiz. 30, 621 (1956) and translated in Soviet Phys. JETP 3, 787 (1956) (ref E-68). Mostly Lebedev feels that Kvartskhava misinterpreted his papers.

E-77 LEBEDEV, S. V., "Explosion of a Metal Due to an Electric Current," Zhur. Eksp. i Teoret. Fiz. 32, 199-207 (1957), Soviet Phys. JETP 5, 243-252 (1957)

Using data from 3 μsec Faraday shutter pictures, coupled with I_t and E_t oscillograms at two energy levels (5×10^5 A/cm^2 and 5×10^6 A/cm^2), the author postulates that anomalous results are due to disturbance of bonds in metal. Mostly W wire.

E-78 LEBEDEV, S. V., "Phenomena in Tungsten Wires Preceding their Disintegration under the Effects of Heavy Current," Zhur. Eksp. i Teoret. Fiz. 27, 605-614 (1954) T

The phenomena described is similar to an EWP just before the wire explodes.

K-7 LEBEDEV, S. V. and KHAIKIN, S. E., "Some Anomalies in the Behavior of Metals Heated by Current Pulses of Great Density," Zhur. Eksp. i Teoret. Fiz. 26, 629-639 (1954)

P-8 LEJEUNE, J. M., "Applications de la methode d'explosion de fils minces à l'étude du spectre de CaO," Bull. Soc. Roy. Sc. Liege 14, 318-322 (1945) (Applications of the method of exploding wire to the study of the spectrum of CaO)

E-79 LEVINE, P. H., TOLLESTRUP, A. V. and WEBB, F. H., JR., "Electrical Conduction in Rapidly Exploded Wires," Proc. Fifth International Conference on Ionization Phenomena in Gases, Vol. II, p. 2034-2054, North-Holland Pub. Co., Amsterdam (1962) H. Maecker (ed)

A study of the relation of resistance to energy and time in a 10^{-7} sec wire explosion. Resistance is related to a time constant more than to energy input. Wires are divided into two classes. Class I - low boiling low ΔH_v metals (Cu, Ag, Al, Au, Sn, Zn, Cd). Class II - high boling, high ΔH_v metals (W, Mo, Pt, Ni, Fe, Tl). Results are given for Ag, Cu, Mo, Pt. Kerr Cell photos discussed but not shown.

J-6 LIDDIARD, T. P. and DROSD, R. D., "Exploding Wires for Light Sources in Fast Photography," U. S. Naval Ordnance Lab. Memo 10840 (1950)

R-6 LOCHTE-HOLTGREVEN, W., "Production and Measurement of High Temperatures," Repts. Progr. Phys. 21, 312-383 (1958)

E-80 LOCHTE-HOLTGREVEN, W., "Über die Elementarvorgänge bei der elektrischen Explosion dünner Metalldrähte," Tagung über Verbrennung, Stosswellen, Detonation, St. Louis (1951), Laboratoire de Research de St. Louis (France) 14/M/51 325-337 (1951) T (Concerning the Elementary Processes in the Electrical Explosion of Thin Metal Wires)

The author divides the E.W.P. process into four periods, 1. Heating and vaporizing, 2. Nonconducting period, 3. Restrike of arc initiated by shock waves, 4. Oscillatory discharge. This article postulates superheating and shockwaves as important features. Mentions the use of Schlieren photographs in the experimental part.

Section E

E-81 LOGINOV, V. A., "Production of the Absorption Spectrum of A l O by the Method of Electrically Exploding a Wire in Air at Atmospheric Pressure," Optika i Spektroskopiia 6, 111-113 (1959), Translation in Optics and Spectroscopy 6, 67-68 (1959)

Apparatus explodes wire and produces intense spark in a hole in textilite for background, then explodes wire in air for the spectrum.

C-3. MANINGER, R. C., "Radial Distribution of Current and Its Effect in an Exploding Wire," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 156-159

X-3 MARCUS, R. A., "Application of the Exploding Wire Technique in Photochemistry," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 307-314

N-6 MARTIN, E. A., "The Underwater Spark: An Example of Gaseous Conduction at about 10,000 Atmospheres," Univ. of Michigan 2048-12-F (July 1956)

R-7 MAYFIELD, E. B., "Radiometric Temperature Measurements of Exploding Wires," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 147-155

P-10 MENZIES, A. C., "Shifts and Reversals in Fuse-Spectra," Proc. Roy. Soc. (London), A117, 88-100 (1927)

E-82 MÜLLER, W., "Studies of Exploding Wire Phenomenon by Use of Kerr Cell Schlieren Photography," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 186-208

The phenomenon of E. W.'s has been studied by Kerr Cell Schlieren photography. Pictures show the shock wave system, the formation of dwell, and reignition.

E-83 MÜLLER, W., "Der Ablauf einer electrischen Drahtexplosion mit Hilfe der Kerr-Zellen-Kamera untersucht," Z. Physik 149, 397-411 (1957) T (Results of an Electric Wire Explosion Investigated by Means of the Kerr Cell Camera)

Used a double Kerr-Cell camera, with knife edges placed in the light path to produce schlieren results. This allowed a study of shock waves in and around the explosion. Detailed descriptions of the equipment and experimental procedure as well as results and analysis are given.

X-4 McFARLANE, H. B., "A High-Voltage, Quick-Acting Fuse, to Protect Capacitor Banks," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 324-344

J-8 NADIG, F. H., BOHN, J. L. and KORNEFF, T., "High Speed Framing Camera for Photographing Exploding Wire Phenomena," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 345-364

E-84 NAGAOKA, H. and FUTAGAMI, T., "Cinematographic Sketch of Electrically Exploded Wires," Proc. Imp. Acad. (Japan) 4, p. 198-199 (1928)

Brief description of the camera which used a double slit shutter. Total exposure 384 microseconds, 14 microsecond exposures.

E-85 NAGAOKA, H. and FUTAGAMI, T., "Electric Explosion in Magnetic Field," Proc. Imp. Acad. (Japan) 4, 283 (1928)

Repeated work reported in E-84 in a magnetic field and noted significant differences.

E-86 NAGAOKA, H. and FUTAGAMI, T., "Electric Explosions," Sci. Papers Ins. Phys. Chem. Res. (Toyko) 8, 269-288 (1928)

Description of apparatus and techniques for explosions. Used drum camera and framing camera. Eleven plates of photographs with descriptions. Explosions in oil with an attempt to cause transmutation. Little theoretical material.

Section E

P-11 NAGAOKA, H., NUKIGAMA, D. and FUTAGAMI, T., "Instantaneous Spectrograms," (various metals) Proc. Imp. Acad. (Japan) 3, 208-212, 258-264, 319-333, 392-418, 499-502 (1927)

E-87 NAGAOKA, H. and FUTAGAMI, T., "Instantaneous Photographs of Electrically Exploded Wires," Proc. Imp. Acad. (Japan) 2, 387-388 (1926)

Photographs taken with rotating drum camera. No explanation of phenomena observed.

P-12 NAGAOKA, H. and FUTAGAMI, T., "Explosion Spectra of Mercury," Proc. Imp. Acad. (Japan) 2, 254-257 (1926)

E-88 NAGAOKA, H., FUTAGAMI, T., and MACHIDA, T., "Electric Explosion of Wires and Threads," Proc. Imp. Acad. (Japan) 2, 328-329 (1926)

Photographs of slow and fast explosions of wires and solution saturated threads.

P-13 NAGAOKA, H., FUTAGAMI, T. and OBATA, H., "Spectra of Metals Excited by Means of High Tension and Heavy Current," Proc. Imp. Acad. (Japan) 2, 161 (1926)

E-89 NAIRNE, E., "Electrical Experiments by Mr. Edward Nairne," Phil. Trans. Roy. Soc. (London) 64, 79-89 (1774)

Description of the static machine, the 64 jar Leyden jar condenser bank and experiments with exploding wires, electrocution of fowl and effect of electricity on plants. Studied conditions in series circuits and what we now call self-inductance. Fascinating historical paper.

E-90 NASH, C. P. and McMILLAN, W. G., "On the Mechanism of Exploding Wires," Phys. Fluids 4, 911-917 (1961)

Measurements of condenser voltage, di/dt, dwell, and shock energy. Explosions were made in He, N_2, O_2, and $CClF_3$. A theory is proposed for the dwell based on Bardeen's theory of metallic resistance. The temp and "compression" changes can be made to account for the resistance increase found by the authors. A hydrodynamic model is proposed for a restrike from the dwell situation, based on spark breakdown mechanism.

E-91 NIPHER, F. E., "Matter in Its Electrically Explosive State," Proc. Am. Phil. Soc. 52, 283-286 (1913)

The author investigates the effect of sending "positive" and "negative" charges through a wire. Negative charges have a greater effect. Condenser consisted of Leyden jar.

E-92 O'DAY, M., CHACE, W. G. and CULLINGTON, E. H., "Recent Experiments on Exploding Wires and High Density Plasmas," Terzo Congresso Internazionale sui Fenomini d'Ionizzazione nei Gas (Third International Congress on Ionization Phenomena in Gases) Venice, p. 784-807 (1957)

Description of various phenomena resulting from wire explosions, pinch effect, electric gun effect, high temperatures, intense light flash. Explosion of hollow conducting cylinders. Appendices give theory of EWP behavior.

E-93 O'ROURKE, R. C., SCHERRER, V. and DOBBIE, C. B., "Production of Strong Cylindrical Shock Waves by Exploding Wires," Bull. Am. Phys. Soc. 2, 47 (1957)

Produced ingoing and outgoing shocks. Measured radii vs. time, spectral luminosity vs. time. Strip film camera used.

M-8 OSHIMA, K., "Blast Waves Produced by Exploding Wire," Aeronautical Res. Inst., Univ. of Tokyo 26, Report 358 (1960)

Section E

E-94 PATERSON, J. E., MURRAY, T. P. and GRIMES, W. F., "Investigations of the Use of an Exploding Wire as a Spectrographic Source," Research Report - Jones and Laughlin Steel Corp., Proj. 633, T-4 (Jan 1956)

An investigation of the feasibility of using an E.W.P as a spectrographic source for analysis of elements such as C, S, P.

E-95 PORTER, H. L., "The Electric Fusion of Fine Wires," Armament Research Establishment, Report 1/53 (1953) Ministry of Supply, Adelphi (London) w: c. 2

An exhaustive study of the fusion of fine wires at an energy level where they do not explode.

R-8 PRAYNING, O., "General Remarks Concerning the Concept of High Temperatures and Their Measurements," Uspekhi Fiz. Nauk (USSR) 55, 598-608 (1955)

E-96 PROTOPOPOV, N. A. and KUL'GAVCHUK, V. M., "Mechanism for Interruption of Current Flow and Production of Shock Waves in a Metal Heated by High-Density Current Pulses," Zh. tech. Fiz. (USSR) 31, 557-564 (1961) Trans. in Soviet Physics - Technical Physics 6, 399-404 (1961)

An investigation of the mechanism by which the metal is heated and the relations of this mechanism to other effects such as the interruption in current flow, shock waves, and burst of optical radiation. The authors propose that the metal vaporizes from the surface inward by a rarefaction wave, hence the speed of sound in the metal is one important factor.

J-9 PUGH, E. M., HEINE-GELDERN, R. V., FONER, S. and MUTSCHLER, E. C., "Kerr Cell Photography of High Speed Phenomena," J. Appl. Phys. 22, 487-493 (1951)

E-97 REITHEL, R. J., BLACKBURN, J. H., SEAY, G. E. and SKOLNICK, S., "The Current Pause in an Exploding Wire," Exploding Wires, Vol. I, Chace and Moore (eds) Plenum Press, New York (1959), p. 19-32

Data obtained suggested different mechanisms for explosions in the cases where dwell and where no dwell occurred. In case of dwell, the current appeared to be carried by the unvaporized wire material during the first pulse, and after the pause, by the vaporized wire material. In no dwell case, breakdown occurred in the air around the wire vapor after which the current path transferred to the metal vapor.

F-2 RIPOCHE, J., "Générateur de Flashes Fonctionnant par Explosion de Fils Métalliques," J. phys. radium 22, 48A-52A (1961) (Exploding Wire Light Flash Generator)

P-14 ROSEN, B., "Spectra of Diatomic Oxides by the Method of Exploded Wire," Nature 156, 570-571 (1945)

M-9 ROUSE, C. A., "Theoretical Analysis of the Hydrodynamic Flow in Exploding Wire Phenomena," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 227-263

E-98 ROUSE, C. A., "Theoretical Calculations of Exploding Wire Phenomenon," Univ. of California Lawrence Radiation Laboratory, UCRL-5684-T (1959)

A theoretical study of the hydrodynamic flow in E. W. considering a time-dependent energy deposition $(2 E_o/\tau) \sin^2 (\pi t/\tau)$. Equation of state used was that calculated from solution of Saha's Equation. Results are reported in the form of graphs of R^2 vs t and R vs t for contact surface and second shock. Results agree well with experiment.

Section E

E-99 RUEBSAMEN, W. C., SHON, F. J. and CHRISNEY, J. B., "Chemical Reaction between Water and Rapidly Heated Metals," North American Aviation NAA SR-197 (Oct 1952)

Wire and foil were heated by condenser discharge under water to determine extent of explosive chemical reaction between the metal and water. Extent of chemical reaction determined by volume of H_2 formed and loss in weight of the metal U, Zn, Al, Ni and a few alloys of Al were investigated. Ni showed the least action. No metals reacted violently unless they were "dispersed" in the water (i.e. exploded under water).

E-100 RUTHERFORD, E., "Disintegration of Elements," Nature 109, 418 (1922)

The author's comments on Wendt and Irion's experiment.

M-10 SAKURAI, A., "On the Propagation of Cylindrical Shock Waves," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 264-270

E-101 SAWYER, R. A. and BECKER, A. L., "On the Explosion Spectra of the Alkaline Earth Metals," Phys. Rev. 21, 373 (1923)

Report of work on explosion of asbestos fibres soaked in solutions of salts.

E-102 SAWYER, R. A. and BECKER, A. L., "Explosion Spectra of Alkaline Earth Metals," Astrophys. J. 57, (1923) p. 98-113

By exploding asbestos threads soaked in a solution of various salts, explosion spectra of alkaline earth metals were studied.

P-15 SAWYER, R. A. and BECKER, A. L., "The Production of Enhanced Line Spectra by a New Method," Science 54 (1921), p. 305-306

E-103 SCHAAFS, W., "Beobachtungen an elektrischen Drahtexplosionen," Z. angew. Physik 11, 63-65 (1959) (Observations on Wire Explosions)

Description of an apparatus for flash X-rays. Drawings of some radiographs of E.W.'s. No actual prints.

E-104 SCHERRER, V. E., "The NRL - AFSWP Exploded Wire Research Program," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 118-134

A theoretical justification for a program to produce super-high temperatures by E. W. s and a description of the water condenser used to get less than microsecond discharges of 15 Kj into 3 mil wires.

E-105 SEYKORA, E. J., "Magnetic Mirror Confinement of Exploding Wire Plasma," Nature 191, 995-996 (1961)

Wire and mirror coil are placed in series and actuated with a 1.7 μF bank at 22 KV with 4 μsec rise time. Mirror coil was 8 turns 0.5 cm Cu with wire on the axis. All experiments in air at 1 atm. Wire was 3 mil dia. Observed with a streak camera the plasma does not expand at restrike. Longitudinal striations are observed.

E-106 SINGER, G. J. and CROSSE, A., "An Account of Some Electrical Experiments by M. DeNelis, of Malines in the Netherlands, with an Extension of Them," Phil. Mag. 46, 161-166 (1815) and ibid 46, 259-264 (1815)

An historic paper on E.W.P. The authors were interested in the explosive force.

E-107 SMITH, S., "A Study of Electrically Exploded Wires, Rotating Mirror Spectrograph," Astrophys. J. 61, 186-203 (1925)

A rotating mirror camera was used to observe continuous spectra with absorption lines.

Section E

E-108 SMITH, S., "Note on Electrically Exploded Wires in High Vacuum," Proc. Natl. Acad. Sci. U. S. 10, 4-5 (1924)

Repeated Wendt and Irion's experiment exploding wire in vacuum and looking for helium. None was found.

E-109 SOBOLEV, N. N., "Investigation of the Electrical Fusion of Thin Wires," Zhur. Eksp. i Teoret. Fiz. 17, 986-997 (1947)

P-16 SPONER, H., "Über Spektren elektrisch zerstäubter Drähte," Naturwissenschaften 12, 619-620 (1924) T (The Spectra of Electrically Dispersed Wires)

X-6 STARR, W. L., "Exploding Wire Plasma Accelerator," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 365-373

E-110 STARR, W. L. and NAFF, J. T., "Acceleration of Metal Derived Plasmas," Lockheed Tech. Memo LMSD-288240 (Dec 1959)

Plasmas were derived from exploding wires, sputtering, arc erosion, and accelerated in "T", rectangular, and coaxial geometry. Impulse was measured by accelerated pendulum. Photos of luminous plasma fronts were made With E.W. there was no measureable dependence of plasma front velocity on wire size. This was true for Pt, Cu, W, Nichrome, Ag and Al.

E-111 SUITS, C. G., "Notes on High-Intensity Sound Waves," General Electric Review 39, 430-434 (1936)

The author uses Schlieren methods and other optical methods to study sound waves produced by E. W.'s. The sound waves are used to extinguish arcs and flames.

Q-7 TATIBANA, F., "Triggering Electrical Breakdown in High Vacuum by Wire Explosion," J. Appl. Phys. (Japan) 30, 71-72 (1961)

E-112 THOMPSON, J. J., "Analysis by Positive Rays of the Heavier Constituents of the Atmosphere, of the Gases in a Vessel in which Radium Chloride had been Stored for Thirteen Years and of the Gases Given Off by Deflagrated Metals," Proc. Roy. Soc. (London) 101A, 290-299 (1922)

Among other things analyzed by positive ray methods the author analyzes "the gases given off when fine wires of tungsten or copper are deflagrated by powerful electric currents."

E-113 TOEPLER, M., "Beobachtung von Metalldampfschichtung bei elektrischer Drahtzerstäubung," Ann. Physik 65, 873-876 (1898) T (Observation of Metal Vapor Coating by Electrical Vaporization of Wires)

An investigation of the vapor deposit produced on glass plates placed 2 or 3 mm from an exploding wire.

E-114 TUCKER, T. J., "Behavior of Exploding Gold Wires," J. Appl. Phys. 32, 1894-1900 (1961)

A study of resistance-current density behavior. Relations of current, action and resistance. Kerr Cell photographs show evidence of arcing around the wire at high current densities.

Section E

E-115 TUCKER, T. J., "Dependent Resistivity of Exploding Wires," J. Appl. Phys. 30, 1841-1842 (1959)

The author relates the dependence of resistivity of Au wires on energy, to arcs through the surrounding air. These arcs are indicated by Kerr Cell photographs of E. W.'s. Current densities 10^7 and 10^8 A/cm^2.

E-116 TUCKER, T. J. and NEILSON, F. W., "The Electrical Behavior of Fine Wires Exploded by a Coaxial Cable Discharge System," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 73-82

By storing energy in a long section of coaxial cable, wires are exploded with a 3 μsec, 600 amp square pulse of energy. Finds energy-to-burst dependent on current density. Voltage and current easily measured because of the completely coaxial arrangement.

R-11 BANYUKOR, M. P. and MAK, A. A., "High-Intensity Pulsed Light Sources," Uspekhi Fiz. Nauk. 66, 301-329 (1958) Trans. in Soviet Physics-Uspekhi 66, 137-155 (1958)

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

The author makes a rather thorough study of E.W.P.'s. Included are considerations of duration, temperature, and spectroscopy. A carefully constructed switch is described but found experimentally disappointing. A mathematical analysis of an oscillating circuit with variable resistance is attempted. Suggested uses for E.W.P. are given.

P-17 VAUDET, G. and SERVANT, R., "Spectres de fils explosés dan l'ultraviolet lointain et la region Schumann," Compt. rend 201, 195-197 (1935) T (Spectra of Exploded Wires in the Far Ultraviolet and Schumann Regions)

E-118 WEBB, F. H., JR., "Study of Electrically Exploded Wire Materials," ESO Report 210-QL-7 (May 1960), Electro-Optical Systems, Inc. Quarterly Progress Report

Discussion of theoretical scaling by Ohm's Law - and direct resistivity - temperature relation. An attempt to find an energy density-resistivity relation.

E-119 WEBB, F. H., JR., "Study of Electrically Exploded Wire Materials," Electro-Optical Systems Report 210-QL-4 (1959)

A study, mostly of Al wires, of 1 mil x .290" wires with millimicrosecond instrumentation - I, E, energy, and Kerr cell photos. A theory of the resistance behavior is put forth balancing vaporization and pinch effects. Radiation entrapment is considered. Radiation is less important in the millimicrosecond region than in the microsecond. Some discussion of a rarefaction wave similar to that proposed by Müller.

E-120 WEBB, F. H., JR., BINGHAM, H. M. and TOLLESTRUP, A. V., "High-Energy Densities before Dwell in Electrically Exploded Wires," Phys. Fluids 3, 318-319 (1960)

A study of maximum energy in the wire before transplosion (up to 10 ev/atom). - di/dt = 3 x 10" amp/sec current rise. Report inertial pressures of $\sim 10^5$ atm where pinch pressure is $\sim 10^3$ atm. Current densities were $\sim 4 \times 10^8$ amp/cm^2. Luminous zone moving at 9 km/sec. Very rapid heating 17 nanoseconds to vaporization of 1 mil approximately $\frac{1}{4}$" long. Ag, Cu and Al wires. Observed dwell, current during dwell. Expansion of luminous zone slows materially at restrike. Some Kerr cell photos.

Section E

E-121 WEBB, F. H., JR., CHASE, N., ERNSTENE, M. and TOLLESTRUP, A. V., "Submicrosecond Wire Explosion Studies at Electro-Optical Systems, Inc," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 33-58

Electrical and optical studies of small (1 mil x 0.290") wires of Al, Cu, Ag, Au, Ni and W exploded with very fast 2000 μμf system charged to 10 or 20 kv. Partly triggered gap and partly thyratron controlled.

E-122 WENDT, G. L. and IRION, G. E., "Experimental Attempts to Decompose Tungsten at High Temperatures," J. Am. Chem. Soc. 44, 1887-1894 (1922)

Explosion of tungsten wires produce a gas which gives a helium spectrum. Authors postulated transmutation.

E-123 WRANA, J., "Vorgänge beim Schmelzen und Verdampfen von Drähten mit sehr hochen Stromdichten," Phys. Ber. 21, 522 (1940) (Processes in the Melting and Vaporization of Wires with Very High Current Densities)

Abstract of E-124

E-124 WRANA, J., "Vorgänge beim Schmelzen und Verdampfen von Drähten mit sehr hochen Stromdichten," Arch. Electrotech. 33, 656-672 (1939) T (Processes in the Melting and Vaporization of Wires with Very High Current Densities)

A study of fuses under high surge-currents. Believes interruption of current due to practically zero conductivity of metal vapor near the boiling point. Some study of inductive over-voltage and the effects of enclosing the wire.

E-125 WRANA, J., "Vorgänge in Sicherungen bei elektrischer Stossbelastung," Electrotech. Z. 59, 11-13 (1938) T (Processes in Fuses Subjected to Surge Currents)

The author investigates the mechanical and electrical behavior of several types of high voltage fuses when subjected to surge currents. He finds it necessary to classify action according to energy of pulse.

A-19 WURSTER, W. H., "High Speed Shutter for Spectrographs," Rev. Sci. Instr. 28, 1093-1094 (1957)

J-12 ZAREM, A. M., MARSHALL, F. R. and HAUSER, S. M., "Millimicrosecond Kerr Cell Camera Shutter," Rev. Sci. Instr. 29, 1041-1044 (1958)

E-126 ZAREM, A. M., MARSHALL, F. R. and POOLE, F. L., "Transient Electrical Discharges: Disintegration of Small Wires," Phys. Rev. 72, 158 (1947)

Studied explosions of platinum wire. Current and voltage oscillograms, Kerr cell photographs.

E-127 ZERNOW, L., WOFFINDEN, G. and KREYENKAGEN, K. N., "High Speed Cinemicrography of Electrically Exploded Tungsten and Molybdenum Wires," Photo Science and Engineering 4, p. 31-36 (1960)

Similar to the work reported in E. W. Vol. I and Soc. Photo Scientists and Engineers meeting paper.

J-13 ZERNOW, L. and HAUVER, G., "Cine-Microscopy of Sparks, Exploding Wires, and Fracture at Framing Rates 10^6/second," Phys. Rev. 98, 1551 (1955)

LIGHT - Section F

E-6 ANDERSON, J. A., "The Spectral Distribution and Opacity of Wire Explosion Vapors," Proc. Nat. Acad. Sci. U. S. 8, p. 231-232 (1922)

E-43 CONN, W. M., "The Use of 'Exploding Wires' as a Light Source of Very High Intensity and Short Duration," J. Opt. Soc. Am. 41, p. 445-449 (1951)

E-45 CONN, W. M., "Note on the Polarization of Light Emitted by Electrically Exploded Wires," Phys. Rev. 58, p. 50-51 (1940)

E-48 DAY, P. B., "The Radiant Intensity of Electrically Exploded Wires," J. Opt. Soc. Am. 43, p. 817 (1953)

E-53 ESCHENBACH, R. C., "Measuring Voltage in an Exploding Wire Discharge," Army Project 4A (July 1948)

N-4 FLOWERS, J.W., "The Channel of the Spark Discharge," Phys. Rev. 64, 225-235 (1943)

J-4 HEINE-GELDERN, R.V., PUGH, E.M. and FONER, S., "Kerr Cell Photography of High Speed Phenomena - Detonation and Shock Phenomena," Phys. Rev. 79, 230 (1950)

J-5 HOLTZWORTH, R. E. and HINZ, D. J., "Exploding Wire Backlighting for the Study of Detonation, Shock and Shaped Charges," Ballistics Research Lab. Report 818 (May 1952)

J-6 LIDDIARD, T. P. and DROSD, R. D., "Exploding Wires for Light Sources in Fast Photography," U.S. Naval Ord. Lab. Memo 10840 (1950)

X-3 MARCUS, R.A., "Application of the Exploding Wire Technique in Photochemistry," Exploding Wires, Vol I, Chace and Moore (eds), Plenum Press, New York (1959) p. 307-314

F-1 OSTER, G. K. and MARCUS, R. A., "Exploding Wire as a Light Source in Flash Photolysis," J. Chem. Phys. 27, 189-192 (1957)

Michrome wire behaves as line source rich in ultraviolet. Light output measured by uranyl oxalate actinometry. Luminous efficiency is 10%. Results found highly reproducible.

F-2 RIPOCHE, J., "Générateur de Flashes Fonctionnant par Explosion de Fils Métalliques," J. phys. radium 22, 48A-52A (1961) (Exploding Wire Light Flash Generator)

Describes apparatus and records light output as a function of time, wire material, and condenser voltage.

E-126 ZAREM, A. M., MARSHALL, F. R., and POOLE, F. L., "Transient Electrical Discharges: Disintegration of Small Wires," Phys. Rev. 72, 158 (1947)

MATHEMATICS - Section G

E-5 ANDERSON, J. A., "Electrically Exploded Wires," International Critical Tables Vol. 5, p. 434 (1934) McGraw-Hill

E-9 ANDERSON, J. A. and SMITH, S., "General Characteristics of Electrically Exploded Wires," Astrophys. J. 64, 295-314 (1926)

A-1 BELLASCHI, P. L., "Heavy Surge Currents - Generation and Measurement," Trans. Am. Inst. Elec. Engrs. 53, 86-94 (1934)

E-22 BETHGE, O., "Mechanische Verformungen durch Elektrische Entladungen," Ann. Physik 8, 475-499 (1931) T (Mechanical Distortions due to Electrical Discharges)

E-47 DAVID, E., "Physikalische Vorgänge bei elektrischen Drahtexplosionen," Z. Physik 150, 162-171 (1958) T (Physical Processes in Electrical Wire Explosions)

M-7 LIN, S., "Cylindrical Shock Waves Produced by Instantaneous Energy Release," J. Appl. Phys. 25, 54-57 (1954)

E-117 VAUDET, G., "Étude et Emploi d'Une Source Lumineuse de Grande Brillance," Ann. Physik 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

MEASUREMENTS - Section H

H-1 ALLIBONE, T. E. and MEEK, J. M., "The Development of the Spark Discharge," Proc. Roy. Soc. (London), A166, 97-126 (1938), ibid A169, 246-268 (1938)

Detailed study of sparks. Measurement techniques are applicable to E.W.P.

P-1 ANDERSON, J. A., "Spectral Energy-Distribution of the High-Current Vacuum Tube," Astrophys. J. 75, 394-406 (1932)

H-2 BENNETT, F.D., "Transient Skin Effects in Exploding Wire Circuits," B.R.L. Report 1137 (August 1961)

A mathematical (Fourier transform) analysis of the coaxial shunt, flat plate condenser (and leads) and tubular condenser. Exact analytic solution not possible, but approximation shows that (1) peak current given within < 1%, (2) initial slope indicated is always less than impressed slope for shunt, (3) as long as characteristic time, $\mu\sigma a^2$ is negligible compared with time of 1 oscillation, transient resistance of condenser and leads is negligible.

E-20 BENNETT, F. D., BURDEN, H. S. and SHEAR, D. D., "Correlated Electrical and Optical Measurements of Exploding Wires," B.R.L. Report 1133, (June 1961)

E-24 BEY, P. P., FAUST, W. R., FULPER, R., JR., LEAVITT, G. E., SHIPMAN, J. D., JR., and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. N. R. L. Prog. Report (1 Nov 61 - 1 Feb 62)

T-1 BEY, P. P., FAUST, W. R., FULPER, R., HARRINGTON, F. D., LEAVITT, G. E., SHIPMAN, J. D. and VITKOVITSKY, I. M., "Exploding Wire Studies," N. R. L. Prog. Report (1 Aug to 1 Nov 61)

A-7 CHACE, W. G. and CULLINGTON, E. H., "Instrumentation for Studies of the Exploding Wire Phenomenon," Instr. Geophys. Res. No. 7, AFCRC-TR-57-235 (1957)

Section H

B-1 COBINE, J. D. and BURGER, E. E., "Analysis of Electrode Phenomena in the High-Current Arc," J. Appl. Phys. 26, 895-900 (1955)

H-3 COX, J. H. and LEGG, J. W., "The Klydonograph and Its Application to Surge Investigations," Trans. Am. Inst. Elec. Engrs. 44, 857-871 (1925)

The Klydonograph, familiar to power engineers but little used by physicists. A useful photographic method of investigating high voltage pulses.

B-2 DIEKE, G. H., "Study of Variations in Light Sources as They Effect Spectroscopy," ASTM Tech. Pub. No. 76, 37 (1946)

E-51 EISELT, B., "Über den Ablauf von Draht Explosionen," Z. Physik 132, 54-71 (1952) T (The Course of Wire Explosions)

E-53 ESCHENBACH, R. C., "Measuring Voltage in an Exploded Wire Discharge," Army Project 4A (July 1948)

B-3 KING, A. S., "Spectroscopic Phenomena of the High Current Arc," Astrophys. J. 62, 238-264 (1925)

E-68 KVARTSKHAVA, I. F., "Concerning Papers of E. S. Khaikin, S. V. Lebedev and B. N. Borodovskia, Published in the Zhur. Eksp. i Teoret. Fiz. (USSR) in 1954-1955," Zhur. Eksp. i Teoret. Fiz. 30, 621 (1957); Soviet Phys. JETP 3, 787 (1956)

E-74 LANGWORTHY, J. B., O'ROURKE, R. C., SHULER, M. P., VITKOVITSKY, I. M., DOBBIE, C. V., VEITH, R. J. and HANSEN, D. F., "Electrically Exploded Wires - Experiment and Theory," Progress Report (1 Mar 58 - 30 Apr 60) N. R. Lab. Report 5489 (1961)

H-4 PARK, J. H. and CONES, H. N., "Puncture Tests on Porcelain Distribution Insulators Using Steep-front Voltage Surges," Trans. Am. Inst. Elec. Engrs 72, 1 (1953)

Production and measurement of steep front voltages.

H-5 PETERS, J. F., "The Klydonograph; an Instrument for Accurately Measuring and Recording Voltage Surges," Elec. World 83, 769-773 (1924)

(See H-3)

T-4 SLACK, C. M. and DICKSON, D. C., "One-millionth-second Radiography and Its Application," Proc. Inst. Radio Engrs. 35, 600-606 (1947)

A-20 ZAREM, A. M. and MARSHALL, F. R., "A Method of Measuring Very High Speed Transient Currents," Rev. Sci. Instr. 20, 133-134 (1949)

PHOTOGRAPHY - Section J

H-1 ALLIBONE, T. E. and MEEK, J. M., "The Development of Spark Discharge," Proc. Roy. Soc. (London) A166, 97-126 (1938) ibid A169, 246-268 (1938)

E-2 ALLEN W. A., HENDRICKS, C. H., MAYFIELD, E. B. and MILLER, E. M., "Electronic Shutter Photographs of Exploding Bridge Wires," Rev. Sci. Instr. 24, 1068-1069 (1953)

P-1 ANDERSON, J. A., "Spectral Energy-Distribution of the High-Current Vacuum Tube," Astrophys. J. 75, 394-406 (1932)

E-12 BARTELS, H., BORTFELDT, J. and BERG, K. -H., "Uber den Zündungsprozess bei Drahtexplosionen," Proc. of the Fifth International Conference on Ionization Phenomena in Gases, H. Maecker (ed), p.1048-1051, North-Holland Pub. Co., Amsterdam (1962) (On the Ignition Process in Wire Explosions)

L-1 BARTELS, H. and EISELT, B., "Über ein einfaches Verfahren zur kinematographischen Aufnahme schnell verlaufender Vorgänge," Optik 6, 56-58 (1950) T (A Simple Method for Cinematographic Photography of Rapidly Occuring Processes)

E-14 BENNETT, F. D., "Flow Fields Produced by Exploding Wires," B. R. L. Report 1075 (May 1959)

E-18 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," B. R. L. Report 1038 (1958)

E-16 BENNETT, F. D., "Energy Partition in Exploding Wire Phenomena," Phys. Fluids 1, 515-522 (1958)

E-17 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Phys Fluids 1, 347-352 (1958)

E-16 BENNETT, F. D., "Energy Partition in the Exploding Wire Phenomenon," B. R. L. Report 1056 (Oct 1958)

E-20 BENNETT, F. D., BURDEN, H. S. and SHEAR, D. D., "Correlated Electrical and Optical Measurements of Exploding Wires," B. R. L. Report 1133 (June 1961)

E-19 BENNETT, F. D. and SHEAR, D. D., "Shock Waves from Exploding Wires at Low Ambient Densities," B. R. L. Report 1152 (Oct 1961)

E-24 BEY, P. P., FAUST, W. R., FULPER, R., JR., LEAVITT, G. E., SHIPMAN, J. D., JR. and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. N. R. L. Prog. Report (1 Nov 61 - 1 Feb 62)

E-37 CONN, W. M., "Fenstermethode zur Beobachtung innerhalb von Metalldämpfen die bei kurzzeitigen Vorgängen auftreten Beispiel: Drahtexplosionen," Naturwissenschaften 45, 6-7 (1958) (Window Methods for Observation within the Metal Vapors Produced in Short Time Events. Example: Exploding Wires)

E-43 CONN, W. M., "The Use of 'Exploding Wires' as a Light Source of Very High Intensity and Short Duration," J. Opt. Soc. Am. 41, 445-449 (1951)

H-3 COX, J. H. and LEGG, J. W., "The Klydonograph and Its Application to Surge Investigations," Trans. Am. Inst. Elec. Engrs. 44, 857-871 (1925)

N-2 EARLY, H. C. and MARTIN, E. A., "The Underwater Spark; a Photographic Light Source of High Intrinsic Brilliance," Trans. Am. Inst. Elec. Engrs. Pt. 1, 44, 788-790 (1955)

E-51 EISELT, B., "Über den Ablauf von Drahtexplosionen," Z. Physik 132, 54-71 (1952) T (The Course of Wire Explosion)

Section J

J-1 FAYOLLE, P. and NASLIN, P., "Photographie Instantanée et Cinématographie Ultra-Rapide," Revue d'Optique Paris (1950) T (Instantaneous Photography and High Speed Cinematography)

A most complete handbook of high speed photography.

N-4 FLOWERS, J. W., "The Channel of the Spark Discharge," Phys. Rev. 64, 225-235 (1943)

J-2 GIBSON, F. C., BOWSER, M. L., RAMALEY, C. W. and SCOTT, F. H., "Image Converter Camera for Studies of Explosive Phenomena," Rev. Sci. Instr. 25, 173-176 (1954)

An image converter camera is described.

J-3 HEINE-GELDERN, R. V., "Photographie Ultra-Rapide au Moyen de Cellules de Kerr et de Fils Explosifs," Photographie + Cinématographie Ultra-Rapides, Actes du 2 ème Congrès International de Photographie et Cinématographie Ultra-Rapides, Paris (1954) p. 238-243 (High-Speed Photography by Means of Kerr-cells and Exploding Wires)

Used E.W. for backlighting of explosive events. E.W. had maximum intensity of 5×10^8 candle power. Used 3μF, 24 KV and Al wire. This same system fired the wire and opened the Kerr cell. Fired with three element spark gap, central element grounded. Required 5μsec to attain full illumination.

J-4 HEINE-GELDERN, R.V., PUGH, E.M. and FONER, S., "Kerr Cell Photography of High Speed Phenomena-Detonation and Shock Phenomena," Phys. Rev. 79, 230 (1950)

An apparatus is described using an exploding wire to furnish light for Kerr cell photographs. Associated equipment and techniques are described.

J-5 HOLTZWORTH, R. E. and HINZ, D. J., "Exploding Wire Backlighting for the Study of Detonation, Shock and Shaped Charges," B. R. L. Report 818 (May 1952)

The authors investigated E.W.P. as a light source and devised a practical system for its use.

E-74 LANGWORTHY, J. B., O'ROURKE, R. C., SHULER, M. P., VITKOVITSKY, I. M., DOBBIE, C. V., VEITH, R. J. and HANSEN, D. F., "Electrically Exploded Wires - Experiments and Theory," Progress Report 5489 N. R. L., (1961)

J-6 LIDDIARD, T. P. and DROSD, R. D., "Exploding Wires for Light Sources in Fast Photography," U. S. Naval Ordnance Laboratory Memo 10840 (1950)

An investigation of the use of very small tungsten and nichrome wires for photography. Found tungsten preferable. Recommended inclosing wire in small glass capillary tubes.

E-80 LOCHTE-HOLTGREVEN, W., "Über die Elementarvorgänge bei der elektrischen Explosion dünner Metalldrähte," Tagung über Verbrennung, Stosswellen, Detonation, St. Louis (1951), Laboratoire de Research de St. Louis (France) 14/M/51 p. 325-337 (1951) T (Concerning the Elementary Processes in the Electrical Explosion of Thin Metal Wires)

J-7 MARGETTS, D. R. and WOLFE, A. E., "Evaluation of an Image Converter as a High-Speed Camera Shutter," Jet. Propul. Lab. Caltec. Memo 20-131 (1956)

Resolution drops from 28/mm to 12/mm when stationary image is pulsed and displaced using magnetic focus and displacement. With lens aperture of f2 overall aperture is f32.

N-6 MARTIN, E. A., "The Underwater Spark: An Example of Gaseous Conduction at about 10,000 Atmospheres," Univ. of Michigan Res. Inst. 2048-12-F (July 1946)

Section J

E-82 MÜLLER, W., "Studies of Exploding Wire Phenomenon by Use of Kerr Cell Schlieren Photography," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 186-208

E-83 MÜLLER, W., "Der Ablauf einer electrischen Drahtexplosion mit Hilfe der Kerr-Zellen-Kamera untersucht," Z. Physik 149, 397-411 (1957) (Result of an Electric Wire Explosion Investigated by Means of the Kerr Cell Camera)

J-8 NADIG, F. H., BOHN, J. L. and KORNEFF, T., "High Speed Framing Camera for Photographing Exploding Wire Phenomena," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 345-364

Description of a multiple reflection, rotating mirror camera with a unique method of obtaining stationary images. Framing intervals of less than 1 μsec are possible.

E-84 NAGAOKA, H. and FUTAGAMI, T., "Cinematographic Sketch of Electrically Exploded Wires," Proc. Imp. Acad. (Japan) 4, 198-199 (1928)

E-86 NAGAOKA, H. and FUTAGAMI, T., "Electric Explosions," Sci. Papers Ins. Phys. and Chem. Res. (Tokyo) 8, 269-288 (1928)

E-87 NAGAOKA, H. and FUTAGAMI, T., "Instantaneous Photographs of Electrically Exploded Wires," Proc. Imp. Acad. (Japan) 2, 387-388 (1926)

H-5 PETERS, J. F., "The Klydonograph," Elec. World 83, 769-773 (1924)

A-15 PREUSS, L. E., "Image Formation of the Rapid Vaporization of Metal Filaments by the Sensitization and Autoradiographic Methods," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, (1959), p. 288-306

J-9 PUGH, E. M., HEINE-GELDERN, R. V., FONER, S. and MUTSCHLER, E. C., "Kerr Cell Photography of High Speed Phenomena," J. Appl. Phys. 22, 487-493 (1951)

The authors used exploding wires to light a metal jet moving at about 1×10^5 cm per second, photographing with Kerr cells. Exploding wire was used as a backlight.

J-10 SCHARDIN, H. and FÜNFER, E., "Grundlagen der Funkenkinematographie," Z. angew. Physik 4, 185-199, 224-238 (1952) (Physical Basis of Spark Cinematography)

Detailed review of spark cinematography including 53 references.

J-11 SULTANOFF, M., "A 0.1 Microsecond Kerr-Cell Shutter," Photo. Eng. 5, 80-90 (1954)

A description of the Hycon model 26 commercial Kerr cell outfit. Some theory of the Kerr cell and a good bibliography.

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

J-12 ZAREM, A. M., MARSHALL, F. R. and HAUSER, S. M., "Millimicrosecond Kerr Cell Camera Shutter," Rev. Sci. Instr. 29, 1041-1044 (1958)

Description of their commercially available camera. Some details of construction and circuitry are given. The cell is operated by a special hydrogen thyratron and a modified transmission line pulse network made of RG58A/U. A set up for photographing E.W.'s is shown with three typical photographs.

Section J

J-13 ZERNOW, L. and HAUVER, G. E., "Cine-Microscopy of Sparks, Exploding Wires and Fracture at Framing Rates of 10^8 per Second," Phys. Rev. 98, 1551 (1955)

Microsecond framing camera photographs.

J-14 ZERNOW, L. and WOFFINDEN, G., "The Cinemicroscopic Observation of Exploding Wires," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 170-185

W and Mo wires exploded with relatively low energy under 25 x microscopic cinegraph, at framing rates of 1.25×10^5 to 1.2×10^6 frames per sec.

E-127 ZERNOW, L., WOFFINDEN, G. and KREYENKAGEN, K. N., "High Speed Cinemicrography of Electrically Exploded Tungsten and Molybdenum Wires," Photo Science and Engineering 4, 31-36 (1960)

Similar to the work reported in E. W. Vol. I and Soc. Photo Scientists and Engineers meeting paper.

J-15 ZERNOW, L., WOFFINDEN, G. and WRIGHT, F., JR., "High Speed Photographic Studies of Electrically Exploded Metal Films and Wires," Paper Presented at Fifth International Congress on High Speed Photography (1960)

Studied pure (99.95%) W and thoriated W wires exploded quite slowly. Thoriated wire forms smaller more uniformly distributed bubbles. Suggests bubbles grow by nucleate boiling. Some study of films and investigation of a dwell phenomenon. Many high speed photomicrographs.

RESISTANCE - Section K

K-1 BARLOW, M., "Experiments on the Apparent Deviation from Ohm's Law for Metals at High Current Densities," Phil. Mag. 9, 1041 (1930)

Using Bridgman's AC-DC method with refinement, the author concludes no deviations up to 3×10^6 A/cm^2 for Pt and Au.

K-2 BONDARENKO, V. V., KVARTSKHAVA, I. F., PLIUTTO, A. A. and CHERNOV, A. A., "Resistance of Metals at High Current Densities," Zhur. Eksp. i Teoret. Fiz. 28, 191-198 (1955); Soviet Phys. JETP 1, 221-226 (1955)

The authors used E.W.P. techniques, but considered conditions only before the wire vaporized. Equipment and instrumentation described. Results given as curves of R vs. energy supplied.

K-3 BORODOVSKAYA, L. N. and LEBEDEV, S. V., "Dependence of the Electrical Conductivity and Electron Emission on the Energy of a Metal in the Process of Its Heating by a Current of High Density," Zhur. Eksp. i Teoret. Fiz. 28, 96-110 (1955); Soviet Phys. JETP 1, 71-83 (1956)

A study of the dependence of the resistance of Ni wire on the energy input to the wire in the region of 10^6 A/cm^2. Discontinuities were observed. Electron emission was similarly studied.

K-4 BOROVIK, E. S., "Electrical Conductivity of Metals at High Current Densities," Dokl. Akad. Nauk. (USSR) 91, 771-774 (1953)

Author finds Pt, W, Cu obey Ohm's Law up to $j = 10^6$ A/cm^2, at this level Bi has 30-40% increase in R. Used constant current pulse method.

Section K

K-5 CHIOTTI, P., "Measurement of the Electrical Resistance of Metals and Alloys at High Temperatures," Rev. Sci. Instr. 25, 876-883 (1954)

Alternating current potentiometric methods for measuring resistance up to the melting point. The method of measuring, equipment, special recorders, and furnace used are described in detail.

E-46 DAVID, E., "Exploding Wires, Calculation of Heating," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 271-279

K-6 IGNATYEVA, L. A. and KALASHNIKOV, S. G., "Electric Resistance of Metals to Pulses of High Current Density," Zhur. Eksp. i Teoret. Fiz. 22, 385-399 (1952)

K-7 LEBEDEV, S. V. and KHAIKIN, S. E., "Some Anomalies in the Behavior of Metals Heated by Current Pulses of Great Density," Zhur. Eksp. i Teoret. Fiz. 26, 629-639 (1956)

Measurements of resistance and of energy during E.W.P. shows anomalies when current density approaches 10 A/cm^2. Energy to raise to the melting point is in excess of the theoretical if time is less than 5×10^{-4} sec.

E-79 LEVINE, P. H., TOLLESTRUP, A. V. and WEBB, F. H. JR., "Electrical Conduction in Rapidly Exploded Wires," Proc. of the Fifth International Conference on Ionization Phenomena in Gases, Vol. II, H. Maecker (ed), p. 2034-2054, North-Holland Pub. Co., Amsterdam (1962)

K-8 MARGENAU, H., "Die Abweichungen vom Ohmeschen Gesetz bei hohen Stromdichten im lichte der Sommerfeldschen, Elektronentheorie," Z. Phys. 56, 259-261 (1929) (The Deviation from Ohm's Law at High Current Density in the Light of Sommerfeld's Electron Theory)

A consideration of conductivity from Sommerfeld's theory using Fermi statistics, Results differ by an order of magnitude from classical theory.

K-9 NORINDER, R. H. and KARSTEN, O., "Experimental Investigations of Resistance and Power within Artificial Lightning Current Paths," Ark. Mat. Astron. Fysik 36A, 1-48 (1949)

Thorough discussion of experimental and theoretical investigation of resistance and power, in discharges of an impulse generator at voltages as high as 2000 KV. (In English)

K-10 POWELL, R. W., "Thermal Conductivities of Molten Metals and Alloys," J. Iron and Steel Inst. (London) 162, 315-324 (1949)

A collection of thermal and electrical data, mostly thermal; and discussion of relations between measurable quantities.

E-96 PROTOPOPOV, N. A. and KUL'GAVCHUK, V. M., "Mechanism for Interruption of Current Flow and Production of Shock Waves in a Metal Heated by High-Density Current Pulses," Zhur. Tech. Fiz. 31, 557-564 (1961), Trans. in Soviet Phys. - Tech. Phys. 6, 399-404 (1961)

K-11 SHABANSKII, V. P., "On Deviation from Ohm's Law in Metals," Zhur. Eksp. i Teoret. Fiz. 27, 147-155 (1954) T

The author presents theoretical evidence that deviations should exist when applied field is strong enough, due to delay in transfer of energy from electrons to the lattice.

E-114 TUCKER, T. J., "Behavior of Exploding Gold Wires," J. Appl. Phys. 32, 1894-1900 (1961)

Section K

K-12 VERESHCHAGIN, L. F., SEMERCHAN, A. A., KUZIN, N. N. and POPOVA, S. V., "The Variation of the Electrical Resistance of Some Metals Up to Pressures of 200,000 Kg/cm^2," Doklady Akad. Nauk, SSSR 136, 320-321 (1961), Trans in Soviet Phys. - Docklady 6, 41-42 (1961)

Resistance of Sb, As, Ca. Discontinuity in ρ for Sb at 1.3×10^5 Kg/cm^2 similar to that in Bi at 1.4×10^5 Kg/cm^2. ρ increases 50%. ρ decreases again after the discontinuity. As has no discontinuity up to 200,000 Kg/cm^2. Ca resistance increases uniformly with increasing pressure. Others decrease except at discontinuity.

E-118 WEBB, F., "Study of Electrically Exploded Wire Materials," ESO Report 210-QL-7 (May 1960), Electro-Optical Systems, Inc. Quarterly Progress Report

ROTATING MIRRORS - Section L

H-1 ALLIBONE, T. E. and MEEK, J. M., "The Development of the Spark Discharge," Proc. Roy. Soc. (London) A166, 97-126 (1938), ibid, A169, 246-268 (1938)

L-1 BARTELS, H. and EISELT, B., "Über ein einfaches Verfahren zur kinematographischen Aufnahme schnell verlaufender Vorgänge," Optik 6, 56-58 (1950) T (A Simple Method for Cinematographic Photography of Rapidly Occurring Processes)

A rotating mirror, multiple image camera using a series of stationary mirrors to form several images. Illustrated with a series from a wire explosion.

M-5 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Bull. Am. Phys. Soc. 3, 292 (1958)

E-17 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Phys. Fluids 1, 347-352 (1958)

E-18 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," B. R. L. Report 1038 (1958)

E-57 FUTAGAMI, T., "On the Electric Explosion Spectrum of Metals," Sci. Papers Inst. Phys. Chem. Research (Tokyo) 31, 1-29 (1937)

L-2 GORDON, G. and CADY, W. M., "Rotating Mirror Optical System," J. Opt. Soc. Am. 40, 852-853 (1950)

A rotating mirror spectrograph suitable for study of sparks and E.W.P. is described; timing by photoelectric tube. The energies used were low.

J-8 NADIG, F. H., BOHN, J. L. and KORNEFF, T., "High Speed Framing Camera for Photographing Exploding Wire Phenomenon," Exploding Wires, Vol. I, Chace and Moore (eds) Plenum Press, New York (1959) p. 345-364

Section L

J-14 ZERNOW, L. and HAUVER, G., "Cine-Microscopy of Sparks, Exploding Wires, and Fracture at Framing Rates of 10^6 per Second," Phys. Rev. 98, 1551 (1955)

SHOCK WAVES - Section M

M-1 BAIRD, K. M., "Shock Waves in Glass," Nature 160, 24-25 (1947)

The author produced shock waves by exploding copper wire sealed in pyrex rod.

M-2 BENNETT, F. D., "Cylindrical Shock Waves from Exploded Wires of Hydrogen-Charged Palladium," B. R. L. Report 1063 (January 1959)

Since stronger shocks are produced when the driving gas has higher sound speed than driven, it was hoped to produce stronger E. W. shocks with Pd-H loaded. The H_2 came out during preliminary heating hence the wires had to be H_2 loaded then Cu plated. Then strong shocks are produced. The process, however, now has become very complex. More study is indicated.

M-3 BENNETT, F. D., "Cylindrical Shock Waves from Exploded Wires of Hydrogen-Charged Palladium," Phys. Fluids 2, 470-471 (1959)

(See M-2)

M-4 BENNETT, F. D., "Flow Fields Produced by Exploding Wires," Exploding Wires Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 211-226

A discussion of shocks produced by exploding fine cylindrical wires. The similarity flows of Lin, Guderleg and Weizsäker are discussed and compared with experimental results.

E-14 BENNETT, F. D., "Flow Fields Produced by Exploding Wires," B. R. L. Report 1075 (May 1959)

Section M

E-15 BENNETT, F. D., "Energy Partition in the Exploding Wire Phenomenon," B. R. L. Report 1056 (Oct 1958)

M-5 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Bull. Am. Phys. Soc. 3, 292 (1958)

Abstract of paper. Rotating mirror and streak camera pictures of exploding wires producing shock waves. Using Pd-H, might get enhanced shocks.

E-16 BENNETT, F. D., "Energy Partition in Exploding Wire Phenomena," Phys. Fluids 1, 515-522 (1958)

E-19 BENNETT, F. D. and SHEAR, D. D., "Shock Waves from Exploding Wires at Low Ambient Densities," B. R. L. Report 1152 (Oct 1961)

A-3 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," B. R. L. Memo Report 1199 (March 1959)

A-2 BENNETT, F. D. and SHEAR, D. D., "Visualization of Cylindrical Shock Waves," Phys. Fluids 2, 338-339 (1959)

A-4 BENNETT, F. D., SHEAR, D. D. and BURDEN, H.S., "Streak Interferometry," B. R. L. Report 1080 (Sep 1959)

A-5 BENNETT, F. D., SHEAR, D. D. and BURDEN, H.S., "Streak Interferometry," J. Opt. Soc. Am. 50, 212-216 (1960)

E-41 CONN, W. M., "Metallic Deposits and Shock Waves Due to Electrically Exploded Wires," Phys. Rev. 98, 1551 (1955)

E-39 CONN, W. M., "Studies of the Mechanism of Electrically Exploded Wires," Naturwissenchaften 42, 65-66 (1955)

E-40 CONN, W. M., "Studien zum Mechanismus von elektrischen Draht explosionen (Metall niederschläge Und Stosswellen)," Z. angew Physik 7, 539-554 (1955) T (Studies on the Mechanism of Electrical Wire Explosions)

M-6 HALPIN, W. J. and HENDRICKS, R. E., "The Use of Pressure Bars and Plates for the Investigation of Shock Waves from Electrically Exploded Wires," Sandia Tech. Memo SCTM 39-60 (51) (1960)

Hopkinson pressure bar (Al rod with barium titanate plate cemented on) used to investigate shocks produced by E.W.'s (4" of #28 Cu). The effects of varying voltage, wire size, wire material, on shock waves produced by the wire were reported. Concluded that pressure bars and plates are useful tools for study of E.W. shock waves.

E-60 HERZOG, A., "Influence of Short Time, High Velocity Impact on Materials Structures," Tech. Memo WCRT-56-93, Wright Air Development Center, Materials Laboratory (Aug 1956)

J-5 HOLTZWORTH, R. E. and HINZ, D. J., "Exploding Wire Backlighting for the Study of Detonation, Shock and Shaped Charges,", B. R. L. Report 818 (May 1952)

E-72 KVARTSKHAVA, I. F., PLIUTTO, A. A., CHARNOV, A. A. and BONDARENKO, V. V., "Electrical Explosion of Metal Wires," Zhur. Eksp. i Teoret. Fiz. 30, 42-53 (1956), Soviet Phys. JETP 3, 40-51 (1956)

M-7 LIN, S., "Cylindrical Shock Waves Produced by Instantaneous Energy Release," J. Appl. Phys. 25, 54-57 (1954)

Theoretical (mathematical) consideration of shock waves from cylinders in the atmosphere. Thin wire is considered as a typical source of the shock wave.

Section M

R-6 LOCHTE-HOLTGREVEN, W., "Production and Measurement of High Temperatures," Reports Progress Phys. 21, 312-383 (1958)

E-80 LOCHTE-HOLTGREVEN, W., "Über die Elementarvorgänge bei der elektrischen Explosion dünner Metalldrähte," Tagung über Verbrennung, Stosswellen, Detonation, St. Louis (1951), Laboratoire de Research de St. Louis (France) 14/M/51 p. 325-337 (1951) T (Concerning the Elementary Processes in the Electrical Explosion of Thin Metal Wires)

E-82 MÜLLER, W., "Studies of Exploding Wire Phenomenon by Use of Kerr Cell Schlieren Photography," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 186-208

E-83 MÜLLER, W., "Der Ablauf einer electrischen Drahtexplosion mit Hilfe der Kerr-Zellen-Kamera untersucht," Z. Physik 149, 397-411 (1957) (Result of an Electric Wire Explosion Investigated by Means of the Kerr Cell Camera)

E-90 NASH, C. P. and McMILLAN, W. G., "On the Mechanism of Exploding Wires," Phys Fluids 4, 911-917 (1961)

E-93 O'ROURKE, R. C., SCHERRER, V. and DOBBIE, C. B., "Production of Strong Cylindrical Shock Waves by Exploding Wires," Bull. Am. Phys. Soc. 2, 47 (1957)

M-8 OSHIMA, K., "Blast Waves Produced by Exploding Wires," Aeronautical Res. Inst., Univ. of Tokyo 26, Report 358 (1960)

A comparison of experiments with theory. Compared with Sakuri's first and second approximations for strong shocks. A new theory is proposed called "quasi-similarity theory" which predicts intermediate stages of decay. A theory of formation and propagation is described which includes several cases.

E-96 PROTOPOPOV, N. A. and KUL'GAVCHUK, V. M., "Mechanism for Interruption of Current Flow and Production of Shock Waves in a Metal Heated by High-Density Current Pulses," Zhur. Tech. Fiz. 31, 557-564 (1961), Trans. in Soviet Phys. - Tech. Phys. 6, 399-404 (1961)

E-98 ROUSE, C. A., "Theoretical Calculations of Exploding Wire Phenomenon," Univ. of California Lawrence Radiation Lab., UCRL-5684-T (1959)

M-9 ROUSE, C. A., "Theoretical Analysis of the Hydrodynamic Flow in Exploding Wire Phenomena," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 227-263

Theoretical calculations by 704 computer, assuming instantaneous deposition of energy in wire. Calculated with (1) different equation of state for copper (2) different equation of state for air (i.e. constant γ law and variable γ law). Shock waves require different energies.

M-10 SAKURAI, A., "On the Propagation of Cylindrical Shock Waves," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 264-270

Taylor-type solution for the strong cylindrical shock from a line source is improved for later stages by expanding solution of basic gas dynamic equation in a series of $(c/u)^2$. This allows a better estimate of energy to produce the shock.

M-11 SCHALL, R. and THOMER, G., "Röntgenblitzaufnahmen von Stosswellen in festen, flussigen, und gasformigen Median," Z. angew. Physik 3, 41-44 (1951) (X-ray Flash Photographs of Shock Waves in Solid, Liquid and Gaseous Media)

The authors used exploding ribbons as a source of shock waves. These waves were studied by flash x-rays.

R-11 VANYUKOR, M. P. and MAK, A. A., "High-Intensity Pulsed Light Sources," Uspekhi Fiz. Nauk. 66, 301-329 (1958), Trans. in Soviet Phys. -Uspekhi 66, 137-155 (1958)

SPARKS - Section N

H-1 ALLIBONE, T. E. and MEEK, J. M., "The Development of the Spark Discharge," Proc. Roy. Soc. (London) A166, 97-126 (1938), ibid A169, 246-268 (1938)

C-1 BELLASCHI, P. L., "Lightning Currents in Field and Laboratory," Elec. Eng. 54, 837-843 (1935)

E-17 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," Phys. Fluids 1, 347-352 (1958)

E-18 BENNETT, F. D., "Cylindrical Shock Waves from Exploding Wires," B. R. L. Report 1038 (1958)

N-1 BLOXSOM, D. E., "Production of High Temperature, Moderate Pressure Gases by Means of Electric Spark Discharges," Arnold Eng. Dev. Cent. AEDC-TN-56-17 (1956)

Discharged condenser into glass chamber and noted rise in temperature. Discharge initiated by E.W.P. Varying the E.W.P. initiator did not effect results, hence following arc was the important feature.

N-2 EARLY, H. C. and MARTIN, E. A., "The Underwater Spark; a Photographic Light Source of High Intrinsic Brilliance," Trans. Am. Inst. Elec. Engrs. Pt 1, 44, 788-790 (1955)

By exploding wires under water, pressure of explosion is increased. Temperature estimated at 4.4×10^4 degrees C. Instantaneous spectra are obtained through a "shatter shutter."

N-3 FINKELNBURG, W., "Continuous Electron Radiation in Gas Discharges," Phys. Rev. 45, 341-342 (1934)

A discussion of continuous spectra produced by "Condensed discharges of which E. W. P. is one.

N-4 FLOWERS, J. W., "The Channel of the Spark Discharge," Phys. Rev. 64, 225-235 (1943)

Although the discussion is entirely about sparks, the techniques are of interest to workers in E.W.P. Moving film camera, current, voltage and light measure equipment are described. There is a discussion of the theory of sparks including the relation of sparks to the sound produced.

E-62 v. HÜBL, A. and v. OBERMAYER, A., "Über einige elektrische Entladungserscheinungen und ihre photographische Fixierung," Sitzungber. d. K. Akad. Wissensch. zu. Wein 98, Abth IIa, 419-430 (1889) (On the Appearance of Several Electrical Discharges, and their Photographic Recording)

N-5 LAWRENCE, E. O. and DUNNINGTON, F. G., "On the Early Stages of Electric Sparks," Phys. Rev. 35, 396-407 (1930)

Although the authors refer to E.W.P. only incidentally, their Kerr cell equipment is of interest.

N-6 MARTIN, E. A., "The Underwater Spark: An Example of Gaseous Conduction at about 10,000 Atmospheres," Univ. of Michigan 2048-12-F (July 1956)

Discusses arc underwater using W wire to initiate the arc. Investigated by measuring current, light output, and by taking Kerr cell photographs. Calculated pressure and temperature.

J-10 SCHARDIN, H. and FÜNFER, E., "Grundlagen der Funken-kinemeto-graphie," Z. angew. Physik 4, 185-199 (1952) and Z. angew. Physik 4, 224-238 (1952) (Physical Basis of Spark Cinematography)

N-7 SMITH, H. L. and EARLY, H. C., "Experimental Studies of Underwater Sparks," Tech. Report Office of Ordnance Research, Ord. Corps, U. S. Army, Project 2048 (Jul 1953)

The authors studied the light output of sparks initiated by E.W.P. under water.

Section N

J-13 ZERNOW, L. and HAUVER, G., "Cine-Microscopy of Sparks, Exploding Wires, and Fractures at Framing Rates of 10^6 per second," Phys. Rev. 98, 1551 (1955)

SPECTROSCOPY - Section P

E-5 ANDERSON, J. A., "Electrically Exploded Wires," International Critical Tables Vol. 4, p. 434 (1934) McGraw-Hill, N. Y.

P-1 ANDERSON, J. A., "Spectral Energy-Distribution of the High-Current Vacuum Tube," Astrophys. J. 75, 394-406 (1932)

> The author studied the spectrum and absolute brightness of light emitted from the discharge of high current through a small diameter tube, partially evacuated at a current density of 10^4 amperes per cm^2, a continuous spectrum was produced independent of electrode and gas composition. Absolute intensity corresponds to a black body above 10^4 degrees K.

E-6 ANDERSON, J. A., "The Spectral Distribution and Opacity of Wire Explosion Vapors," Proc. Nat. Acad. Sci. U. S. 8, 231-232 (1922)

E-7 ANDERSON, J. A., "Spectra of Explosions," Proc. Nat. Acad. Sci. U. S. 6, 42-43 (1920)

E-8 ANDERSON, J. A., "The Spectrum of Electrically Exploded Wires," Astrophys. J. 51, 37-48 (1920)

E-12 BARTELS, H., BORTFELDT, J. and BERG, K. -H., "Über den Zündungsprozess bei Drahtexplosionen," Proceedings of the Fifth International Conference on Ionization Phenomena in Gases, Vol. I, p. 1048-1051, H. Maecker (ed), North-Holland Pub. Co., Amsterdam (1962) (On the Ignition Process in Wire Explosions)

R-1 BEHRENS, W., "Temperatur Bestimmung bei Elektrischen Draht Explosionen," Dis. Hannover 1935 Abs. in Physik Ber, 16, 1958 (1935) T (Temperature Determination in Electric Wire Explosions)

Section P

E-23 BEUCHELT, R. and BÖHM, E., "Über eine Temperatur - und Druckmessung im Plasma von Drahtexplosionen," Naturwissenschaften 44, 507 (1957) (Temperature and Pressure Measurement in the Plasma from Exploding Wires)

T-1 BEY, P. P., FAUST, W. R., FULPER, R., HARRINGTON, F. D., LEAVITT, G. E., SHIPMAN, J. D. and VITKOVITSKY, I. M., "Exploding Wire Studies," N. R. L. Prog. Report (1 Aug to 1 Nov 1961)

P-2 BODSON, E. and DEHALU, F., "Nouvelles récherches sur les bandes de l'oxyde d'aluminium," Bull. Acad. Belg. 23, 408 - (1937) (New research on the bands of aluminum oxide)

> Principally theoretical spectroscopy. The oxide was produced by 'exploding' a wire with a battery source.

P-3 COHEUR, F. P., "Contributions a l'étude du spectre de bands de la molecule TiO," Bull. Soc. Roy. Sc. Liege 12, 98-103 (1943) (Contributions to the study of the band spectrum of the TiO molecule)

> A wire (first a Ti wire, later a Cu wire loaded with $T.0_2$ powder) was "exploded" by connecting it across a 110 volt d c battery, resulting in the passage of 100 amps. The resulting band spectra were studied.

P-4 COHEUR, F. P. and ROSEN, B., "Le spectre des bandes de l'oxyde d'aluminium," Bull. Soc. Roy. Sc. Liege 10, 405-413 (1941) (The band spectrum of aluminum oxide)

> The problem was to study the formation of aluminum oxide (AlO) when Al wire was exploded using a 110 volt battery.

E-39 CONN, W. M., "Studies of the Mechanism of Electrically Exploded Wires," Naturwissenschaften 42, 65-66 (1955)

E-40 CONN, W. M., "Studien zum Mechanismus von electrischen Drahtexplosionen (Metallniederschläge und Stosswellen)," Z. angew. Physik 7, 539-554 (1955) T (Studies on the Mechanism of Electrical Wire Explosions)

P-5 DELSEMME, A. and ROSEN, B., "Spectre de FeO," Bull. Soc. Roy. Sc. Liege 14, 70-80 (1945) (The spectrum of FeO)

The spectrum was produced by "exploding" a wire with a battery of 50-100 volts. The switching was a rotating disc which also had a slot used as a shutter.

B-2 DIEKE, G. H., "Study of Variations in Light Sources as They Effect Spectroscopy," ASTM Tech. Pub. No. 76, 37 (1946)

E-50 ECKSTEIN, L. and FREEMAN, I. M., "Das Spektrum explodierender Lithiumdrähte," Z. Physik 64, 547-555 (1960) (The Spectrum of Exploded Lithium Wires)

N-3 FINKELNBURG, W., "Continuous Electron Radiation in Gas Discharges," Phys. Rev. 45, 341-342 (1934)

E-57 FUTAGAMI, T., "On the Electric Explosion Spectrum of Metals," Sci. Papers Inst. Phys. Chem. Research (Tokyo) 31, 1-29 (1937)

E-59 HAUVER, G. E., "ASpectrograph with Space-time Resolution and Its Application to the Study of Exploding Tungsten Wires," B. R. L. Report 913 (July 1955)

E-61 HORI, T., "On the Absorption Spectra Produced by the Explosion of Various Elements (Hg, Cu, Fe, etc.)," Sci. Papers Inst. Phys. Chem. Research (Tokyo) 4, 59-78 (1926)

B-3 KING, A. S., "Spectroscopic Phenomena of the High-Current Arc," Astrophys. J. 62, 238-264 (1925)

Section P

P-6 KNAUSS, H. P. and BRYAN, A. L., "Spectral Characteristics of Electrically Exploded Mercury," Phys. Rev. 47, 842-844 (1935)

The spectrum of a stream of mercury acting as a wire in an E.W.P. was studied. The authors attribute the broadening to impact damping and Stark effect.

E-74 LANGWORTHY, J. B., O'ROURKE, R. C., SHULER, M. P., VITKOVITSKY, I. M., DOBBIE, C. V., VEITH, R. J. and HANSEN, D. F., "Electrically Exploded Wires - Experiments and Theory," Progress Report 1/III/58 to 30/VI/60, NRL Rept. 5489 (1961)

N-5 LAWRENCE, E. O. and DUNNINGTON, F. G., "On the Early Stages of Electric Sparks," Phys. Rev. 35, 396-407 (1930)

P-7 LEJEUNE, J. M. and ROSEN, B., "Recherches sur le spectre d'oxyde de cuivre," Bull. Soc. Roy. Sc., Liege 14, 81- (1945) (Research on the spectrum of copper oxide)

A wire imbedded in a pile of CuO was "exploded" by 100 amps. from a battery and the resulting spectrum analyzed.

P-8 LEJEUNE, J. M., "Applications de la methode d'explosion de fils minces à l'étude du spectre de CaO," Bull. Soc. Roy. Sc. Liege 14, 318-322 (1945) (Applications of the method of exploding wire to the study of the spectrum of CaO)

The spectrum was produced by "exploding" a Cu wire loaded with CaO. Spectra were studied at 100 amp level (intense) and 10 amp level (feeble).

E-81 LOGINOV, V. A., "Production of the Absorption Spectrum of A I O by the Method of Electrically Exploding a Wire in Air at Atmospheric Pressure," Optika i Spektroskopia 6, 111-113 (1959), Trans. in Optics and Spectroscopy 6, 67-68 (1959)

P-9 MALET, L. and ROSEN, B., "Contributions a l'étude du spectre de FeO," Bull. Soc. Roy. Sc. Liege 14, 377-381 (1945), (Contribution to the study of the FeO spectrum)

A spectrographic study. The oxide formed in the products of a mild (100A) wire explosion.

R-7 MAYFIELD, E. B., "Radiometric Temperature Measurements of Exploding Wires," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 147-155

P-10 MENZIES, A. C., "Shifts and Reversals in Fuse-Spectra," Proc. Roy. Soc. (London), A117, 88-100 (1927)

Although the currents used were low (100 amps) this is essentially E.W.P.

P-11 NAGAOKA, H., NUKIYAMA, D. and FUTAGAMI, T., "Instantaneous Spectrograms," (various metals), Proc. Imp. Acad. (Japan) 3, 208-212, 258-264, 319-333, 392-418, 499-502 (1927)

The explosion spectra of many metals are described and illustrated in this series of articles.

P-12 NAGAOKA, H. and FUTAGAMI, T., "Explosion Spectra of Mercury," Proc. Imp. Acad. (Japan) 2, 254-257 (1926)

The authors used two methods: (1) mercuric oxide in carbon electrodes, and (2) exploding a jet of liquid mercury from iron tube. They concluded the second method more like E.W.P.

P-13 NAGAOKA, H., FUTAGAMI, T. and OBATA, H., "Spectra of Metals Excited by Means of High Tension and Heavy Current," Proc. Imp. Acad. (Japan) 2, 161 (1926)

The authors report using explosion spectra to analyze small amounts of materials placed in depressions of carbon electrodes and then exploded. They caution that the spectrum is different from any ordinary spectrum.

Section P

E-94 PATERSON, J. E., MURRAY, T. P. and GRIMES, W. F., "Investigations of the Use of an Exploding Wire as a Spectrographic Source," Research Report - Jones and Laughlin Steel Corp., Project 633 T-4 (Jan 1956)

P-14 ROSEN, B., "Spectra of Diatomic Oxides by the Method of Exploded Wire," Nature 156, 570-571 (1945)

An announcement of the forthcoming series in the Bull. Soc. Roy. Sci. Liege. Brief mention of line series of FeO, NiO, CiO, CuO, CoO, with promise of more detail in later papers.

E-102 SAWYER, R. A. and BECKER, A. L., "On the Explosion Spectra of the Alkaline Earth Metals," Phys. Rev. 21, 373 (1923)

P-15 SAWYER, R. A. and BECKER, A. L., "The Production of Enhanced Line Spectra by a New Method," Science 54, 305-306 (1921)

Explosion of asbestos threads soaked in a solution of salt.

E-107 SMITH, S., "A Study of Electrically Exploded Wires, Rotating Mirror Spectrograph," Astrophys. J. 61, 186-203 (1925)

E-108 SMITH, S., "Note on Electrically Exploded Wires in High Vacuum," Proc. Nat. Acad. Sci. U. S. 10, 4-5 (1924)

P-16 SPONER, H., "Über Spektren elektrisch zerstäubter Drähte," Naturwissenschaften 12, 619-620 (1924) T (The Spectra of Electrically Dispersed Wires)

The author follows Anderson and examines spectra. Attempts to arrange absorption spectra of Bi in a spectrographic scheme. No investigation of the E.W.P.as such.

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

P-17 VAUDET, G. and SERVANT, R., "Spectres de fils explosés dans l'ultraviolet lointain et la region Schumann," Compt. rend. 201, 195-197 (1935) T (Spectra of Exploded Wires in the Far Ultraviolet and Schumann Region)

Spectra of wires exploded in vacuum were studied in UV and Schumann region. Fe, Cu, Al and Zn were investigated, Al most thoroughly.

A-19 WURSTER, W. H., "High Speed Shutter for Spectrographs," Rev. Sci. Instr. 28, 1093-1094 (1957)

SWITCHES - Section Q

Q-1 Anon. "5,000,000-Ampere Arc," Radio-Electronics - , 45 (September 1960)

A brief description of the Boeing (Seattle) arc driven wind tunnel. Arc is 7 megajoule discharged in few milliseconds. Exploding steel piano wire used as switch to start the arc.

Q-2 BELLASCHI, P. L., "Laboratory Lightning - the Microsecond Switch," Elect. J. 33, 273-275 (1936)

A microsecond switch consists of a length of resistance wire between the current and the voltage generator. The discharge of the voltage generator fuses the wire and establishes an arc path in about 2 microseconds.

Q-3 BROADBENT, T. E., "The Breakdown Mechanism of Certain Triggered Spark Gaps," Brit. J. Appl. Phys. 8, 37-40 (1957)

Investigation of factors determining gap length vs. breakdown voltage. Effect of various methods of triggering on gap behavior.

Q-4 CRAGGS, J. D., HAINE, N. E. and MEEK, J. M., "The Development of Triggered Spark-Gaps for High Power Modulators," Proc. Inst. Elec. Engrs. (London) 93; 3A, 191 (1946)

A discussion of the concentric triggered gap useful for controlling E.W.P.

Q-5 CULLINGTON, E. H., CHACE, W. G. and MORGAN, R. L., "Lovotron - A Low Voltage Triggered Switch Gap," Instrumentation for Geophysical Research, AFCRC-TR-55-227 (September 1955)

Description of a concentric triggered gap of low time jitter useful at any voltage down to 2 KV.

Q-6 JUDKINS, R. O., "Investigation of a High Current Switch Tube," Sandia Corp. Tech. Memo; Case 628.00 (July 1955) (157-55-51)

Gaseous discharge tube with an inductance of 5 microhenries and a jitter of 5 microseconds. This operates on the principle of storing a supply of electrons above a grid-cathode. Then by driving the electrons through the openings in the grid-cathode to the anode region, the gap is fired.

K-9 NORINDER, H. and KARSTEN, O., "Experimental Investigations of Resistance and Power within Artificial Lightning Current Paths," Ark. Mat. Astron. Fysik 36A, 1-48 (1949)

Q-7 TATIBANA, F., "Triggering Electrical Breakdown in High Vacuum by Wire Explosion," J. Appl. Phys. Japan 30, 71-72 (1961)

Discharges 2 to 10 KV on the concentric gap were started by EWon right. Used fuse wire, Cu, and Al about 0.25 mm x 25 mm. Distance 25 cm along vacuum tube. Delay of 4-8 microseconds after wire explodes. Mechanism checked by putting glass plate in front of E.W.explosion only if some opening.

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

TEMPERATURE - Section R

E-6 ANDERSON, J. A., "The Spectral Distribution and Opacity of Wire Explosion Va pors," Proc. Nat. Acad. Sci. U. S. 8, 231-232 (1922)

E-8 ANDERSON, J. A., "The Spectrum of Electrically Exploded Wires," Astrophys. J. 51, 37-48 (1920)

R-1 BEHRENS, W., "Temperatur Bestimmung bei Elektrischen Draht Explosionen," Dis. Hannover 1935; abs Physik Ber. 16, 1958 (1935) T (Temperature Determination in Electric Wire Explosions)

A consideration of methods of determining temperature in wire explosions.

E-23 BEUCHELT, R. and BÖHM, E., "Über eine Temperatur - und Druckmessung im Plasma von Drahtexplosionen," Naturwissenschaften 44, 507 (1957), (Temperature and Pressure Measurement in the Plasma from Exploding Wires)

N-1 BLOXSOM, D. E., "Production of High Temperature, Moderate Pressure Gases by Means of Electric Spark Discharges," Arnold Eng. Dev. Cent. AEDC-TN-56-17 (1956)

B-1 COBINE, J. D. and BURGER, E. E., "Analysis of Electrode Phenomena in the High-Current Arc," J. Appl. Phys. 26, 895-900 (1955)

E-39 CONN, W. M., "Studies of the Mechanism of Electrically Exploded Wires," Naturwisseenschaften 42, 65-66 (1955)

R-2 CONN, W. M., "Temperature, Its Measurement and Control in Science and Industry," Am. Inst. of Physics, p. 770 Reinhold Pub. Co. (1941)

A short paragraph on E.W.P. as a source of high temperature. Bibliography of 6 references.

E-45 CONN, W. M., "Note on the Polarization of Light Emitted by Electrically Exploded Wires," Phys. Rev. 58, 50-51 (1940)

R-3 CONN, W. M. and DEEG, E. W., "Use of the Solar Furnace as an Intermediate Imaging Source for Attaining Extreme Temperatures for a Short Time," Bull. Am. Phys. Soc. 3, 375 (1958)

Abstract of a paper to be given at APS meeting in Chicago November 1958. Combination of E.W.P.and solar furnace. Mentions previous work with E.W.P.and arc image furnace. Abstract gives the impression this is an idea, not an accomplished experiment.

E-46 DAVID, E., "Exploding Wires, Calculation of Heating," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 271-279

E-48 DAY, P. B., "The Radiant Intensity of Electrically Exploded Wires," J. Opt. Soc. Am. 43, 817 (1953)

N-2 EARLY, H. C. and MARTIN, E. A., "The Underwater Spark; a Photographic Light Source of High Intrinsic Brilliance," Trans. Am. Inst. Elect. Engrs. Pt 1, 44, 788-790 (1955)

R-4 EDELS, H., "The Determination of the Temperatures of an Electrical Discharge in a Gas," The British Electrical and Allied Industries Research Association, Technical Report Reference L/T 230 (1950)

A short discussion (51 pages) of the theory of temperature in a discharge and the methods of measuring and calculating temperatures.

E-55 FOURNET, M., "Phénomenes provoqués par des implosions de courant intenses dans des conducteurs résistants," Comptes Rendu 252, 2084-2086 (1961) (Phenomena Produced by Implosions of Heavy Current in Resistive Conductors)

Section R

E-56 FÜNFER, E., KEILHACKER, M. and LEHNER, G., "Zum Mechanismus von Drahtexplosionen,", Z. angew. Physik 10, 157-162 (1959) (On the Mechanisms of Wire Explosions)

E-57 FUTAGAMI, T., "On the Electric Explosion Spectrum of Metals," Sci. Papers Inst. Phys. Chem. Research (Tokyo) 31, 1-29 (1937)

R-5 HERZFELD, C. M., "A Study of Basic Limitations to the Concept and Measurement of Temperature: Incomplete Equilibrium," N. B. S. Report 4420 (Jan 1956)

Discusses the limitations imposed by the system under study, rather than the measuring equipment.

E-60 HERZOG, A., "Influence of Short Time, High Velocity Impact on Materials Structures," Tech. Memo WCRT-56-93, Wright Air Development Center Materials Laboratory (Aug 1956)

Q-6 JUDKINS, R. O., "Investigation of a High Current Switch Tube," Sandia Corp. Tech. Memo, Case 628.00 (July 1955) (157-55-51)

R-6 LOCHTE-HOLTGREVEN, W., "Production and Measurement of High Temperatures," Repts. Progr. Phys. 21, 312-383 (1958)

A review article with sections on measurement, production of high temperature. Measurement by observations of continua and line intensities and shapes. Production by arc, pulsed discharges and sparks, E.W.'s, plasma jets and shock waves, chemical reactions.

N-6 MARTIN, E. A., "The Underwater Spark; An Example of Gaseous Conduction at about 10,000 Atmospheres, Univ. of Michigan 2048-12-F (July 1956)

R-7 MAYFIELD, E. B., "Radiometric Temperature Measurements of Exploding Wires," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959), p. 147-155

Use of a four color spectrograph monitored by photoelectric cells to determine temperature using Wien radiation equation. Unusually low temperatures around 4000°K were found.

R-8 PRAYNING, O., "General Remarks Concerning the Concept of High Temperatures and their Measurement," Uspekhi Fiz. Nauk 55, 598-608 (1955)

Temperature defined simply as kinetic energy of molecules. Discusses methods, including E.W.P. of obtaining temperatures above 50,000° K.

R-9 PREINING, O., "Laboratoriumsmässige Herstellung von hohen Temperaturen (bis 55,000°)," Osterreichische Chemiker-Zeitung 55, 67-72 (1954) (Production of High Temperatures (up to 55,000°) in the laboratory)

Describes two types (1) short period and (2) continuous. (1) Nuclear explosions, explosions, E.W.P., hi-power sparks, (2) continuous - arcs, water stabilized arcs. Brief measurement of theory of temperature and of methods of measurement.

R-10 SAHA, M. N., "On the Problem of Temperature Radiation of Gases," Phil. Mag. 41, 267-278 (1921)

Examines the status of the problem at the time of the article and suggests methods of attack. Does not arrive at an answer.

E-104 SCHERRER, V. E., "The NRL-AFSWP Exploded Wire Research Program," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 118-134

Section R

R-11 VANYUKOR, M. P. and MAK, A. A., "High-Intensity Pulsed Light Sources," Uspekhi Fiz. Nauk. 66, 301-329 (1958), Trans. in Soviet Physics Uspekhi 66, 137-155 (1958)

Discusses: Spark discharge in gases, spark discharges in capillaries, gliding spark discharge, electric explosion of wires and shock waves. A section on measuring brightness and temperature of pulsed light sources. Brightness determined by photographic and photoelectric methods. A discussion of the various methods available for measuring temperature in discharges lasting only 10^{-7} sec.

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (The Study and Use of a Light Source of Great Brilliance)

E-118 WEBB, F., "Study of Electrically Exploded Wire Materials," ESO Report 210-QL-7 (May 1960), Electro-Optical Systems, Inc. Quarterly Progress Report

THEORY - Section S

E-2 ALLEN, W. A., HENDRICKS, C. H., MAYFIELD, E. B. and MILLER, F. M., "Electronic Shutter Photographs of Exploding Bridge Wires," Rev. Sci. Instr. 24, 1068-1069 (1953)

E-9 ANDERSON, J. A. and SMITH, S., "General Characteristics of Electrically Exploded Wires," Astrophys. J. 64, 295-314 (1926)

E-6 ANDERSON, J. A., "The Spectral Distribution and Opacity of Wire Explosion Vapors," Proc. Nat. Acad. Sci. U. S. 8, 231-232 (1922)

E-8 ANDERSON, J. A., "The Spectrum of Electrically Exploded Wires," Astrophys. J. 51, 37-48 (1920)

E-7 ANDERSON, J. A., "Spectra of Explosions," Proc. Nat. Acad. Sci. U. S. 6, 42-43 (1920)

E-13 BAXTER, H. W., Electric Fuses, Edward Arnold (ed), London (1950)

R-1 BEHRENS, W., "Temperatur Bestimmung bei Elektrischen Draht Explosionen," Dis. Hannover, abs. in Physik Ber. 16, 1958 (1935) T (Temperature Determination in Electric Wire Explosions)

E-22 BETHGE, O., "Mechanische Verformungen durch electrische Engladungen," Ann. Physik 8, 475-499 (1931) T (Mechanical Distortions due to Electrical Discharges)

E-26 BRAUN, F., "Der Mechanismus der electrischen Zerstäubung; Schmelzen von Kohlenstoff; Zerlegung von Metallegierungen," Ann. Physik 17, 359-363 (1905) T (The Mechanism of Electrical Sputtering; Fusion of Carbon; Segregation of Alloys)

Section S

E-29 CHACE, W. G., "The Liquid Behavior of Exploding Wires," Phys. Fluids 2, 230-235 (1959)

E-41 CONN, W. M., "Metallic Deposits and Shock Waves Due to Electrically 'Exploded' Wires," Phys. Rev. 98, 1551 (1955)

E-39 CONN, W. M., "Studies of the Mechanism of Electrically Exploded Wires," Naturwissenschaften 42, 65-66 (1955)

E-40 CONN, W. M., "Studien zum Mechanismus von electrischen Drahtexplosionen," Z. angew. Physik 7, 539-554 (1955) T (Studies on the Mechanism of Electrical Wire Explosions)

E-42 CONN, W. M., "A New Effect Observed in Connection with Electrically 'Exploded' Wires," Nature 169, 150 (1952)

E-45 CONN, W. M., "Note on the Polarization of Light Emitted by Electrically Exploded Wires," Phys. Rev. 58, 50-51 (1940)

E-46 DAVID, E., "Exploding Wires, Calculation of Heating," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 271-279

E-47 DAVID, E., "Physikalische Vorgänge bei elektrischen Drahtexplosionen," Z. Physik 150, 162-171 (1958) T (Physical Processes in Electrical Wire Explosions)

E-51 EISELT, B., "Über den Ablauf von Draht explosionen," Z. Physik 132, 54-71 (1952) T (The Course of Wire Explosions)

E-53 ESCHENBACH, R. C., "Measuring Voltage in an Exploded Wire Discharge," Army Project 4A (July 1948)

N-3 FINKELNBURG, W., "Continuous Electron Radiation in Gas Discharges," Phys. Rev. 45, 341-342 (1934)

E-56 FÜNFER, E., KEILHACKER, M. and LEHNER, G., "Zum Mechanismus von Drahtexplosionen," Z. angew Physik 10, 157-162 (1959) (On the Mechanism of Wire Explosions)

C-2 HERING, C., "Revision of Some of the Electromagnetic Laws," J. Franklin Inst. 192, 599-622 (1921)

E-65 KEILHACKER, M., "Über den Mechanismus der explosionsartigen Verdampfung von Kupferdrähten durch sehr intensive Stromstösse und das Verhalten des Kupfers bei den dabei auftretenden hohen Drucken und Temperaturen," Z. angew Physik 12, 49-59 (1960) (On the Mechanism of Explosive Vaporization of Copper Wires by Very Large Current Pulses and the Behavior of Copper at the Resulting High Pressures and Temperatures)

E-66 KLEEN, W., "Über den Durchgang der Elektrizität durch metallische Haardrähte," Ann. Physik 11, 579-605 (1931) (On the Passage of Electricity thru Fine Metal Wires)

S-1 KLUGE, W. and HOCKER, K. H., "Ohmic Heating of Fully Ionized Plasmas," Proc. of the Fourth International Conference on Ionization Phenomena in Gases, Vol. II, N. R. Nilsson (ed), North-Holland Pub. Co., Amsterdam (1960)

Condenser discharged across whirl-stabilized arc. No pinch, no skin effect, no "E. W." behavior was discovered. Current rose instantaneously to 10^5 amps from 10^2 A. Phenomenon was studied by oscillograms of I(t) di/dt, E (t); and with image converter photos of the expanding arc column. Ohmic heating was the simple explanation of all observed data. (This indicates that E. W. phenomena do not occur in the plasma, but in the still condensed phase material).

E-68 KVARTSKHAVA, I. F., "Concerning Papers of E. S. Khaikin, S. V. Lebedev and B. N. Borodovskia Published in the Zhur. Eksp. i Teoret. Fiz. in 1954-1955," Zhur. Eksp. i Teoret. Fiz. 30, 621 (1957); Soviet Phys. JETP 3, 787 (1956)

E-71 KVARTSKHAVA, I. F., BONDARENKO, V. V. PLIUTTO, A. A. and CHERNOV, A. A., "Oscillographic Determination of Energy of Electric Explosion of Wires," Zhur. Eksp. i Teoret. Fiz. 31, 745-751 (1956); Soviet Phys. JETP 4, 623-629 (1957)

E-72 KVARTSKHAVA, I. F., PLIUTTO, A. A., CHARNOV, A. A. and BONDARENKO, V. V., "Electrical Explosion of Metal Wires," Zhur. Eksp. i Teoret. Fiz. 30, 42-53 (1956) Soviet Phys. JETP 3, 40151 (1956)

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E-74 LANGWORTHY, J. B., O'ROURKE, R. C., SHULER, M. P., VITKOVITSKY, I. M., DOBBIE, C. V., VEITH, R. J. and HANSEN, D. F., "Electrically Exploded Wires - Experiments and Theory," NRL Report 5489 (1961)

E-75 LÄPPLE, H., Electric Fuses, A Critical Review of Published Information, Butterworth, London (1952)

E-77 LEBEDEV, S. V., "Explosion of a Metal Due to an Electric Current," Zhur. Eksp. i Teoret. Fiz. 32, 199-207 (1957) Soviet Phys. JETP 5, 243-252 (1957)

E-78 LEBEDEV, S. V., "Phenomena in Tungsten Wires Preceding Their Disintegration under the Effects of Heavy Current," Zhur. Eksp. i Teoret. Fiz. 27, 605-614 (1954)

K-7 LEBEDEV, S. V. and KHAIKIN, S. E., "Some Anomalies in the Behavior of Metals Heated by Current Pulses of Great Density," Zhur. Eksp. i Teoret. Fiz. 26, 629-639 (1954)

K-8 MARGENAU, H., "Die Abweichungen vom Ohmeschen Gesetz bei hohen Stromdichten im Lichte der Sommerfeldschen, Elektronentheorie," Z. Physik 56, 259-261 (1929) (The Deviation from Ohm's Law at High Current Density in the Light of Sommerfeld's Electron Theory)

S-2 MEEKER, M. E., "Solid and Solid-Liquid Phases in Wires at High Current Densities," Sandia Tech. Memo SCTM 314-58 (51) (1958)

Study of thermodynamic and energy balance in an E.W. up to the point of complete melting. Studies were made of losses and of pressures both magnetic and inertial. Energy to reach Curie point was discussed.

E-85 NAGAOKA, H. and FUTAGAMI, T., "Electric Explosion in Magnetic Field," Proc. Imp. Acad. (Japan) 4, 283 (1928)

E-84 NAGAOKA, H. and FUTAGAMI, T., "Cinematographic Sketch of Electrically Exploded Wires," Proc. Imp. Acad. (Japan) 4, 198-199 (1928)

E-90 NASH, C. P. and McMILLAN, W. G., "On the Mechanism of Exploding Wires," Phys. Fluids 4, 911-917 (1961)

S-3 PLATEAU, J., "The Figures of Equilibrium of a Liquid Mass Withdrawn from the Action of Gravity," Ann. Rep. Smithsonian Inst. 18, 207-285 (1865), ibid 19, 285-369 (1865), ibid 20, 411-435 (1866), ibid 21, 256-289 (1867)

Exhaustive discussion of the stability of various liquid shapes, p 207-285 (1864) discusses matters which led to the development of the unduloid theory of Kleen.

E-95 PORTER, H. L., "The Electric Fusion of Fine Wires," Armament Research Establishment Report 1/53 (1953), Ministry of Supply, Adelphi, London w. c. 2

E-100 RUTHERFORD, E., "Disintegration of Elements," Nature 109, 418 (1922)

E-102 SAWYER, R. A. and BECKER, A. L., "The Explosion Spectra of the Alkaline Earth Metals," Astrophys. J. 57, 98-113 (1923)

K-11 SHABANSKII, V. P., "On Deviations from Ohm's Law in Metals," Zhur. Eksp. i Teoret. Fiz. 27, 147-155 (1954) T

E-107 SMITH, S., "A Study of Electrically Exploded Wires, Rotating Mirror Spectrograph," Astrophys. J. 61, 186-203 (1925)

E-109 SOBOLEV, N. N., "Investigation of the Electrical Fusion of Thin Wires," Zhur. Eksp. i Teoret. Fiz. 17, 986-997 (1947)

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E-112 THOMPSON, J. J., "Analysis by Positive Rays of the Heavier Constituents of the Atmosphere, of the Gases in a Vessel in which Radium Chloride had been Stored for Thirteen Years and of the Gases Given Off by Deflagrated Metals," Proc. Roy. Soc. (London) 101A, 290-299 (1922)

E-117 VAUDET, G., "Étude et Emploi d'une Source Lumineuse de Grande Brillance," Ann. Phys. 9, 645-722 (1938) T (Study and Use of a Light Source of Great Brilliance)

E-119 WEBB, F., "Study of Electrically Exploded Wire Materials," Electro-Optical Systems Report 210-OL-4 (1959)

E-123 WRANA, J., (Abstract of E-124), Phys. Ber. 21, 522 (1940)

E-124 WRANA, J., "Vorgänge beim Schmelzen und Verdampfen von Drahten mit sehr hochen Stromdichten," Arch. Electrotechnik 33, 656-672 (1939) (Processes in the Melting and Vaporization of Wires with Very High Current Densities)

E-125 WRANA, J., "Vorgänge in Sicherungen bei elektrischer Stossbelastung," Electrotech Z. 59, 11-13 (1938) T (Processes in Fuses Subjected to Surge Currents)

E-126 ZAREM, A. M., MARSHALL, F. R. and POOLE, F. L., "Transient Electrical Discharges; Disintegration of Small Wires," Phys. Rev. 72, 158 (1947)

X-RAYS - Section T

E-24 BEY, P. P., FAUST, W. R., FULPER, R., JR., LEAVITT, G. E., SHIPMAN, J. D., JR. and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. Naval Res. Lab. Progress Report (Nov 61 - Feb 62)

T-1 BEY, P. P., FAUST, W. R., FULPER, R., HARRINGTON, F. D., LEAVITT, G. E., SHIPMAN, J. D. and VITKOVITSKY, I. M., "Exploding Wire Studies," U. S. Naval Res. Lab. Progress Report (Aug - Nov 61)

Describes measurement of X-rays from wires with absorbers and photomultipliers studying directional uniformity. Time resolved spectra of imploding Al cylinder. Also describes their new voltage measuring system. Results of new mylar capacitor.

A-6 BREIDENBACH, H. I., JR., "A Fractional Microsecond X-ray Pulse Generator Studying High Explosive Phenomena," Rev. Sci. Instr. 20, 899-903 (1949)

T-2 MILLER, S. W. and SHOENS, C. J., "Sub-Microsecond X-ray Unit for Explosives Research," Poulter Labs. Tech. Report 002-55, Stanford Research Inst. (June 1955)

Description of a narrow beam flash X-ray unit, suitable for explosive, hence E.W.P. studies.

T-3 PASZEK, J. J., TAYLOR, B. C. and SQUIER, J. L., "Low Voltage Flash Radiography," B. R. L. Report 645 (Feb 1953)

Detailed description of flash radiography equipment. Types of tubes suitable are discussed and compared.

E-103 SCHAAFS, W., "Beobachtungen an elektrischen Drahtexplosionen," Z. angew Physik 11, 63-65 (1959) (Observations on Wire Explosions)

Section T

M-11 SCHALL, R. and THOMER, G., "Röntgenblitz aufnahmen von Stosswellen in festen, flussigen und gasformigen Median," Z. angew. Physik 3, 41-44 (1951) (X-ray Flash Photographs of Shock Waves in Solid, Liquid and Gaseous Media)

T-4 SLACK, C. M. and DICKSON, D. C., "One-Millionth-Second Radiograph and Its Applications," Proc. Inst. Radio Engrs. 35, 600-606 (1947)

Description of equipment. Bibliography.

EXPLODING FOILS AND FILMS - Section U

U-1 CNARE, E. C., "Observations on the Striations of Electrically Exploded Copper Foils," J. Appl. Phys. 32, 1043-1044 (1961)

The author reports peculiar, regular striations consisting of alternately "cold" and "hot" regions across a thin foil when exploded at 20 KV. Arcs which seem to be the result of the striations occur along the edges. Only high conductivity materials, Cu, Ag and Al exhibit striations. Spacing is dependent only on foil thickness.

U-2 KATZENSTEIN, J., "Electric Discharge Through Small Conductors," Univ. of New Mexico Tech. Report (Sep 1960)

Polyethylene filaments were coated with graphite and exploded. Shots were carried out in a vacuum of 10^{-5} mm Hg, and photographed from the end with a streak camera. Current determined by a Rogowski coil and voltage with a resistive divider. Author finds divider unreliable. The polyethylene filaments show irregular multiple expansions after a very long constrained period (up to 3 μsec). There is no explanation of these phenomena.

X-5 SCHIFF, D., "Bonding Experiments with Exploding Foils," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959), p. 283-287

U-3 WUNSCH, D. C., SOAPES, T. D. and GUENTHER, A. H., "Acceleration of Thin Plates by Exploding Foil Techniques," A. F. Special Weapons Lab Report AFSWC-TDR-61-75 (Jan 1962)

A technique for the acceleration of thin plates to high velocities by exploding foils has been developed. The plates, primarily Mylar and Lucite are used to produce a high-impulse, short-time loading of materials. Velocities up to 5×10^5 cm/sec have been achieved. A brief description of equipment including the capacitor system, cameras, backlighting, etc., is given.

E-28 CHACE, W. G., "Observations in High Density Plasmas Produced by Exploding Wires," Proceedings of the Fourth International Conference on Ionization Phenomena in Gases, Vol. II, pp. IVE1191 - IVE1195, N. R Nilsson (ed), North-Holland Pub. Co., Amsterdam (1960)

E-63 KATZENSTEIN, J., "The Exploding Wire as Fast Dynamic Pinch," Univ. of New Mexico Final Tech. Report (July 1961)

E-105 SEYKORA, E. J., "Magnetic Mirror Confinement of Exploding Wire Plasma," Nature 191, 995-996 (1961)

E-110 STARR, W. L. and NAFF, J. T., "Acceleration of Metal Derived Plasmas," Lockheed Tech. Memo LMSD-288240 (Dec 1959)

X-6 STARR, W. L., "Exploding Wire Plasma Accelerator," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 365-373

Section X

X-3 MARCUS, R. A., "Application of the Exploding Wire Technique in Photochemistry," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959), p. 307-314

> The short duration and high actinic value of light from E.W.'s make them a desirable light source for certain photochemical reactions. Various relations are discussed.

A-13 MARSHAK, I. S., "On the Practical Application of Exploding Wires," Optika i Spectroskopia 10, 801-804 (1961), Trans. in Optics and Spectroscopy 10, 424-426 (1961)

X-4 McFARLANE, H. B., "A High-Voltage, Quick-Acting Fuse, to Protect Capacitor Banks," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 324-344

> A high-voltage fuse designed to protect capacitor banks is described. Design criteria are given and a possible mechanism is theorized.

F-1 OSTER, G. K. and MARCUS, R. A., "Exploding Wire as a Light Source in Flash Photolysis," J. Chem. Phys. 27, 189-192 (1957)

X-5 SCHIFF, D., "Bonding Experiments with Exploding Foils," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959), p. 283-287

> Various materials otherwise difficult to join may be bonded by clamping with a Ta foil between them and exploding the foil. Quartz may be so bonded, as well as ceramics.

X-6 STARR, W. L., "Exploding Wire Plasma Accelerator," Exploding Wires, Vol. I, Chace and Moore (eds), Plenum Press, New York (1959) p. 365-373

> A device that accelerates plasma from E.W. to 8×10^6 cm/sec is described. Impulse is 10^3 dyne-sec. Measuring system as well as E.W. system is described.

E-110 STARR, W. L. and NAFF, J. T., "Acceleration of Metal Derived Plasmas," Lockheed Tech. Memo LMSD-288240 (Dec 1959)

Q-7 TATIBANA, F., "Triggering Electrical Breakdown in High Vacuum by Wire Explosion," J Appl. Phys. (Japan) 30, 71-72 (1961)

U-3 WUNSCH, D. C., SOAPES, T. D. and GUENTHER, A. H., "Acceleration of Thin Plates by Exploding Foil Techniques," AF Special Weapons Lab. Report AFSWC-TDR-61-75 (Jan 1962)

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