Report No. FAA-RD-81-22

LEVEL II

12

GROUNDING, BONDING, SHIELDING AND LIGHTNING BIBLIOGRAPHY 1972 to 1979

by
Thomas E. Brewer
and
W. Marshall Leach, Jr.

Georgia Institute of Technology
School of Electrical Engineering
Atlanta, Georgia 30332

February 1981

Final Report

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

(9) Final rept. Jun 79 - 30 Sep 80,

Technical Report Documentation Page

1. Report No. (19) (18) FAA-RD-81-22 ✓	2. Government Accession No. AD-A098539	3. Recipient's Catalog No.

4. Title and Subtitle

(6) Grounding, Bonding, Shielding, and Lightning Bibliography 1972 to 1979

5. Report Date (11) February 1981

6. Performing Organization Code

7. Author(s) (10) Thomas E. Brewer ~~Marshall~~ Leach, Jr

8. Performing Organization Report No. (12) 160

9. Performing Organization Name and Address

Georgia Institute of Technology
School of Electrical Engineering
Atlanta, Georgia 30332

10. Work Unit No. (TRAIS)

11. Contract or Grant No. (15) F3060Ø2-78-C-Ø12Ø ✓

13. Type of Report and Period Covered

June 20, 1979 - September 30, 1980

12. Sponsoring Agency Name and Address

Department of Transportation
Federal Aviation Administration
Washington, D.C. 20590

14. Sponsoring Agency Code

ARD-442

15. Supplementary Notes

This effort was administered under the Post Doctoral Program, Rome Air Development Center, Task PR N-0-5126, PR N-9-5294

16. Abstract

As a result of a literature search carried out in conjunction with an extensive effort concerning grounding, bonding, shielding, and lightning a bibliography was compiled. The bibliography, covering the period 1972 to 1979, is contained in this report.

17. Key Words	18. Distribution Statement
Grounding Bonding Shielding Lightning	Document is available to the public through the National Technical Information Service, Springfield, VA 22161.

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	158	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

This report was prepared by the School of Electrical Engineering of the Georgia Institute of Technology. The effort was administered under the Post Doctoral Program directed by Jacob Scherer, Rome Air Development Center. Technical monitors were F. S. Sakate and John H. Edwards, Jr.

The overall Post Doctoral Program principal investigator at Georgia Tech is Demetrius T. Paris. The lead investigator was W. Marshall Leach, Jr. The project research engineer was Thomas E. Brewer.

CONTENTS

Anon, "Earth Fault Test Apparatus (EFTA)," BBC Engineering, (GB), no. 92, October 1972, p. 34.

The apparatus avoids the need to open circuit the technical-earth cable and can remain in operation continuously. A toroidal core carrying several windings permanently surrounds the technical-earth cable. One winding is tuned to form a very high Q circuit resonating at 5 KHz. The presence of the oscillation is monitored by a detector amplifier feeding appropriate alarm circuits. The technical-earth cable, passing through the toroidal core, acts as another winding and, when a fault exists between the sound equipment and any other earthed metal work, behaves as a short-circuited turn and severely damps the tuned-circuit. The oscillator is so designed that the decrease in Q of the tuned-circuit causes oscillation of output from the detector amplifier.

Anon, "Tower Maintenance, or, The Bigger they Are," Communications, July 1972, pp. 6-7.

Recommendations are made for initial and regular inspection and maintenance of tower guys, structural components, lighting, paint work, alignment, foundation, anchoring and earthing.

Anon, "The Economics of Earthing and Consumer Protection," Electrical Review, (GB), vol. 190, no. 12, March 24, 1972, pp. 400-401.

Controversial views on all-insulated wiring systems and protective multiple earthings are presented.

Anon, "Earthing High Voltage Substations," Electrical Times, (GB), vol. 161, no. 10, March 9, 1972, pp. 35-36.

Methods of earthing substations above 100 KV are outlined and earth resistance measurement problems are discussed.

Anon, "Electrical Grounding Bracket," NASA Technical Brief, Brief 72-10045, 1972.

The brief describes a specially shaped bracket which fits around a typical multiple-pin conector and supports a grounding bar to which shield ground wires can be fastened. It is simply a rigidly supported, rounded strip of metal onto which may be soldered the shieldground leads of the shielded wires leading to the connector pins.

The electrical grounding bracket simplifies solder operations and the dressing of shield terminations. Because each shieldground lead can be soldered independently to the bracket, it is a simple matter to alter the wiring configuration of the connector or to remove or add shielded wires. The bracket also permits addition or

deletion of a ground circuit without disturbing the remaining ground wires, and the grounding bracket may itself be unfastened from the connector for electrical tests.

Anon, "Voltage Rating Investigation for Application of Lightning Arresters on Distribution Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, no. 3, May/June 1972, pp. 1067-1074.

A method for the selection of votlage ratings of distribution-type lightning arresters for use with power distribution systems is presented. This method is based upon an evaluation of circuit parameters, operating voltage limits, type of construction and distribution transformer magnetizing reactance. The coefficient of earthing is used to determine the degree of system grounding.

J. Belin and J. Vigneron, "Onde de Foudre se Propageant le Long d'une Ligne Wise a la Terre - Z. Etude Numerique (Lightning Wave Propagation Along Grounded Line-2)," Revue Generale de l'Electricite, vol. 81, no. 4, April 1972, pp. 263-272.

This paper is in French with an English translation of the title.

R. P. Benedict and R. J. Russo, "A Note on Grounded Thermocouple Circuits," Transactions of the ASME, Journal of Basic Engineering, vol. 94, no. 2, June 1972, pp. 377-380.

Basic circuits involving the thermocouple as a temperature-sensing device have been described and analyzed in the literature. However, relatively little has been written on the thermocouple as part of an overall instrument circuit wherein external electrical effects are important. After reviewing the more important electrical effects which are extraneous to the basic thermocouple circuit, the problem of multiple grounds in a thermocouple proper is considered in some detail. Experiment and analysis indicate that serious errors in temperature measurement can result from the use of improper grounds in thermocouple circuits.

E. W. Boehne, R. E. Koch, G. L. Gailbrois and H. W. Miduiecky, "Coordination of Lightning Arresters and Current-Limiting Fuses," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, no. 3, May/June 1972, pp. 1075-1078.

The use of a combination of fuses and lightning arresters for the lightning protection of power systems is discussed. A high fault current may produce a high voltage arc across a fuse which may then spark over to a lightning arrester and damage it. For this reason, it is recommended that higher voltage lightning arresters be used.

H. Brown, "Don't Leave System Grounding to Chance," EDN, vol. 17, no. 2, January 15, 1972, pp. 22-27.

The importance of proper grounding practices in electronic circuits is discussed. Many grounding problems can be eliminated by the use of a single-point ground. The special considerations involved in signal interconnection between various units in a single-point grounded system are outlined. It is emphasized that the use of the chassis as a ground may lead to problems.

Brown Boveri & Company, "Earth Protection Circuit," Patent UK 1 280 704, filed 1969, issued 1972.

Discloses an earth protection circuit for a three phase star connected alternator having a three phase transformer with a star connected primary and an open delta secondary. It has filters between the transformer secondary and a rectifier and between a single phase transformer secondary winding and a second rectifier, the relative magnitudes of the d.c. outputs of the rectifier being used to indicate an earth fault.

A. D. Bunch and R. F. Kauter, "Electromagnetic Shielded Connector," IBM Technical Disclosure Bulletin, vol. 15, no. 1, June 1972, pp. 34-35.

Describes a spring device for allowing continuous machine shielding where a gap has been made for connection by wires of external circuitry.

A. D. Bunch and R. F. Kantner, "Creped Foil Cable Shield," IBM Technical Disclosure Bulletin, vol. 15, no. 1, June 1972, p. 36.

Describes a cable in which shielding is provided by a creped paper tape with a conductive foil on the surface. A drain wire is also provided for easy termination.

U. Burger, "Brown Boveri Range of Lightning Arresters Design and Applications," Brown Boveri Review, vol. 59, no. 4, April 1972, pp. 155-162.

A description is given of thoroughly tested lightning arresters for use on power transmission systems. Various voltage level applications are discussed.

U. V. Cesana, I. J. Marwick and J. H. McNamara, "Factors Affecting the Stability of Semiconducting Polyfin Shielding Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, no. 3, May/June 1972, pp. 932-940.

In selecting extrudable semiconducting polyfins for use as conductor and insulation shields for high voltage power cables, too much empahsis is often placed on initial volume resistivity. An engineering analysis, covering electrical, chemical and physical requirements for these shields, reveals that a different balance of properties is desirable for each application and that volume resistivity may be of secondary importance. This paper covers the results of an extensive library investigation to determine the effects of temperature, time, materials processing,

solvents, and electrical tape adhesives of nine commercially available semiconducting materials, and five experimental variations, and offers a guide for selecting semiconducting compounds for optimum service performance.

J. A. Cooper and L. J. Allen, "The Lightning Arrester-Connector - A New Concept in System Electrical Protection," 1972 Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

A new type of lightning arrestor for the protection of signal cables is described. It is compact and can be incorporated into the connector housing of the cable. A diagram of this lightning arrester-connector is given along with the results of lightning simulation tests on this device.

G. Cornfield, "Voltage Surges Induced on Overhead Lines by Lightning Strokes," Proceedings of the Institution of Electrical Engineers, (London), vol. 119, no. 7, July 1972, pp. 893-894.

The author points out an error made by another author in a 1967 paper. A corrected plot of the predicted lightning induced voltage surge is given.

R. B. Cowdell, "Nomographs Simplify Calculations of Magnetic Shielding Effectiveness," EDN, vol. 17, no. 17, September 1, 1972, pp. 44-48.

Some nomographs for the calculation of magnetic absorption losses and reflection losses are given. The effect of permeability on magnetic shielding effectiveness is discussed.

J. T. DeLorenzo, "Measurements of the Shielding Effectiveness of Coaxial and Two-Conductor Cables," Review of Scientific Instruments, vol. 43, no. 1, January 1972, pp. 161-164.

A technique of measuring the electromagnetic shielding effectiveness of coaxial cables is discussed. A diagram of the test setup used is given. Plots of the measured shielding effectiveness of various cables are given for the frequency range 10 kHz to 10 MHz. A comparison between calculated and measured results is made.

J. R. Dunki-Jacobs, "The Effect of Arcing Ground Faults on Low-Voltage System Design," Proceedings of the 1972 Seventh Annual Meeting of the IEEE Industry Applications Society, Philadelphia, PA, October 9-12, 1972, pp. 161-170.

The author attempts to present a fundamental story on the subject of arcing-ground faults to the extent that not only a greater appreciation can be gained from the elusive nature of this type of fault but also a better understanding of the

requirements for applying protective devices. This knowledge is used to evaluate the degree of effectiveness of direct-acting, phase overcurrent trip devices which leads into a discussion of the various ground fault protection modes. Subsequently the consequences of ground faults occurring on low voltage systems protected by fuses are discussed to highlight the adverse consequences of single phasing.

J. R. Dunki-Jacobs, "The Effects of Arcing Ground Faults on Low-Voltage System Design," IEEE Transactions on Industry Applications, vol. IA-8, no. 3, May-June 1972, pp. 223-230.

This paper is identical to the previous paper.

A. H. Erlund, "Lightning Protection for T1 Carrier," Telephone Engineer and Management, vol. 76,no. 16, August 15, 1972, pp. 55-57.

The author discusses telephone line grounding problems and describes for properly grounding T1 carrier system repeaters: totally grounded; floating repeater; and by-pass.

F. A. Fisher, "Effects of an Approaching Lightning Stroke on Aircraft Electrical Systems," 1972 Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

The manner in which lightning interacts with an aircraft is discussed. Lightning simulation studies are described. No equations are derived or results plotted.

V. Fritsch, "Gesichtspunkte fuer den Bau von Gebaeudeblitzschulzanlagen (Principles for the Structure of Lightning Protection Systems for Buildings)," Bulletin de l'Association Suisse des Electriciens, vol. 63, no. 14, July 8, 1972, pp. 768-771.

This paper is in German with an English translation of the title.

L. Genov, B. Siromakhov and V. Velichkov, "Determination of Line Earth-Return Wire Cross-Sections with Regard to their Thermal Stability," Electrical Technology, USSR, (GB), vol. 2, 1972, p. 167.

An algorithm is proposed for evaluation of the parameters of aluminum-steel earth-return wires on transmission lines, having regard in particular to the thermal stability and mechanical strength of the earth-return wires. The approach to the nearest substation is also treated.

T. N. Giao and M. P. Sarma, "Effect of a Two Layer Earth on the Electric Field Near HVDC Ground Electrodes," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, November/December 1972, pp. 2356-2365.

Analysis of the potential and field distribution in the vicinity of HVDC ground electrodes has until now been confined to the case of homogeneous earth. However, the case of an electrode buried in non-uniform earth is of greater practical interest. In most practical cases, the resistance variation of the earth may reasonably be characterized by a two-layer earth model, comprising a top layer of finite depth followed by a layer of different resistivity extending practically down to infinity. A method of analyzing the electric field in the vicinity of HVDC ground electrodes, buried in the top layer of a two-layer earth model is presented in this paper. The method is applied to several practical electrode configurations to determine the current distribution along the electrode-soil boundary as well as the potential and field distribution in the vicinity. A method of normalization is suggested and all the results are presented in the normalized form.

B. N. Gorin and N. S. Berlina, "Method for Assessing the Protective Effect of Earth-Return Wire Lightning Rods with Regard to Dispersion Characteristics," Electric Technology USSR, vol. 2, 1972, pp. 121-137.

A theoretical analysis of the probability of lightning strikes the power transmission lines is given. It is recommended that, above 1150 kV, the shield wires be located well above the conductors.

B. N. Gorin, V. I. Levitov and A. V. Shkilev, "Razryady Molnii v Ostankinskuyu Telebashnyu (Lightning Discharges on the Ostankino TV Tower)," Elektrichestvo, no. 2, February 1972, pp. 24-29.

This paper is in Russian with an English translation of the title.

W. Heise, "Contribution to the Protection of Flying Objects against the Effects of Lightning," Technische Mitteilungen AEG-Telefunken, (Germany), vol. 62, no. 7, 1972, pp. 319-323.

This paper is in German with a English translation of the title and abstract.

Three typical ways by which lightning currents may penetrate an aircraft are illustrated. A discussion of the lightning protection of radomes is included. The results of lightning simulation tests are included.

T. H. Herring, "A Design Problem for the Grounding Session," 1972 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

This paper serves as an introduction to a session on grounding held at this symposium. The grounding problem is outlined. Some of the topics addressed are: in a system with more than one power supply should all power supplies be grounded to the earth ground on the grounds merely bonded together, should the power supply ground be connected to the equipment shield, should the shields be bonded together, etc.

D. L. Hillhouse, "Circuit for Impulses Testing of Gas-Tube Lightning Arresters," IEEE Transactions on Communications, vol. COM-20, no. 5, October 1972, pp. 936-941.

A circuit for testing gas-tube lightning arresters, used to protect telephone lines from lightning, is described. Breakdown voltages vary from 250 to 400 V dc. The double exponential model is used for lightning current theoretical formulation and oscillograms of the measured currents are given.

J. W. Hodgkiss and G. W. Mattews, "Techniques for Protecting Brushless A.C. Generators," Electrical Times, (GB), vol. 161, no. 23, June 8, 1972, pp. 34-36.

A discussion of general considerations, earthing, and differential protection are covered.

R. M. Huey, "An Elementary Approach to the Problem of Partial Shielding," 1972 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

An approximate method of analyzing the electromagnetic shielding effectiveness of a structure with an aperture whose size is comparable to a wavelength is presented. This technique resolves the field transmitted through the aperture into four components. The results obtained indicate that this approximate technique is most accurate when the desired shielding is less than 15 to 20 dB.

F. B. Hunt, "Determining Peak Currents that Cause Ground Potential Rise," Proceedings of the IEEE 1972 International Conference on Communications, Philadelphia, PA, June 19-21, 1972.

The maximum possible ground current is determied for various power system impedances as a single phase to ground fault changes to a two phase to ground fault. The method of calculating the currents during the transient period is described and typical values are tabulated. These ground fault currents are needed to select protective equipment for communications circuits from the ground potential rise.

J. D. Ibbott, "The Effect of Lightning on Materials," Aircraft Engineering, vol. 44, no. 4, April 1972, pp. 25-28.

The effects of lightning on metallic, nonconducting and semiconducting materials used in aircraft are discussed. Simulated lightning tests were performed on these materials. Among the structures tested was the radome of the Concorde.

IEE, Conference on International Medium Voltage Earthing Practices, March 21-23, 1972, IEE, London.

This is the contents of an international conference on grounding techniques in use on medium voltage power systems (240-415 V). It contains thirty one papers on power system grounds and is application oriented. Subjects range from grounding in coal mines to grounding on ships.

N. Infurchia, "Lightning Protection for Traffic Controllers through Stringent Ground Bonding," Traffic Engineering, vol. 42, no. 5, February 1972, pp. 34-35, 48.

Proper grounding and bonding techniques to protect highway traffic control cabinets from lightning induced damage are discussed. If cables are connected through waterproof conduct, it is emphasized that they must be bonded together. Friction-type bond connectors are not recommended for this application.

Y. Ishida, "Induced Lightning Surges in Paired Telephone Cables," Review of the Electrical Communications Laboratory, (Tokyo), vol. 20, no. 3-4, March/April 1972, pp. 252-262.

Not available.

M. Krakowski, "Shielding Effect in a System Due to Currents in Parallel Conductors," Archiwum Elektrotechniki, (Poland), vol. 21, no. 1, 1972, pp. 107-123.

The active power in the conducting medium due to currents in a parallel multiconductor system is examined. The conducting medium possesses two layer structure; namely, a non-ferromagnetic shield is placed on the surface of the semi-infinite medium. The active power density on the surface of the shield is calculated for cylindrical and ribbon conductors. Furthermore, the total active power in the conducting medium is computed. The effect of shield thickness is examined. The considerations are based on idealized assumption that the permeability of the ferromagnetic medium is constant. It is shown, however, that the effect of variation in the permeability within wide ranges is very small.

J. E. LaCrosse, "Delta to Wye Conversion Technique Proves to be Economical," Transmission and Distribution, vol. 24, no. 3, March 1972, pp. 80-81.

Grounding the corner of delta distribution circuits during conversions to wye has resulted in substantial labor savings and in one case eliminated an estimated six-hour interruption.

C. C. Lambert, R. L. Waters and F. J. Morris, "An Exotic Low Frequency Shielded Enclosure," 1972 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

A description of a shielded room is given. It is designed to be shielded from low frequency magnetic fields. Plots of the shielding as a function of wall thickness and the shielding effectiveness as a function of frequency are given. Photographs of the room and the building that houses it are given.

W. L. Leicester, "Earthing Practice Overseas," Electrical Times, (GB), vol. 161, no. 16, April 20, 1972, pp. 33-36.

The need to protect electricity users from shock hazard is the determining fator for a country's earthing philosophy and this philosophy must be an extension of the approach adopted by the electricity supply companies. For this reason the types of electricity supplies available must be considered.

N. A. McDonald, "Electric and Magnetic Coupling through Small Apertures in Shield Walls of any Thickness," IEEE Transactions on Microwave Theory and Techniques, vol. MTT-20, no. 10, October 1972, pp. 689-695.

An analysis of the coupling between two microwave cavities is given. The coefficients of electric and magnetic coupling are determined as functions of shield wall thickness. These results can be used to determine the degradation in shielding effectiveness of an enclosure at microwave frequencies due to an aperture in the shield wall.

H. K. Mertel, "Explicit Grounding Allusions," 1972 Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

Some common misconceptions about system grounding are discussed. The ground plane, ground wire, ground bus, etc. may be a different potentials because of ground currents. It is emphasized that an equi-potential ground reference is not an accident and that it must be designed, built and tested.

M. I. Mikhailov and E. L. Portnov, "Measurement of Grounding Device Spreading Resistance," Telecommunications and Radio Engineering Part 1: Telecommunications," vol. 26, no. 2, February 1972, pp, 38-41.

The theory underlying the choice of distances between grounding devices and auxiliary electrodes when measuring grounding device spreading resistance by using the three electrode circuit is described. Curves for determining optimal electrode spacing when the electrodes and grounding devices are colinear are given. If the recommendation electrode spacing is observed, the measurement error will not exceed two percent.

C. M. Miller, "Capacitances of a Shielded Balanced-Pair Transmission Line," The Bell System Technical Journal, vol. 51, no. 3, March 1972, pp. 759-776.

Algorithms for the determination of the mutual and conductor-to-ground capacitance for a shielded balanced pair transmission line are derived. The solution is expressed as an infinite determinant.

E. Mueller, H. Steinbigler and J. Wiesinger, "Le Calcul Numerique des Tensions Induites dans des Boucles Proches d'Installation de Protection Contre la Foudre (Numerical Calculation of Voltages Induced in Loops near Lightning Protection Systems)," Bulletin de l'Association Suisse des Electriciens, vol. 63, no. 18, September 2, 1972, pp. 1025-1031.

This paper is in French with an English translation of the title.

E. Nasser, "Sparking of Lightning Arresters Due to Conductive Contaminants," Journal of the Franklin Institute, vol. 294, no. 6, December 1972, pp. 469-481.

Not available.

R. W. Nettleton, "Safety Considerations in Light Electrical Testing," SERT Journal, (GB), vol. 6, no. 5, September 1972, pp. 101-103.

The author describes four wiring systems for laboratories used for light electrical testing, and live chassis testing in particular. The relative safety of each system is discussed with reference to the effectiveness of fusing, electric shock protection, accidental contact with earth, and contact with other working positions. A system using an isolation transformer to the item under test with all other equipment on "raw" mains with an earth was preferred.

A. R. Norden, "Ground Connector for Conduit," U.S. Patent 3 706 959, filed 1971, issued 1972.

A grounding device is disclosed wherein a bushing is adapted to be threaded onto an end of conduit extending through a wall of a housing and a grounding lug is secured on the periphery of the bushing. The lug has a resilient C-shaped wire clamping portion and resilient wings extending from opposite ends thereof formed

so as to provide spring tensioned connections to the periphery of the bushing. The wings have teeth adapted to make grounding connections with the wall of an enclosure or box upon threading of the bushing onto conduit extending through the enclosure, additionally providing anti-turning means to prevent the lug from rotating on its mounting screw.

E. T. Pierce, "Triggered Lightning and Some Unsuspected Lightning Hazards," Naval Research Reviews, vol. 25, no. 3, March 1972, pp. 14-28.

A review of the methods by which man accidentally initiates lightning is given. These include: tall buildings, rockets with trailing wires, aircraft and thermonuclear explosions. Any time an electrif field of approximately 1000 volts per meter occurs and the potential difference between the conductor initiating the lightning and the adjacent atmosphere is about a million volts a lightning discharge will occur. The vulnerability of systems, such as microcircuits, to lightning is discussed.

K. E. Poulheim, V. Lossmer and W. Schluter, "The Equipment for Incorporation Analysis in the Medical Department of the National Center for Radiation Protection of the GDR," 2nd European Congress on Radiation Protection, May 3-5, 1972.

For critical examination of incorporation in man besides the extensive medical evaluation it is necessary to have the cooperation of various physical methods, and in some cases, chemical preparation of samples. Equipments will be presented for incorporation analysis which are available in the medical department. Technical parameters and details of the construction, especially for the whole body counters, are given. The difficulties will be pointed out in building a high sensitive whole body counter near large broadcasting stations or other high frequency trouble sources. The realized precautions of the RF-shielding, and some results from whole-body counter measurements, are given. The future program of measurements and development is outlined.

The procedings of this meeting are published in: Health Physics Problems of Internal Contamination, Akademiai Kiado, Budapest, 1973.

P. G. Provoost and W. F. J. Kersten, "Correlation between Step Response and Errors in Recording Front Chopped High Voltage Lightning Impulses," Elektrotechniek, vol. 50, no. 3, February 3, 1972, pp. 105-111.

A description of a graphical method of estimating the amplitude and time errors in recording lightning impulses is given. Actual lightning data is used.

J. Prunieras and D. Chevallier, "Onde de Foudre se Propageant le Long d'une Ligne Mise a la Terre - 1. Etude Theorique (Lightning Wave Propagating Along a Line Ending in the Earth)," Revue Generale de l'Electricite, vol. 81, no. 3, March 1972, pp. 198-202.

This paper is in French with an English translation of the title.

R. S. Rawling, "Medium Voltage Earthing Practice in Quarries," Mining Technology, (GB), vol. 549, no. 624, October 1972, pp. 143-145.

This article gives a theoretical background followed by a discussion on conductivity, rules and regulations and earthing continuity.

A. A. Regotti, "Changing Concepts and Equipment Applied on Grounded Low Voltage Systems," IEEE Transactions on Industry Applications, vol. IA-8, no. 3, May-June 1972, pp. 231-236.

Without firm assurances from the operating management for continued availability of skilled and experienced maintenance personnel, the authors favor the solidly grounded system utilizing sensitive protection devices for isolation of low-level and above-ground ground facilities.

E. Reyner, II, "Impedance Control and Shielding Are Two Different Things," Electronic Engineer, (Philadelphia), vol. 31, no. 7, July 1972, pp. 22-24.

This is the fifth of a five part article dealing with the packaging of high speed integrated circuits. The two basic ways of wiring high-speed digital systems are discussed. The first technique is fully shielded and uses a grounded conductor that completely surrounds the signal lead in a manner similar to a coaxial cable. The second technique used has both ground and signal leads unshielded. This open system is recommended because of economy for all but the most sensitive circuits. Methods of determining impedances and crosstalk between unshielded conductors are included.

K. D. Richards, "To Determine the Effect of Earthed Interphase Barriers on Electrical Equipment," Mining Technology, (GB), vol. 54, no. 618, April 1972, pp. 12-13.

This article describes tests to determine correlation between types of fault and level of destruction by short circuit.

V. N. Rikh, "Shielding 400 kV Lines Against Direct Lightning Strokes," Electrical Engineer, (Australia), vol. 49, no. 4, April 1972, pp. 33-34.

Points out that the behavior of lightning with reference to the transmission lines has been tested and investigated over the past few decades. As a result many approaches to ensure safe line design against direct lightning strokes have been suggested and sometimes subsequently modified. Out of these the one which has been most favored assumes that the lightning stroke of a given potential is

attracted to an object which first comes within its attraction zone, the attraction distance increasing as the stroke potential is increased.

O. D. Ringness, "Overhead Shielding of Transmission Lines Improves Reliability," Transmission and Distribution, vol. 24, no. 4, April 1972, pp. 58-66.

Points out that while shielding may add thirty percent to the cost of line construction, the substantial benefits resulting justify this expense.

S. M. Roy, "Grounding of Large Electrical Installations in Limited Area of High Earth Resistivity," Journal of the Institution of Engineers (India) Electrical Engineering Division, vol. 52, pt. EL-6, no. 12, August 1972, pp. 308-314.

Grounding of large electrical installations in limited areas of high earth resistivity poses special problems. Recommended low values of ground resistance are difficult to ahcieve for such cases. However, the installation can be made safe by limiting the potential gradients and by adopting special means. Design of a grounding mat and determination of step and touch potentials encountered involve lengthy calculations or a computer program by way of varying the depth of burial, spacing and number of parallel paths of the grounding conductor. With a few sets of calculations given in this paper, the length of conductor required to limit the above variants giving the required information at a glance and making the designing processes simpler.

F. Ruehling, "Modelluntersuchungen Ueber den Shutzram und Ihre Bedeutung fuer Gebaeudeblitzbleiter (Model Studies of the Shelter and their Importance for Building Lightning Rod)," Bulletin de l'Association Suisse de Electriciens, vol. 63, no. 10, May 13, 1972, pp. 522-528.

This paper is in German with an English translation of the title.

M. A. Sargent, "Monte Carlo Simulation of the Lightning Performance of Overhead Shielding Networks of High Voltage Stations," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, no. 4, July/August 1972, pp. 1651-1656.

A statistical analysis of the lightning protection for a power transmission system is given. An electrogeometric model is used to model the overhead lightning shield wire network. The number of lightning strokes expected to strike a station per year is determined as a function of the electrogeometric parameters.

A. W. Scheide, "Evaluation of the Shielding Properties of Cable Trays for Use in an Industrial Environment," IEEE Transactions on Industry Applications, vol. IA-8, no. 6, November-December 1972, pp. 783-787.

The electromagnetic and electrostatic shielding properties of cable trays for control cables are discussed. Shielding efficiencies for cable trays made from various materials were experimentally measured. A plot of the shielding efficiency as a function of frequency is given.

F. Schoffel, "New Data Acquired in the Realm of Practical Short-Circuit Tests on Experimental Earthing and Shorting Devices," 2nd International Colloquim of the International Section of the ISSA for the Prevention of Occupational Risks Due to Electricity, Colgne, Germany, November 30 -December 1, 1972.

A summary of the papers is given.

R. B. Schulz, "RF Shielding and Electrical Properties of Boron and Carbon Fibre Reinforced Composites," 1972 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

Plots of the shielding effectiveness of boron and carbon composites are given. Formulas for determining the conductivity of these materials are given.

J. F. Shaeffer and G. L. Weinstock, "Aircraft Initiation of Lightning Strikes," 1972 Electronics and Aerospace Systems Convention, Washington, D.C., October 16-18, 1972, pp. 70-76.

The mechanism by which an aircraft can trigger a lightning strike when flying through a highly charged atmosphere is discussed. Both analytical results and lightning simulation tests are presented. The specific aircraft analyzed were the B-52 and F-4.

B. E. Smith, "Progress Report on the Use of Aluminum Neutral Cable," Underground Engineering, vol. 3, no. 5, August-September 1972, pp. 13-15.

This paper expresses the Virginia Electric Company's concern about the availability and high cost of copper for utility application. Studies of alternate materials have resulted in the application of aluminum and other metals and plastics as a substitute for copper for such products as overhead wire, insulated conductors, grounding rods, transformer windings, bus bars and counterpoise installations.

R. Starrett and R. Locke, "Economical Shield Terminations for Electronic Wiring," Insulation/Circuits, vol. 18, no. 4, April 1972, pp. 30-31.

Shield termination for making electrical contact to cable shielding braids are discussed. The primary requirement for a shield termination is to provide a low

impedance path to ground. The five common methods for terminating shields are discussed.

H, Stephanides and M. Schmid, "Surtensions Engendrees par des Coups de Foundre dans une Installation de Cables a Gaines Permutees (Lightning Overvoltages in the Cable Systems with Combined Sheathing)," Bulletin de l'Association Suisse des Electriciens, vol. 63, no. 3, February 5, 1972, pp. 125-134.

This paper is in French with an English translation of the title.

M. R. Swinehart, "Electrical Noise in Machine Tool Controls," IEEE Transactions on Industry Applications, vol. IA-8, no. 5, September-October 1972, pp. 535-541.

The most troublesome electrical noise source in industrial control systems, the "showering arc," and the resulting induced noise in adjacent lines is characterized by oscillograms and other measurements. It is shown that shunt capacitance due to wiring can increase the severity of this noise. Transient voltage peaks of 1700 V have been observed; 2000V peaks are common in 120V a.c. systems. Malfunctions of control systems due to these transients can be its source. A method of providing assistance in the selection of a capacitor quench circuit is presented, showing that capacitors of not more than 0.5 microfarads are adequate.

A. L. Timotin, "Skin Effect in Shielded Straight Flat Conductors," Revue Roumaine des Sciences Techniques. Serie Electrotechnique et Energetique, (Romania), vol. 17, no. 1, 1972, pp. 3-22.

The influence of a perfectly conductive rectangular cross-section shield on the edge-effect in a straight flat conductor is presented. The distribution of the linear current density in the flatbar, the A.C. resistance, the reactance of the shielded bar, and the force density in the sides of the shield are determined using the magnetic vector potential. It is shown that the presence of the shield around the conductor reduces the edge effect in the bar, uniformizing the current density distribution.

K. D. Tran and J. Robert, "Digital Simulation and Analysis of Surges on Polyphase Transmission Lines with Earth Return," IEEE Transactions on Power Apparatus and Systems, vol. PAS-91, no. 2, March/April 1972, pp. 445-451.

A method of analysis and a digital simulation of surges on polyphase EHV transmission lines with earth return are presented. The analysis allows mathematical calculations of switching surge wvefronts and gives a better insight into the distortions of the waves due to the earth-resistance. This digital simulation is easy and straightforward. It is based on the property "the more the groundmode propagates, the more its time delay increases." Simulated curves are found to be in good agreement with analytical results and with test oscillograms.

W. Vogel, "Basic Considerations on the Problem of Electromagnetic Compatibility," 1972 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1972.

The electromagnetic compatibility problem is discussed in broad terms. Among the topics covered are: the effects of power lines on equipment via the ground lead, the effects of a nonzero impedance in the ground circuit and the effects of the equipment shield on the system.

J. Wiesinger, "Integration der Gebaeudeinstallation in die Blitzschutzanlage (Integration of the Lightning Protection of Various Buildings)," Bulletin de l'association Suisse des Electriciens, vol. 63, no. 3, February 5, 1972, pp. 117-124.

This paper is in German with an English translation of the title.

D. Woods, "Shielded-Open-Circuit Discontinuity Capacitance of a Coaxial Line," Proceeding of the Institution of Electrical Engineers, (London), vol. 119, no. 12, December 1972, pp. 1691-1692.

An analysis of the capacitance of a coaxial cable with a shielded outer conductor and a discontinuous inner conductor is given. Results are given in tabular form.

1973

J. Bajorek, "Wplyw Uwarstwienia Gruntow na Wlasnosci Statyczne Dlugich Uziomow (Effect of Ground Stratification on the Static Properties of Long Grounding Electrodes)," Przeglad Elektrotechniczny, vol. 49, no. 8, August 1973, pp. 360-363.

This paper is in Polish with an English translation of the title.

C. B. Barksdale, "Lightning and Surge Protection of CATV Facilities," 22nd Annual National Cable Television Association Convention, Anaheim, California, June 17-20, 1973, pp. 29-32.

Not available.

K. Berger, "Oszillographische Messungen des Feldverlaufs in der Naehe des Blitzeinschlags auf dem Monte San Salvatore (Oscillographic Measurements of the Field-Strength Distribution in the Vicinity of Lightning Strikes on the Monte San Salvatore)," Bulletin de l'Association Suisse des Electriciens, vol. 64, no. 3, February 3, 1973, pp. 120-136.

This paper is in German with an English translation of the title.

V. M. Brekhov and V. P. Larionov, "Lightning Protection of Aircraft Fairing," Elektrichestuo, (USSR), no. 11, 1972, pp. 89-90.

The results of a study of a lightning protection system for the nose cowl of an aircraft are reported.

D. W. Clifford, "Lightning Simulation Testing in Aerospace," Institute of Environmental Sciences 19th Annual Technical Meeting on Realism in Environmental Testing and Control, Anaheim, CA, April 2-5, 1973, pp. 388-396.

A summary of the lightning strike histories of selected aerospace vehicles is given. A technique of simulating lightning that accurately models the hazards to aerospace vehicles is reported. A typical test used a 1.6 megavolt generator and a 600 kilojoule high current simulator.

J. A. Cooper and L. J. Allen, "Lightning Arrestor-Connector Concept," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-15, no. 3, August 1973, pp. 104-110.

A description of a new compact lightning arrestor is given. The arrestor can be incorporated into a multipin housing to protect components in missiles, aircraft and ground systems from lightning damage. Both

experimental and theoretical data are presented. Current levels tested were in the 200 kA range.

G. I. Denisenko, V. S. Perkhach, B. Kinash and I. V. Lishchak, "O Metodike Otsenki Nadezhnosti Skhem Grozozashchity Podstantsii (On the Methods of Evaluation of Lightning Protection Schemes at Substations)," Izv Vyssh Uchebn Zaved, Energ, no. 3, March 1973, pp. 23-27.

This paper is in Russian with an English translation of the title and abstract.

An algorithm for evaluating the lightning protection schemes at substations is presented. The worst case parameters are used.

G. I. Denisenko, V. S. Perkhach, B. M. Kinash and I. V. Lishchak, "Sopostavlenie Raschetnykh Urovnei Grozoupornosti Podstantsii, Poluchennykh na Osnove Uproshchennoi i Tochnio Metodiki (Comparison of the Rated Levels of Lightning Security of Substations, Calculated by Simplified and Exact Methods)," Izv Vyssh Uchebn Zaved, Energ, no. 5, May 1973, pp. 30-37.

This paper is in Russian with an English translation of the title and abstract.

An evaluation of the effectiveness of the lightning protection system at a power substation is given. Two algorithms are used and the voltage level is 110-500 kV.

D. A. Douglass, "Lightning Induced Current Surges on a Buried Multicoaxial Cable System," Wire Journal, vol. 6, no. 1, January 1973, pp. 45-51.

This is the first of a two part article.

A buried multicoaxial cable is modeled as a distributed transmission line which accurately predicts current surges due to lightning bolts to the shield of the cable. Statistical data on lightning is given and related to probability of shorts between the two conductors.

D. A. Douglass, "Lightning Induced Current Surges on a Buried Multicoaxial Cable System," Wire Journal, vol. 6, no. 2, February 1973, pp. 56-60.

This is the second part of a two part article. The transmission line equations developed in part one are solved. A plot of lightning induced current as a function of time is given.

J. Driller and V. Parsonnet, "An Electromagnetic Shielding System for Image Intensifiers," Medical and Biological Engineering, (GB), vol. 11, no. 6, November 1973, pp. 797-798.

A method of providing magnetic shielding for an image intensifier tube used in conjunction with X-ray pictures is described. A thin coil is placed around the face of the intensifier and Mu-metal screens are used.

J. H. Evans, "Assessment of the Lightning Protection Policies of the British Distribution System," IEE Conference Publication, (London), no. 108, 1973, pp. 18-24.

The effectiveness of the lightning protection system in use in England is discussed. A description of the sequence of opening and closing of circuit breakers is given.

R. H. Golde, Lightning Protection, England, Arnold, London, 1973.

This book concerns the lightning protection of buildings. Thunderstorms and lightning discharges are explained. The protection of structures ranging from church steeples to telecommunications towers from lightning damage is discussed. Maintenance recommendations for lightning protection equipment are given. The effects of lightning on humans and animals and recommended protection measures are also discussed.

B. F. Golosnov and V. V. Platonov, "Screening Effect of Power Cable Armor and Sheath," Electrical Technology USSR, (GB), no. 3, 1973, pp. 40-48.

Reports results of a test analysis for low frequencies. A screening factor is derived which decreases with increasing frequency and is independent of the core section. This contributes to an induction method of interphase fault location, having regard to lead and aluminum sheaths.

D. B. Goodrich, "Computer Aided Magnetic Field Calculations for Nonlinear Shielding Materials," IEEE Transactions on Magnetics, vol. MAG-9, no. 3, September 1973, pp. 261-265.

This article describes a general computer program, developed to calculate magnetic fields in the presence of ferromagnetic shields by solving the two-dimensional Laplace equation on a rectangular grid of up to 5,000 nodes using the difference-equation technique. The magnetic flux density was assumed to be either a linear or nonlinear function of the magnetic field intensity. Shielding material thickness for most applications is small compared to the difference equation grid resolution. Therefore, a resistor network analogy was used to appropriately modify the difference equation for thin materials on a uniform grid.

A. P. Hale, "Electromagnetic Shielding," 1973 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1973.

Electromagnetic shielding practices in Europe are discussed. This paper is illustrated with practical examples of shielded rooms or buildings. Plots of shielding attenuation as a function of frequency are given.

L. Halme and J. Annanpalo, "Use of Magnetic Materials for Improvement of Screening Properties of Different Types of Cables," 1973 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1973.

The theory of interference voltages coupling through the transfer impedance into coaxial cables having single, double, and triple outer conductors and the use of magnetic materials between the outer conductors is presented. Measured transfer impedances of different cable types are shown. Further, the crosstalk attenuation between electrically short coaxial cables is derived and measured crosstalk attenuations are presented for different coaxial cable types. The measurements were carried out up to 80 MHz, and the measuring limit was 180 db of crosstalk attenuation. The use of magnetic material improves the screening efficiency considerably in the frequency range 10 KHz to 10 MHz. The use of a conducting layer and a high permeability tape in shielding of balances pairs is treated and results of cross talk attenuation measurements are shown. Finally, the screening performance of magnetic shielded coaxial cables under heavy interfering currents is treated. Measurement results are shown of tests made with a current pulse of 20 to 460 amp. peak value flowing in the outer conductor.

R. A. Harvie, "Hazards During Ground Faults on 480 Volt Grounded Systems," 1973 Industrial and Commercial Power Systems Technical Conference, Atlanta, GA, May 13-16, 1973, pp. 64-70.

It is known that arcing ground faults on 480 volt systems are often too small to actuate phase protective devices. GFI's have been introduced to ensure clearance of such faults. They are costly when used in quantity, and are mandatory only on large capacity circuits. Their use will, therefore, be limited. The hazard of exposure voltages which are not removed by phase protective devices, therefore, remains of great concern. The magnitude of exposure voltage on several common systems is explored and the relative safety evaluated. Different systems produce exposure voltages with maximums ranging from 40 to 190 volts. Means are presented for reducing the exposure voltage on those systems which are most hazardous.

Y. Iwasa, "Magnetic Shielding on Magnetically Levitated Vehicles," Proceedings of the IEEE, vol. 61, no. 5, May 1973, pp. 598-603.

Shielding is needed to protect passengers in a vehicle from stray d.c. magnetic fields coming from the superconducting dipoles carried by the

vehicle. In addition, the superconducting dipoles must be shielded against various a.c. magnetic fields. The author considers shielding of a.c. magnetic fields generated by the propulsion windings for the case of a linear-synchronous motor active guideway.

J. B. Johnson and J. R. Stevenson, "Neutral Grounding and the Prevention of Neutral Instability," IEEE Transactions on Power Apparatus and Systems, vol. PAS-92, no. 1, January/February 1973, pp. 341-345.

Investigative results from a systems-in-miniature setup are presented concerning the stability of Y-connected potential transformers, and the effect of potential transformers as generator neutral grounding devices. Included is the influence of a resistance burden on the neutral grounding transformer.

M. Kazahaya, W. J. Sitkewich and C. W. Hargens, "A Systematic Approach to Lightning Protection of Industrial Instrumentation Systems," Advances in Instrumentation, 28th Annual Instrument Society of America Conference, vol. 28, part 4, Houston, TX, October 15-13, 1973, paper 860.

Methods of protecting industrial instrumentation systems from lightning damage are discussed. Combinations of gas arrestors, Zener diodes and current limiting resistors are used for instrument signal and dc supply lines while gas arrestors and metal oxide varistors are used for the 120 volts ac power supply lines. Test results are given.

E. T. Krasovskaya, "Kharakteristiki Elektricheskoi Prochnosti Izolyatsii vl pri Nestandartnyk Impul'sakh Grozovykh Perenapryazhenii (Characteristics of Electrical Strength of Insulation of Aerial Lines During Extraordinary Surges of Lightning Overvoltages)," Izv Vyssh Uchebn Zaved, Energ, no. 3, March 1973, pp. 23-32.

This paper is in Russian with an English translation of the title and abstract.

The effects of lightning on the insulation used on power transmission lines are discussed. An attempt to coordinate the insulation and lightning protection requirements for power transmission lines is made.

T. Kuono and S. Kato, "An Impulse Voltage Divider Covered with Metal Cylinder and Improvement of its Response Characteristics," Electrical Engineering in Japan, (USA), vol. 93, no. 3, May-June 1973, pp. 49-55.

Most impulse voltage dividers used at present are shielded from electromagnetic radiation interference by grounded metal cylindrical covers. However, the stray capacitances between voltage-dividing resistances and

the metal shield cover worsen the response characteristics. A method is proposed to improve the response characteristics in which the input voltage is picked up by using a small capacitance voltage divider and applied to a shaping filter. The output voltage of this filter is then superimposed on the output voltage of another voltage divider.

C. N. McDowell and M. J. Bernstein, "Surface Transfer Impedance Measurements on Submarine Coaxial Cables," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-15, no. 4, November 1973, pp. 188-190.

The surface transfer impedances (STI) of several flexible subminiature coaxial cables, such as RG-174/U and RG-188/U, plus smaller coaxial shielded wires, were measured to determine E. M. shielding characteristics. The results cover the frequency range 0.1-50 MHz and correlate well with previous theoretical models and with experimental values for larger cables, such as RG-58. Copper-braided subminiature cables had STI values 2-5 times larger than those for RG-58.

D. Mukhedkar, Y. Gervais and F. Dawalibi, "Modeling of Potential Distribution Around a Grounding Electrode," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-92, no. 5, September/October 1973, pp. 1455-1459.

A twin layer model is used for experimental determination of the potential distribution around and near different ground electrodes. An attempt is made to study the effect of local top layer discontinuities on potential distribution in a twin layer model.

A. C. Newton, F. Martin, S. J. St. Lorent and W. T. Toner, "A Method for Producing Long, Cylindrical, Super Conducting Flux Shields," Review of Scientific Instruments, vol. 44, no. 2, February 1973, pp. 244-245.

A technique is described for making long, cylindrical, magnetic flux shields from an alloy superconducting tape.

D. F. Oakeshott, "Lightning Performance and Protection Practice of the British 132 kV System," IEE Conference Publication, (London), no. 108, 1973, pp. 25-29.

The main features of the lightning protection system are outlined and some aspects of its performance in thunderstorms are reviewed.

H. Otoy, M.Yajima and M. Yokota, "A Corrugated Wire-Filled Aluminum Sheath to Screen Telephone Cable from Inductive Interference," Dainichi-Nippon Cables Review, (Japan), no. 53, March 1973, pp. 1-9.

A description is given of a steel wire filled aluminum sheath for the protection of telephone lines from inductive interference caused by nearby power lines. The effectiveness of the magnetic shielding was determined experimentally.

K. J. Owen, "Electrical Power Systems Neutral Grounding Practice to Minimize Downtime," 59th Annual Meeting of the Technical Section of the Canadian Pulp and Paper Association, Montreal, Canada, January 23-26, 1973, pp. 23-26.

The philosophies used in the past to determine the merits of operating power systems in a grounded or ungrounded neutral mode are considered no longer completely valid, due to the advent in recent years of monitoring devices, highly sensitive to very small deviations in normal phase-ground conditions. It is the intent then to review these philosophies and propose a particular approach--namely high resistance grounds to the function of the neutral that retains the advantages and reduces the disadvantages of past power system operation, still leaving the operator of the power system the option of selecting the mode of operation; that is, to trip or annunciate only when phase-ground relationship becomes abnormal. It is also proposed that this concept will minimize both the rate of and elapsed down times.

L. C. Peterson, "Problems with Large Ground Fault Currents in Utility Substations in or near Industrial Sites," IEEE 1973 Annual Pulp and Paper Industry Technical Conference, Jacksonville, FL, May 1-4, 1973, pp. 35-41.

One of the prime functions of equipment grounding is for safety to life and property. In designing an industrial power system that obtains any energy from a utility with a high ground fault current capability, it may be advisable to isolate the industrial and utility ground grids for safety reasons. A review of present practices as well as suggested modifications with an actual design example is presented.

L. J. Powell, Jr., "Influence of Third Harmonic Circulating Currents in Selecting Neutral Grounding Devices," IEEE 1973 Annual Pulp and Paper Industry Technical Conference, Jacksonville, FL, May 1-4, 1973, pp. 24-32.

It has long been recognized that third harmonic currents can and often do appear in the neutral of mill generators. This paper reviews the causes of such currents and the effects these currents can have in the paper mill power system. The common methods of neutral grounding will be discussed with regard to circulating harmonic currents.

R. Radebaugh, N. V. Frederick and J. D. Siegwarth, "Flexible Laminates for Thermally Grounded Terminal Strips and Shielded Electrical Leads at Low Temperatures," Cryogenics, vol. 13, no. 1, January 1973, pp. 41-43.

A method of constructing compact terminal strips for electrical leads in cryostats from flexible electrical laminates is described. This produces a better "thermal ground" than can be achieved with round wire.

F. Rating, "Practical and Theoretical Investigation of the Protection (of Telecommunications Cables) Against Lightning Currents by Ferromagnetic Tubes," Fernmelde-Praxis, (Germany), vol. 50, no. 7, April 10, 1973, pp. 276-298.

This paper is in German with an English translation of the title and abstract.

A summary of the methods used to protect telecommunications cables from lightning damage is given. An analysis of ferromagnetic tubes is given which accounts for the magnetic saturation at high current levels. Results of lightning simulation tests of these tubes are presented.

E. M. Reyner, II, "Impedance and Shielding Control in 'Open' Interconnection Systems," Electronic Packaging and Production, vol. 13, no. 1, January 1973, pp. 42-44, 48, 51-52, 55-56, 59.

Electromagnetic shielding considerations in electronic systems using an open rather than shielded interconnection system are discussed. The use of twisted pairs is recommended because of their excellent shielding effectiveness for low frequency application.

C. J. Richards, "Electromagnetic Aspects of Radio Interference Suppression and Systems Earthing Methods," Electronic Display and Data Systems: Constructional Practice, McGraw Hill, 1973.

This section deals with noise sources of a non-random nature and attempts to outline established practical methods for reducing such noise in circuits associated with the transmission, reception, and processing of electromagnetic energy, transmission recpetion energy.

B. N. Rikh, "Adequate Margins for H. V. Line Lightning," Electrical Engineering, (Australia), vol. 50, no. 7, July 1973, pp. 26-28.

A method of determining shielding angles associated with various ground wire heights to give adequate margins against direct lightning strikes in high-voltage tranmission lines is described.

D. Schieber, "Shielding Performance of Metallic Cylinders," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-15, no. 1, February 1973, pp. 12-16.

The electromagnetic shielding effectiveness of metal cylinders is analyzed. The Hertzian potentials are used to solve the field equations. Solutions to Maxwell's equations are obtained in terms of Bessel and Hankel functions. The shielding effectiveness is plotted as a function of the product of the radius of the cylinder and the frequency of the incident field.

H. M. Smith, "Utility Grounding Practices," Cablecasting-Cable TV Engineering, vol. 9, no. 2, July-August 1973, pp. 6-10.

This article discusses the principles and safety regulations of earthing techniques. The author describes the optimum methods and some of the problems involved.

R. E. Snyder, "New Protection System May Eliminate Lightning Damage," World Oil, vol. 176, no. 1, January 1973, pp. 59-61.

The paper purposes the use of dissipation arrays to neutralize charged clouds before they can reach the structures to be protected. With this method, the potential energy between cloud and ground is continually discharged over a long period. The structure to be protected must be surrounded by these dissipation arrays.

S. Szpor, "Polish Developments in Inductance Coils for Lightning Protection of Power Stations and Substations," Proceedings of the Institution of Electrical Engineers, (London), vol. 120, no. 5, May 1973, pp. 610-612.

The use of inductance coils to protect power stations and substations from lightning damage is discussed. These inductance coils have been found to be a perfect substitute for overhead lightning shield wires. A photograph of a coil and a tabulation of field results are given.

B. Thapar and R. P. Nagar, "Impulse Characteristics of Horizontally-Buried Straight Conductors Used as Grounding Electrode," Journal of the Institution of Engineers (India) Electrical Engineering Division, vol. 54, pt. EL1, October 1973, pp. 11-15.

To predict the impulse behavior of grounding electrodes, it is necessary to evaluate the effect of the various factors controlling the impulse characteristics. In this paper an analytical method is developed to determine the effect of those factors and to evaluate the impulse grounding impedance of a single horizontal conductor subjected to impulse currents.

It is shown that the impulse grounding impedance of a straight horizontal electrode does not change if the length of the conductor is increased beyond its effective length, which depends upon the resistivity of the soil and the time-to-peak of the applied impulse current. An equivalent lumped network is defined to represent the single horizontal grounding conductor.

J. R. Wait, "Electromagnetic Induction in Conductive Shells," Canadian Journal of Physics, (Canada), vol. 51, no. 2, January 15, 1973, pp. 209-218.

The shielding characteristics of thin conductive shells are considered. Both elliptical and spheroidal shapes are treated using a thin-sheet boundary condition. It is shown that the form of the solutions is relatively simple if the angular variation of the shell thickness is taken to vary in a prescribed fashion. The reduction factor is expressed in terms of the frequency and shell dimensions. The results for cylindrical and spherical shells are obtained as special cases.

G. W. Walsh, "A Review of Lightning Protection and Grounding Practices," IEEE Transactions on Industry Applications, vol. IA-9, no. 2, March-April 1973, pp. 133-148.

Guides are presented to facilitate proper economic lightning protection of industrial power system component arrangements. Basic concepts of the traveling wave nature of lightning are included to enhance understanding of protective practives as they have developed and emphasizing the need for careful adherence to approved practices in critical areas. The grounding treatment is very brief, being limited to the most salient considerations of equipment grounding in relation to the overall lightning protective system and the ground fault protective system. The paper is referenced throughtout to current industry standards, application guides, and codes.

G. W. Walsh, "A Review of Lightning Protection and Grounding Practices," 8th Annual Meeting of the IEEE Industry Applications Society, Milwaukee, Wisconsin, October 8-11, 1973, pp. 465-480.

This paper is identical to the previous paper.

G. N. Webb and D. Gordon, "Study of Relative Effectiveness of Conduits and Grounding Conductors in Reducing Potential Difference in a Patient's Room Produced by Fault Currents," Proceedings of the 26th Annual Conference on Engineering in Medicine and Biology, Minneapolis, Minnesota, September 30 - October 4, 1973, p. 241.

In the interests of patient safety an understanding of the function of power conductors, conduits and parallel conductive paths inside and outside the conduit, during fault conditions is important in assessing grounding procedures and estimating potential differences in the patient vicinity. More references on this subject deal with massive fault currents on major feeders and do not consider the potentials that may develop in a patient room when fault currents do occur which do not operate current limiting devices.

A. Wendorft, "Ground-Fault Protection of a 15 kV Cable System," Enegetyka, (Poland), vol. 27, no. 3, March 1973, pp. 89-90.

The results of the protection functioning in a part of the Krakow 15 kV cable system is discussed. Due to an expansion and modernization this part of the cable system has been equipped with a ground-fault tripping protection and with an automatic emergency feed closing.

R. B. West, "Equipment Grounding for Reliable Ground Fault Protection in Electrical Systems Below 600 volts," 1973 Industrial and Commercial Power Systems Technical Conference, May 13-16, 1973, pp. 48-63.

Equipment grounding is one of the most important, but least understood, requirements for reliable ground fault protection. This paper defines the basic objectives of equipment grounding and analyzes the role of equipment grounding conductors in providing ground fault protection for electrical systems below 600 volts.

R. O. D. Whitt, "Trends and Practices in Grounding and Fault Protection Using Static Devices," IEEE Transactions on Industry Applications, vol. IA-9, no. 2, March-April 1973, pp. 149-157.

Grounded and ungrounded systems are in general use in both commercial and industrial distribution systems. This paper briefly identifies the types of systms in use in each category and lists some of the main advantages and disadvantages of each. The need for adequate protection has been recognized by the 1971 Electrical Code (national). This recognition is being complemented by Underwriters Laboratories with the introduction of appropriate standards. With the passing of the Occupational Safety and Health Act of 1970, more emphasis than ever before will be placed on adherence to the preceding code and standards. This paper reviews the various methods of detecting ground faults using static devices and describes some of the equipment available for these applications.

L. Yenraque, "Sneak Ground Currents in A-C Power Systems," Electrical Construction and Maintenance, vo. 72, no. 11, November 1973, p. 80.

Sneak currents in A.C. power systems are those currents that flow in the grounding conductor for no apparent reason. Regardless of the size of the system, ground currents will be present to some extent, whether measurable or not, contributing to malfunctioning of sensitive equipment and nuisance tripping of grounding fault protective devices. In this paper suggestions of possible methods to aid attenuation and control these ground currents are given.

F. J. Young, "Pulse Shielding by Nonferrous and Ferromagnetic Materials," Proceedings of the IEEE, vol. 61, no. 4, April 1973, pp. 404-413.

The problems encountered in pulse shielding by ferromagnetic materials are discussed. A limiting nonlinear shielding theory for magnetic materials based on the classic switching theory of ferromagnetism is established and verified experimentally. The limiting nonlinear theory includes the influence of saturation induction, coercive force, electrical conductivity, and pulse charge. The pulse shielding effectiveness of many types of shielding materials, both ferrous and nonferrous, is analyzed. The material costs and weights are compared. It is shown that below a certain pulse level (current), nickel-iron alloys produce the lightest shields. Above that current level, nonferrous materials become lighter because they are less dense. Suggestions for the improvement of ferrous alloys are included.

L. Y. M. Yu, "Determination of Induced Currents and Voltages in Earth Wires During Faults," Proceedings of the Institution of Electrical Engineers, (GB), vol. 120, no. 6, June 1973, pp. 689-692.

The multiconductor analysis introduced to the study of the current and voltage distributions of power transmission lines of any configuration may account for the induced currents and voltages in earth wires at any point of interest along a transmission line under fault or normal conditions at any operating voltage leveis. The earth wires are employed as individual entities in the analysis along with the line conductors in extra-high voltage transmission lines of power frequency. From the safety and reliability in earth wires under the fault conditions of the line conductors is significant and important for those power transmission lines operated at high-voltage or extra-high-voltage levels.

1974

R. N. Allan, "Electrostatic Fields Underneath Power Lines Operated at Very High Voltages," Proceedings of the Institute of Electrical Engineers, (GB), vol. 121, no. 11, November 1974, pp. 1404-1408.

The intensity of the electrostatic field at ground level due to transmission lines operating at 765, 1100, and 1500 kV have been calculated as a function of lateral distance under the line. These results showed that the maximum field varied from 15 to 20 kV/m. It was found that this field could be reduced significantly by interposing earth shield wires between the line conductors and earth; the intensities being most affected by the number of wires. It was also shown that a nonuniform distribution of these wires is essential to ensure maximum effectiveness. However, because these shield wires add nothing to the operating of lines, but will add to their cost, it is necessary to define values of fields that can be tolerated at ground level.

A. Ametani, "Stratified Earth Effects on Wave Propagation Frequency -Dependent Parameters," IEEE Transactions on Power Apparatus and Systems, vol. PAS-93, no. 5, September/October 1974, pp. 1233-1239.

Stratified earth effects on wave propagation are investigated using a three layer earth impedance with arbitrary earth resistivities, permeabilities, and permittivities. Significant differences are observed between homogeneous earth and stratifier earth cases. It appears to be necessary to account for the stratification of a real earth in the calculations of frequency-dependent parameters.

Anon, "Economic Optimization of Telecommunications Cable Sheathing," Kabel-Cables, (Switzerland), no. 2, 1974, pp. 13-18.

This paper is in French and German with an English translation of the title and abstract.

An algorithm for the optimization of the electromagnetic shielding of telecommunications cable sheathing is presented.

Anon, "Earthing System Devices," Electrical Equipment, (GB), vol. 13, no. 6, June 1974, pp. 30-31, 33, 35.

Since at some time or other most electrical installations will suffer, at least occasionally, from leakage currents, lightning strikes, static buildup or short circuits these abnormal conditions have to be catered for. This means that most systems have to have an effective and reliable earthing arrangement. Indeed it does not take long, reading accident investigation reports, to discover that the omission or failure of an earthing system can and has resulted in loss of supply for some lengthy periods, fire and subsequent equipment damage and even loss of life. Several devices for making earthing systems including the thermoweld electrical connection process are discussed.

P. B. Barker, E. M. Dembinski and R. C. Hughes, "Anti-Corona Shields for UHV Applications," CEGB Technical Disclosure Bulletin, (GB), no. 226, March 1974, pp. 1-2.

The invention concerns the use of lightweight shields, toroidal in shape, made basically of reinforced polymeric resin and metal sprayed, the object being to prevent corona discharges on equipment operating at ultra high voltage.

K. Berger, "Blitzforschung und Gebaeudeblitszchutz (Lightning Research and Lightning Protection of Buildings), Bulletin de l'Association Suisse des Electriciens, vol. 65, no. 26, December 28, 1974, pp. 1899-1902.

This paper is in German with an English translation of the title.

S. I. Bondarenko, S. S. Vinogradov, G. A. Gogadze, S. S. Perepelkin and V. I. Sheremet, "Shielding Properties of Superconducting Shields," Soviet Physics, Technical Physics, vol. 19, no. 6, December 1974, pp. 824-828.

An analysis is given of the theoretical magnetic shielding properties of a superconducting plane with an aperture. Numerous geometric configurations are analyzed. A comparison with experimental data is included.

H. S. Cabayan, G. O. Fitzpatrick and M. L. Robonson, "FM Response of Shielded Cables," 1974 International IEEE Antennas and Propagation Symposium, Atlanta, GA, June 10-12, 1974.

The results reported are for a braid-shielded coaxial cable with a single core conductor. The extension to a multi-conductor cable follows essentially the same procedure. A transmission line model is used to determine the currents on the surface of the exterior shield due to the external field excitation. The cable shield is assumed to be a solid cylinder above a perfectly conducting ground; it is loaded arbitrarily at both ends. The average electric and magnetic intensities at the outer surface of the cable shield can then be determined. The penetration of the electric and magnetic fields is described by means of capacitive and inductive coupling parameters, respectively. Once the distribution of excitation sources across the length of the interior of the cable is known, interior currents can be determined for arbitrary end loadings.

H. D. Campbell, "Transient Shielding Efficiencies of Ferromagnetic Cable Shields," Proceedings of the 13th 23rd International Wire and Cable Symposium, Atlantic City, N.J., December 3-5, 1974, pp. 226-238.

The use of ferromagnetic cable shields to minimize interference to communications cables is discussed. The shielding efficiencies are determined as functions of the interfering frequency and magnitude. Test circuit configurations are given.

U. V. Cesana, J. H. McNamara and I. J. Marwich, "A Superior Shielding System for Solid Dielectric Power Cables," 1974 Underground Transmission and Distribution Conference, Dallas, TX, April 1-5, 1974, pp. 490-498.

A performance analysis compares the relative merits of extruded semiconducting insulation shielding layers and thin semiconducting coatings, for characteristics such as stability under cyclic current loading, flexibility and handling, temperature coefficients of resistivity, thermal aging, moisture resistance and conformance with the insulation surface. Thus a value analysis of the power cables covered in this paper and their installation requirements clearly favors the thin polymeric semiconducting coatings. Methods of manufacture, material properties and components, procedures for splicing and terminating and cable design criteria are also described in this paper.

J. C. Chang, "Interim Report on the Study of Electromagnetic Inductive Interference from 11.4 kV Three Phase, Four Wire, Common-Neutral Multi-Grounded Power-Distribution System to Telecommunications Circuits," 1974 Electromagnetic Compatibility Symposium, IEEE, New York, 1974.

The problem of inductive coupling from power lines to telecommunications circuits is analyzed. It was recommended that telecommunications cables be shielded, that the metal sheaths be bonded at each joint of multi-cable routes, that the iron conduit be bonded to each manhole and that the sheath be grounded at one end. Plots of measured coupling are given.

A. K. Chizhov, "Shielding of a Magnetic Field by a Hard Superconductor," Soviet Physics, Technical Physics, (USA), vol. 18, no. 11, May 1974, pp. 1499-1503.

The magnetic shielding properties of superconducting shields are discussed. It is shown that there are two types of magnetic shielding. The first type invovles a complete compensation of the field by the surface currents and the second involves a partial compensation.

D. A. Conti and R. H. J. Cary, "Radome Obscurations and their Equivalent Sources," 12th Symposium on Electromagnetic Windows, Atlanta, GA, June 12-14, 1974, pp. 1-7.

An analytic technique of replacing an obscuration on a radome, for purposes of analysis, with a source having the same cross section whose local amplitude is equal and in phase opposition to that of the unperturbed incident field is presented. Different types of obscurations are analyzed.

A. N. Crespo, "Electromagnetic Shielding of Operating Theaters and Intensive Care Wards," IEEE Electrolatina (Mexico), vol. 8, no. 1, March 1974, pp. 9-16.

This paper is in Spanish with an English translation of the title and abstract.

Operating rooms and intensive therapy wards require electromagnetic shielding because of sensitive electronic equipment used. Mathematical models are proposed for the shielding problem. Solid metal and wire mesh are used for shielding and formulas for calculating their attenuation are given. Methods of estimating the cost of shielding are given.

F. Dawalibi and D. Mukhedkar, "Ground Electrode Resistance Measurements in Non-Uniform Soils," IEEE Transactions on Power Apparatus and Systems, vol. PAS-93, no. 1, January/February 1974, pp. 109-115.

Ground electrode resistance measurements are usually done by fall of potential method. The potential probe position (0.618 rule) has been calculated for homogeneous soil. Theoretical computation and experimental verification of the potential probe position in non-homogeneous soil is presented. The experimental work was carried out on a twin layer laboratory model.

H. W. Denny and J. A. Woody, "Considerations in the Design of a Grounding System for a Complex Electronic Facility," 1974 IEEE Electromagnetic Compatibility Sympsoium, IEEE, New York, 1974.

A description of four basic noise immunization techniques associated with signal grounding is given. A grounding philosophy which uses the best features of each of these immunization techniques is proposed. Which grounding technique is best depends on the frequency range of interest.

S. R. Freeman, "Earth Loop Testing and P.M.E. Systems," Electrical Times, (GB), no. 4301, October 10, 1974, p. 15.

Outlines the development of protective devices since 1930's. Discusses the importance of installing sensitive current balance trips. Questions some aspects of protetive multiple earthing; e.g., the hazards in the event of breakage of the neutral connection. Suggests that a regular test of p.m.e. installations with a line-earth tester is needed. Outlines the development of a universal tester with combined test facilities.

J. A. French, S. P. Kleczkowski, J. A. Kornfeld and M. Trynoski, "Conductive Gasket," IBM Technical Disclosure Bulletin, vol. 27, no. 5, October 1974, p. 1304.

The gasket is flexible, carbon filled silicone compound molded into a cover U-shape and fastened to one side of a cover or frame with clips or adhesive. When the gasket is squeezed between the cover and frame, electrical and mechanical contact occurs despite very low closure forces.

W. H. Furry, "Shielding of the Magnetic Field of a Slowly Moving Point Charge by a Conducting Surface," American Journal of Physics, vol. 42, no. 7, August 1974, pp. 649-667.

Solutions of the electromagnetic field equations are obtained for the magnetic field produced by a slowly moving charge on the opposite side of a conducting plane surface and also outside a conducting sphere.

K. Grohmann, H. D. Hahlbohm, H. Lubbig and H. Ramin, "Current Comparators with Superconducting Shields," Cryogenics, (GB), vol. 14, no. 9, September 1974, pp. 499-502.

It is shown that the iron cores of conventional current comparators may be replaced by superconducting shields. Their function is to transmit the magnetic field of the exciting ratio windings regardless of their position and shape to a detector winding. A toroidal shield system with two modificiations, a nested one and a helical one, has been combined with a SQUID to build up current comparators for d.c. and a.c. applications. The smallest d.c. error was found to be one half of one billionth. Finally, a practical example is given of the application of high precision cyrogenic current comparators.

A. P. Hale, "Electromagnetic Shielding as Applied to Defense Communications, Communications 74, Brighton, Sussex, England, June 4-7, 1974.

The requirements for electromagnetic shielding fall into three primary categories. Firstly, the establishment of a "quiet zone" for the alignment repair and measurement of sensitive equipment is needed where the presence of ambient radio signals would complicate and confuse the work in hand. The second requirement is the protection of operational communications equipment such as computers and similar digital equipment against the effects of high power signal sources, such as radar installations, which would otherwise cause malfunctioning of the protected equipment, the third case where shielding is normally employed is in the security field where it is frequently deemed advisable to protect computer installations, conference rooms, etc., against the possibility of eavesdropping.

W. Haubitzer, "Schirmwirk und Wirbelstromverluste Einer Leitenden Hohlkugel in Magentischen Wechselfeld (Shielding Effect and Eddy Current Losses of a Hollow Sphere in a Magnetic Alternating Field), Zeitschrift fur Elektrische Informatins - und Energietechnik, vol. 4, no. 2, 1974, pp. 97-104.

This paper is in German with an English translation of the title.

L. C. Hoots, S. A. Moorefield, J. R. Stahman and M. P. Amason, "Lightning Protection for Advanced Aircraft Radomes Based on the Segmented Lightning

Diverter Strip," 12th Symposium on Electromagnetic Windows, Atlanta, GA, June 12-14, 1974, pp. 138-143.

The use of segmented lightning diverters, both commercially available and a new developed high temperature strip, to protect aircraft radomes from lightning damage is discussed. Proper bonding techniques were developed and the performance of 300 degree and 600 degree radomes was evaluated. Simulated lightning tests were performed for a radome made of lightweight polyimide foam.

R. M. Huey and K. Rajaratnam, "Identification of Electrical Parameters in Large Earth Grids," IEEE Transactions on Power Apparatus and Systems, vol. PAS-93, no. 1, January/February 1974, pp. 187-195.

The conductors in the earthgrid of a large electric power station must withstand for the maximum fault duration, current due to the worst case unbalanced fault. The fault duration and the worst case fault current may be calculated by well-known means. However, the division of fault current when it is injected into the earth grid is difficult to determine with confidence. The authors describe a scale modeling experimental technique which can yield improved data on the division of fault return current within an earth grid.

C. Ionesch, "Transient Forces in Individually Screened Three Phase Conductor Systems," Revue Roumaine des Sciences Techniques, Serie Electrotechnique et Energetique, vol. 19, no. 3, 1974, pp. 397-427.

A method is suggested for the study of the transient operating conditions in systems of conductors, individually screened by thin, imperfectly conducting, circular cylindrical screens. The solving by the known methods of the equations of electromagnetic fields, leads to solutions to determine the magnetic field induction and the electromagnetic forces in the transient operating conditions, corresponding to various types of injuries. The conclusions experimentally verified, are that the advantage of a nearly perfect screening of phases that appears in the steadystate operating conditions in the case of such a screening, is equally maintained in transient operating conditions.

S. Karkkainen and V. Palva, "Application of Probability Calculations to the Study of the Earthing Voltage Requirements for Electrical Safety Codes," Sahko, (Finland), vol. 47, no. 11, November 1974, pp. 463-471.

This article is concerned with the determination of requirements related to earthing system voltage, these requirements being one of the main subjects under review in the new electrical safety code. For the first time this is performed with the aid of probability calculations. Various practical cases are classified in groups, the maximum permissible voltages of which are determined on the basis of accident probabilities of certain values. In the calculations, general stress-strength considerations are made use of. Hereby are taken into account the frequencies of occurrence of various danger situations as well as the calculated probabilities of being exposed to touch and pace voltages.

Diverter Strip," 12th Symposium on Electromagnetic Windows, Atlanta, GA, June 12-14, 1974, pp. 138-143.

The use of segmented lightning diverters, both commercially available and a new developed high temperature strip, to protect aircraft radomes from lightning damage is discussed. Proper bonding techniques were developed and the performance of 300 degree and 600 degree radomes was evaluated. Simulated lightning tests were performed for a radome made of lightweight polyimide foam.

R. M. Huey and K. Rajaratnam, "Identification of Electrical Parameters in Large Earth Grids," IEEE Transactions on Power Apparatus and Systems, vol. PAS-93, no. 1, January/February 1974, pp. 187-195.

The conductors in the earthgrid of a large electric power station must withstand for the maximum fault duration, current due to the worst case unbalanced fault. The fault duration and the worst case fault current may be calculated by well-known means. However, the division of fault current when it is injected into the earth grid is difficult to determine with confidence. The authors describe a scale modeling experimental technique which can yield improved data on the division of fault return current within an earth grid.

C. Ionesch, "Transient Forces in Individually Screened Three Phase Conductor Systems," Revue Roumaine des Sciences Techniques, Serie Electrotechnique et Energetique, vol. 19, no. 3, 1974, pp. 397-427.

A method is suggested for the study of the transient operating conditions in systems of conductors, individually screened by thin, imperfectly conducting, circular cylindrical screens. The solving by the known methods of the equations of electromagnetic fields, leads to solutions to determine the magnetic field induction and the electromagnetic forces in the transient operating conditions, corresponding to various types of injuries. The conclusions experimentally verified, are that the advantage of a nearly perfect screening of phases that appears in the steadystate operating conditions in the case of such a screening, is equally maintained in transient operating conditions.

S. Karkkainen and V. Palva, "Application of Probability Calculations to the Study of the Earthing Voltage Requirements for Electrical Safety Codes," Sahko, (Finland), vol. 47, no. 11, November 1974, pp. 463-471.

This article is concerned with the determination of requirements related to earthing system voltage, these requirements being one of the main subjects under review in the new electrical safety code. For the first time this is performed with the aid of probability calculations. Various practical cases are classified in groups, the maximum permissible voltages of which are determined on the basis of accident probabilities of certain values. In the calculations, general stress-strength considerations are made use of. Hereby are taken into account the frequencies of occurrence of various danger situations as well as the calculated probabilities of being exposed to touch and pace voltages.

long specimens using high currents with a uniform current distribution along the cable shield. Measurements were made in the frequency range 0.5 to 100 MHz. The method is offered as a standard technique for measuring the shielding effectiveness of shielded cables.

M. I. Kontorovich and V. P. Akimov, "Shielding Characteristics of a Spherical Grid," Radio Engineering and Physics, vol. 19, no. 1, January 1974, pp. 14-20.

The shielding characteristics of a spherical grid are examined by using the technique of averaging the boundary to determine the coefficient of penetration. The grid consists of thin conductors forming a system of meridians at equal angular spacings.

W. C. Kotheimer, "Shielding and Grounding Control Cables," Transmission and Distribution, vol. 26, no. 7, July 1974, pp. 52-55.

Two general sources for surges, aside from lightning, found in control circuits of switching stations are considered: switching phenomena on the high voltage system and switching on any of the low voltage systems in the station, including the control system itself. The subject of cable shielding is concerned chiefly with protection from surges outside the control circuit, the most severe being those originating on the high voltage system.

N. L. Kusters and M. P. MacMartin, "Guarded Double Insulation - A Technique for Reducing the Shock Hazards of Grounded Electrical Systems," Fifth Canadian Medical and Biological Engineering Conference, Montreal, Canada, September 3-6, 1974.

Describes a technique, making use of both guarding and double insulation, which reduces the shock hazard of electromedical apparatus. The technique is suitable for use in treatment areas where both the patient and the electrical supply system are connected to ground. The addition of a guarded, double-insulated power input circuit to each piece of electromedical equipment prevents current from flooding from the power source to the grounding circuit, and makes an equipotential ground possible in a patient area.

V. F. Laslo, Y. G. Samoilov and G. N. Tsitsikyan, "Induced Currents in Electrically Coupled Screens of Charge Conductors," Electric Technology USSR, (GB), no. 1, 1974, pp. 99-107.

Proposes a method for evaluating contour currents induced in electrically coupled screens of conductors which are screened phase to phase. An estimate of compensation is made to offset overheating at very large power stations.

P. J. Leblanc, "Engineering Structural Foam Resins - Electromagnetic Shielding of GE Engineering Structural Foam," 17th Annual Convention of the Society of Vacuum Coaters, Detroit, Michigan, May 1-2,1974, pp. 37-40.

Not available.

M. A. Martin, "Normal and Short Circuit Operating Characteristics of Metallic Shielding Solid Dielectric Power Cable," IEEE Transactions on Power Apparatus and Systems, vol. PAS-93, no. 2, March-April 1974, pp. 601-613.

This article includes test data on thermal runs of single conductor shielded power cable under typical installation conditions which confirm published ampacity data, and hence the theoretical procedure employed for calculating the ampacity of single conductor cable with circulating current losses. Simulated fault tests conducted in the field at typically high currents and with circuit breaker reclosures provide data on the performance of various types shields on solid dielectric power cable under line to ground fault conditions. The fault current capability of various type metallic shields has been determined by laboratory tests. Laboratory tests data on a new design metallic shield, type LC, are presented.

L. B. McClung and B. W. Whittington, "Ground Fault Tests on a High Resistance Grounded 13.8 kV Electrical Distribution System of a Modern Large Chemical Plant (Arcing)," IEEE Transactions on Industry Applications, vol. IA-10, no. 5, September/October 1974, pp. 601-617.

Actual ground fault tests were conducted to determine the behavior of low magnitude arcing ground faults in a closed air-filled 13.8 kV terminal chamber. Ground current magnitudes between 10 and 50A were allowed to flow under various ground fault conditions. At higher ground fault current levels the ionization of the air-filled chamber progesses at a rapid rate, and the arc is sustained or phase to phase faulting quickly occurs. The practical consideration appears to be that if ground fault current can be limited to 10A or less then initial ground faults will either clear themselves to create solid ground paths. This can allow the system to operate until an orderly shutdown procedure can be initiated.

W. Meier, "An Earth Fault Monitor for 'Floating' Control Systems," Siemens Review, (Germany), vol. 41, no. 5, May 1974, pp. 233-236.

Floating systems are becoming more and more popular in the electronic control field. However, such systems cannot operate reliably unless an earth fault monitor is installed to monitor them for earth faults and if necessary, give immediate warning of such faults. The earth fault monitor EA-2 operates on the principle of differential current measurement. The monitor, which is connected to earth via a high resistance, sends out a pulsating search current, which produces a voltage drop across a resistor, the magnitude of the voltage drop varying with the magnitude of the earth-fault resistance.

long specimens using high currents with a uniform current distribution along the cable shield. Measurements were made in the frequency range 0.5 to 100 MHz. The method is offered as a standard technique for measuring the shielding effectiveness of shielded cables.

M. I. Kontorovich and V. P. Akimov, "Shielding Characteristics of a Spherical Grid," Radio Engineering and Physics, vol. 19, no. 1, January 1974, pp. 14-20.

The shielding characteristics of a spherical grid are examined by using the technique of averaging the boundary to determine the coefficient of penetration. The grid consists of thin conductors forming a system of meridians at equal angular spacings.

W. C. Kotheimer, "Shielding and Grounding Control Cables," Transmission and Distribution, vol. 26, no. 7, July 1974, pp. 52-55.

Two general sources for surges, aside from lightning, found in control circuits of switching stations are considered: switching phenomena on the high voltage system and switching on any of the low voltage systems in the station, including the control system itself. The subject of cable shielding is concerned chiefly with protection from surges outside the control circuit, the most severe being those originating on the high voltage system.

N. L. Kusters and M. P. MacMartin, "Guarded Double Insulation - A Technique for Reducing the Shock Hazards of Grounded Electrical Systems," Fifth Canadian Medical and Biological Engineering Conference, Montreal, Canada, September 3-6, 1974.

Describes a technique, making use of both guarding and double insulation, which reduces the shock hazard of electromedical apparatus. The technique is suitable for use in treatment areas where both the patient and the electrical supply system are connected to ground. The addition of a guarded, double-insulated power input circuit to each piece of electromedical equipment prevents current from flooding from the power source to the grounding circuit, and makes an equipotential ground possible in a patient area.

V. F. Laslo, Y. G. Samoilov and G. N. Tsitsikyan, "Induced Currents in Electrically Coupled Screens of Charge Conductors," Electric Technology USSR, (GB), no. 1, 1974, pp. 99-107.

Proposes a method for evaluating contour currents induced in electrically coupled screens of conductors which are screened phase to phase. An estimate of compensation is made to offset overheating at very large power stations.

R. J. Provencal, "The Role of Premolded Connector Shield in the Cable Shielding Circuit," 1974 Underground Transmission and Distribution Conference, Dallas, TX, April 1-5, 1974, pp. 241-246.

The reason for the cable shielding circuit problem followed by a review of the properties of cable shields and premodeled connector shields will be the primary concern of this paper. Suggested methods of selecting cable shields and interconnecting shield to premolded connector shields, other cable shields, and ground electrodes are presented. Finally, case histories of systems in which cable shielding circuits were improperly designed are included.

D. L. Reinhard, "Metallic Coatings for Electromagnetic Shielding," 17th Annual Convention of the Society of Vacuum Coaters, Detroit, Michigan, May 1-2, 1974, pp. 33-36.

Not available.

H. M. Ryan and J. Whiskard, "Recent Studies in the Clothier Laboratory," Reyrolle Parsons Review, (GB), vol. 2, no. 2, Winter 1974-1975.

Recent high voltage research at the Clothier Laboratory is discussed. Included is aircraft lightning strike studies. The time period covered is from 1970 to 1974.

R. J. Quellette, "Ground Shielded Current and Potential Transformers that Answer the Need for Underground-Primary Metering Applications," 1974 Underground Transmission and Distribution Conference, Dallas, TX, April 1-5, 1974, pp. 375-377.

As the industry's need for primary metering of underground services develops, a need is emerging for ground-shielded dry-type metering transformers designed for padmounting in an enclosure as individual components with the capability of mating with loadbreak and nonloadbreak cable terminations.

M. B. Raber, "Grounding Circuits - Methods of Measurement and Effectiveness," Fifth Canadian Medical and Biological Engineering Conference, Montreal, Canada, September 3-6, 1974.

It is becoming common to measure resistance or continuity of grounding circuits by impressing a high current on the circuit. It is not generally appreciated that if the circuit is wholly or partially within steel conduit, the resistance so measured is dependent upon the circuit path. Experimental results show why a local equipotential grounding system appears safer than ordinary conduit grounding, thought it may be less effective in fault current return. Implications for patient care areas are discussed.

A. A. Regotti and H. W. Wargo, "Groundfault Protection and Detection for Industrial and Commercial Distribution Systems," Westinghouse Engineer, vol. 34, no. 3, July 1974, pp. 80-83.

Deals with the characteristics of grounded and ungrounded distribution systems when phase-to-ground faults occur. Since those are the most common faults in distribution systems, they should have a major role (along with economic considerations) in determining the kind and amount of fault protection equipment to include in a system.

A. A. Regotti and H. W. Wargo, "Grounding for Industrial and Commercial Distribution Systems," Westinghouse Engineer, vol. 34, no. 2, April 1974, pp. 41-45.

Phase to ground faults are the most common kind in distribution systems. Therefore, the kind of system grounding used (if any) and the ground-fault protection applied are important. They should be carefully chosen to fit the particular application.

C. E. Straham, III, "Solid-State Microwave Equipment Protected from Lightning," Oil and Gas Journal, vol. 72, no. 23, June 10, 1974, pp. 68-70.

The protection of microwave repeaters from lightning damage is discussed. Proper grounding and bonding techniques are discussed. It is recommended that the tower be grounded with a ground rod at each guy wire. Extensive use of bonding is recommended. The use of diode devices for lightning protection is also discussed.

T. Toshima and I. Nishi, "Analysis of Operation of a Transformer with Electrostatic Shielding," Review of the Electrical Communications Laboratory, (Japan), vol. 22, no. 7-8, July-August 1974, pp. 663-673.

Operational characteristics of a transformer with arbitrary winding ratio and electrostatic shielding are analyzed by introducing the parallel multi-wire model and applying the distributed constant theory. From calculated results, it is clarified that the real part of the input impedance characteristics can be adjusted by modifying the secondary winding structure and the imaginary part can be adjusted by modifying the primary structure. By using this input impedance adjusting method, it is possible to build practical shielded transformers that operate quite satisfactorily over a wide frequency range. The experimental data are closely coincident with calculated results.

S. B. Torrence, "Cable Reel Speeds Truck Grounding, Increases Safety," Electrical World, vol. 181, no. 7, April 1, 1974, pp. 90-91.

A reel for speeding up the handling of grounding cable that is required for safety grounding of a construction vehicle has been developed through the

coordinated efforts of the Upper Cumberland Electric Membership Corp., Carthage TN, and Kearney International, Inc., Chicago, Ill. The reel simplifies the grounding assignment, and thus encourages compliance by crew members with all OSHA rules. The grounding reel reduces the time required to set up safety grounding conditions at each work location. It eliminates labor and material costs formerly required for frequent replacement of grounding cables that were damaged whey they were laid randomly across the mud and rock of the work site. Also it saves as much as an hour a day for a crew, and therefore will save its original cost in a short time.

R. K. Traeger, H. C. Olson and L. J. Allen, "Development of a Lightning Arrestor Connector," IEEE 1974 Electronic Components Conference, Washington, D.C., May 13-15, 1974, pp. 65-75.

The development of a lightning arrestor connector for use in missiles and aircraft is reported. An LJT connector is used with an air breakdown providing the arresting mechanism. This arrestor was tested at current levels of 200 kA and will limit induced voltages to less than 2,000 volts.

R. D. Vance, "Shape Foil into a Magnetic Shield with Scissors," Electronic Design, vol. 22, no. 18, September 1, 1974, pp. 86-89.

A proposed solution to many common magnetic shielding problems is given which requires only a pair of scissors and a sheet of magnetic foil. Formulas are given for the number of layers required and the thickness of the shield. The foil is then unwrapped around the structure and measurements taken to determine whether refinements are required.

W. Vogl, "Estimation of the Shielding Effect of Practical Sheaths with the Aid of Physical Equivalent Circuit Diagrams," 1974 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1974.

A method of calculating the electromagnetic shielding provided by a cable sheath is presented. A circuits approach is used rather than a field theory approach. No results are plotted.

R. B. West, "Equipment Grounding for Reliable Ground-Fault Protection in Electrical Systems Below 600 V," IEEE Transactions on Industry Applications, vol. IA-10, no. 2, March/April 1974, pp. 175-183.

This paper is identical to the 1973 publication.

E. E. Wick, "Electromagnetic Compatibility Considerations in System Integration," Proceeding of the IEEE 1974 National Aerospace and Electronics Conference, Dayton, Ohio, May 13-15, 1974, pp. 317-324.

Among the integrated EMC system requirements discussed is the lightning protection of aircraft.

A. Wright, "Earthproving for Portable Plant," Electrical Times, (GB), no. 4291, July 25, 1974, p. 12.

Examines the main requirements of protection of portable and transportable equipment and illustrates how, typically, it is achieved in practice. A typical earth proving unit connected to a portable appliance which monitors impedance of the earth loop and disconnects the appliance should this impedance exceed a predetermined value is described. It also rapidly disconnects the appliance should an earth fault appear. The main advantage of this protection is that it does not depend upon sensing current flowing through an operator in contact with the appliance.

P. G. Wright, "Using the Structure's Reinforcing Steel as an Electrical Earth," New Zealand Engineering, (New Zealand), vol. 29, no. 1, January 15, 1974, pp. 15-20.

This paper summarizes the earthing requirements for electrical and lightning protection purposes and describes the still little known method, as titled, which consistently achieves better results than conventional methods. It details the application to a major building complex, compares theoretical and measured results, and relates aspects applicable to prestressing steels. It recommends that this method be published and incorporated into the Electrical Wiring Regulations as an optional approved method.

T. Wu and L. Tsai, "Shielding Properties of Thick Conducting Cylindrical Shells," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-16, no. 4, November 1974, pp. 201-204.

The shielding properties of a thick cylindrical shell of finite conductivity is presented. The analysis uses straightforward separation of variables methods via cylindrical harmonic functions. The results show that significant attenuation of the incident fields are achieved for thick cylindrical shields thus demonstrating that the resonances noted in earlier work using thin shell models can be alleviated.

A. I. Yakobs and P. I. Petrov, "On Allowing for the 'Longitudinal' Impedance of Horizontal Elements in Large Earthings," Electric Technology USSR, (GB), no. 1, 1974, pp. 9-22.

The use of extra high voltage (500 kV or more) for power transmission has led to considerable changes in some of the parameters of transformer substations (surface area, earth fault current, etc.) which have a great influence on earthing design. Widespread use is now made of reinforced-concrete structures which can be used as natural earthings. A limit is found to the equipotential assumption in the analysis of complex earthing grids. It is shown that the induced potential algorithm can lead to 50 percent error or more. A new model is proposed which

allows for distributed parameters on horizontal elements in calculating electric characteristics of complex earthings.

O. W. Zastrow, "Electrical Grounding Design for Safety and Corrosion Control," West Virginia University Experiment Station Bulletin, no. 113, 1974.

Not available.

1975

V. E. Acuna, "Transfer Impedance Measurement as a Test of Electromagnetic Compatibility," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

The determination of the shielding parameters of EMI gaskets is made experimentally due to the prohibitively difficult associated theoretical problem. Different configurations of electromagnetic fields and their effects on coaxial cables are analyzed in this paper. The use of the transfer impedance of an EMI gasket as a measure of the shielding effectiveness is proposed.

Y. I. Aleksakhin, N. Y. Kazarinov and E. A. Perel'shtein, "Shielding of Quasistationary Magnetic Fields by Thin Metal Plates," Soviet Physics Technical Physics, vol. 20, no. 5, 1975, pp. 590-595.

A description of a method for the analysis of the magnetic shielding properties of thin metal plates is given. The magnetic vector potential is expressed in terms of Green's function and used to solve the electromagnetic field problem. Plots of the coupled magnetic field are given.

A. Alric, "General Installation, Bonding Requirements and Techniques," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The necessity of proper electrical bonding on aircraft is emphasized and secondary values for both the primary and secondary bond are given for various types. A description of bonding techniques for structures, pipes and accessories is given.

M. P. Amason, G. J. Cassel and J. T. Kung, "Aircraft Application of Segmented-Strip Lightning Protection Systems," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The use of segmented lightning strip diverters to protect radome installations from lightning is discussed. These diverters were found to be transparent to most of the sophisticated antenna and radar systems enclosed by the radomes. Laboratory test data is included.

R. B. Anderson and H. Kroninger, "Lightning Phenomena in the Aerospace Environment. II. Lightning Strikes to Aircraft," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Statistics on lighting strikes to aircraft are presented for the period 1948-1975. The altitude of the aircraft and the amount of damage are reported.

R. B. Anderson and H. Kroninger, "Lightning Phenomena in the Aerospace Environment II. Lightning Strikes to Aircraft," Transactions of the South African Institute of Electrical Engineers, (South Africa), vol. 66, pt. 8, August 1975, pp. 172-175.

Lightning strikes to aircraft occur when ascending or descending through or near clouds. While cruising at an altitude of 10 kilometers or greater, there is little danger of a lightning strike to an aircraft. This paper details lightning damage to aircraft accumulated over a 26 year period by South African Airways. Lightning strike probabilities ranged from 1.8 to 3.5 per 1000 hours of flying time. Damage to the aircraft instruments or frame occurred in 40 percent of the lightning strikes.

R. J. Auburn, "Development of Requirements for Aircraft Fuel Tank Explosion Prevention," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Some examples of aircraft fueltank ignition caused by lightning are given. A fire protection system is recommended which uses nitrogen inerting and a polyurethane foam tank filler for flame arresting.

D. R. Awerkamp, "Radiated Field Strength Method for Measurement of the RF Shielding Characteristics of EMI Gaskets," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

The advantages and disadvantages of using the radiated field strength measurement technique to determine the shielding effectivenes of gaskets are discussed. No comparisons are made with the conducted or transfer impedance techniques.

K. Berger, "Development and Properties of Positive Lightning Flashes at Mount S. Salvatore with a Short View to the Problem of Aviation Protection," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Lightning data measured at Mount San Salvatore is presented. Six different types of flashes are defined and illustrated with current oscillograms of the positive downward flashes.

R. Boll and H. Keller, "Flexible Tubing for Magnetic Shielding," Siemens Review, vol. 42, no. 8, August 1975, p. 366.

The development of a flexible tubing for magnetic shielding of cables is described. A plot of the shielding factor of this flexible tubing as a function of frequency is given for the frequency range 10 Hz to 100 kHz.

S. I. Bondarenko and V. I. Sheremet, "Superconducting Magnetic Shields," Soviet Physics, Technical Physics, vol. 19, no. 7, January 1975, pp. 952-955.

The magnetic shielding effectiveness of superconducting shields was experimentally determined. These shields may be open or closed at the ends. Magnetic fields were lowered from one thousandth to 350 Oersteds to less than three millionths of an Oersted in a volume of 0.6 liters.

S. I. Bondarenko, V. I. Sheremet, S. S. Vinogradov and V. V. Ryabonol, "Multilayer Superconducting Shield," Soviet Physics - Technical Physics, vol. 20, no. 1, July 1975, pp. 73-76.

The magnetic shielding of an enclosure of volume 400 cubic centimeters is discussed. Three coaxial superconducting lead shells are used as the magnetic shield. The residual magnetic field was 3 billionths of an Oersted.

A. Brandolini, "A Study on Electrical Grounding Models for Impulse Currents and Comparative Tests with Differently Shaped Electrodes," Elettrotecnica, (Italy), vol. 62, no. 10, October 1975, pp. 885-896.

This paper is in Italian with an English translation of the title and abstract.

The use of grounding to protect electrical power systems from damage by impulsive currents, such as lightning, is discussed. Experimental results are presented for various electrode shapes in an attempt to determine the optimum electrode shape.

A. P. Brokaw, "Designing Sensitive Circuits? Don't Take Grounds for Granted," EDN, vol. 20, no. 18, October 5, 1975, pp. 44-50.

This is an op-amp user's guide which discussed the proper grounding procedures to use with op-amps. The most common ground mistakes are caused by the assumption that all ground points in a network are at the same potential.

B. J. C. Burrows, "Induced Voltages, Measurement Techniques and Typical Values," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Voltages induced by lightning in aircraft circuits are reported. Both theoretical models and experimentally measured data are included.

C. L. Chen, "Transient Protection Devices," 1975 IEEE Electromagnetic Compatibility Symposium Record, IEEE, New York, 1975.

The operation and characteristics of several transient protectors, viz. glow lamps, spark gaps, avalanche diodes and varistors, are reviewed and compared. Particular emphasis is placed on the protection of low-voltage solid-state components from high voltage or current transients. This is a hardware paper dealing with device characteristics.

D. W. Clifford, "Scale Model Lightning Attach Point Testing," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

This paper deals with lightning strikes to aircraft. The value of using attack point tests on scale models to determine probable lihgtning attach points and swept stroke lightning zones on aircraft is discussed. Considered in the analysis are the size, accuracy and construction of the scale model, air gap spacing, electrode geometry and polarity, number of strikes at each position, high voltage waveshape and the effect of grounding the model. The data obtained was found to be similar to lightning strike distributions encountered in actual flights.

D. A. Conti and R. H. J. Cary, "Radome Protection Techniques," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The protection of radomes from lightning is discussed. If a radome is completely shielded from lightning by enclosing it in a metal cage, the radar system performance is severly degraded. Compromises that are required are discussed.

R. B. Cowdell, "Coupling Model Programs for the HP65," 1975 IEEE Electromagnetic Compatibility Symposium Record, IEEE, New York, 1975.

A summary of the computing power of the Hewlett Packard 65 calculator is given. Sample programs, written for the HP65 calculator shielding problems are included. This paper is just an application note for this model calculator.

F. Dawalibi and D. Mukhedkar, "Optimum Design of Substation Grounding in a Two Layer Earth Structure. Part I - Analytical Study," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 2, March/April 1975, pp. 252-261.

This is the first of a series of three papers dealing with grounding systems for substations.

A numerical algorithm for the calcultion of the ground voltage and resistance for any complex electrode in a two layer earth structure is given. Plots of the ground voltage are given.

F. Dawalibi and D. Mukhedkar, "Optimum Design of Substation Grounding in a Two Layer Earth Structure. Part II - Comparison between Theoretical and Experimental Results," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 2, March/April 1975, pp. 262-266.

This is the second in a series of three papers dealing with grounding systems for substations.

Experimentally measured ground voltage and resistances are plotted. These are compared to those calculated in Part I in this sequence of three papers.

F. Dawalibi and D. Mukhedkar, "Optimum Design of Substation Grounding in a Two Layer Earth Structure. Part III - Study of Grounding Grids Performance and New Electrodes Configuration," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 2, March/April 1975, pp. 267-272.

This is the third in a series of three papers dealing with grounding systems for substations.

A discussion of the significance of the authors first two papers when practical grounding rods are used and a comparison of grounding grids with other types of electrodes are given.

V. R. Ditton, "Coupling to Aerospace Cables at Microwave Frequencies," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

At high frequencies, the RF coupling problem is divided into two parts: effective aperture and shielding effectiveness. The coupled in power is proportional to the product of the effective aperture and the shielding effectiveness. In the 1 to 10 GHz range, the MIL-STD-1377 technique is used to measure the shielding effectiveness. This technique compares favorably with anechoic chamber techniques. Graphical results for the cumulative probability density function of the received power are given.

T. H. Dodds and H. E. Spindle, "Grounding of Gas Insulated Substations," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 4, July/August 1975, pp. 1183-1191.

The special problems involved in grounding gas insulated substations are discussed. The outer sheath of high voltage cables must be grounded. The potential difference between the outer sheath voltage to the station ground is used to determine the maximum distance between grounding points required for personnel safety.

F. A. Fisher and K. J. Maxwell, "Aperture and Diffusion Computer Programs for Prediction of Lightning Induced Voltages," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

This paper describes two computer programs for the calculation of the electromagnetic fields coupled into an aircraft by a lightning strike. One program analyzes coupling through apertures on the aircraft structure and the other analyzes coupling through the skin of the aircraft. The programs are user oriented and do not require an understanding of the coupling mechanism.

C. Gary, A. Cinador and R. Fieux, "La Foudre: Etude du Phenomene -Application a la Protection des Lignes de Transport - 1. (Lightning: Study of the Phenomenon, Application to the Protection of Power Transmission Lines)," Revue Generale de l'Electricte, vol. 84, no. 1, January 1975, pp. 24-34.

This paper is in French with an English translation of the title.

This paper is the first in a sequence of three papers. The nature of lightning is discussed and a lightning frequency map of France is given. The protection of power lines from lightning is discussed.

C. Gary, A. Cinador and R. Fieux, "La Foudre: Etude du Phenomene -Application a la Protection des Lignes de Transport - 2. (Lightning: Study of the Phenomenon, Application to the Protection of Power Transmission Lines)," Revue Generale de l'Electricte, vol. 84, no. 1, January 1975, pp. 35-43.

This paper is in French with an English translation of the title.

This paper is the second in a sequence of three papers. The protection of high voltage power lines from lightning is discussed.

C. Gary, A. Cinador and R. Fieux, "La Foudre: Etude du Phenomene -Application a la Protection des Lignes de Transport - 3. (Lightning: Study of the Phenomenon, Application to the Protection of Power Transmission Lines)," Revue Generale de l'Electricte, vol. 84, no. 1, January 1975, pp. 44-62.

This paper is in French with an English translation of the title.

This paper is the third in a sequence of three papers. The results of lightning on an experimental line of a few spans is decsribed. Lightning was induced by firing a rocket at overhead clouds (cumlo nimbus) with a conducting wire behind it. The tower was selected to be 24 meters high and was grounded with stranded copper. Oscillograms of lightning induced currents are given.

C. J. Hanover, "Electromagnetic Compatibility Assurance Tests for Airborne Systems Controls in an RF-Polluted Environment," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

Provides a checklist for the design of systems with good electromagnetic compatibility characteristics. The importance of grounding, bonding and shielding the equipment is emphasized.

A. W. Hanson, "Techniques of Strike Tests on Structures, Components and Materials," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Methods of generating lightning tests waveforms are discussed. Diagrams of the test instrumentation are given.

D. J. Hatch and M. M. B. Raber, "Grounding and Safety," IEEE Transactions on Biomedical Engineering, vol. BME-22, no. 1, January 1975, pp. 62-65.

Several basic facts about the effects of steel conduits in a.c. power systems are reviewed to show that the geometry of a grounding path may have a greater impact on its effectiveness as a ground return path than its d.c. resistance. Data are presented on the effect of 1/2" E.M.T. conduit and No. 10 conductors in tests simulating regular room wiring under ground fault conditions. It is shown that an internal grounding conductor tied to the conduit produces the lowest practical limit to votlage differences in the ground circuit; additional grounding paths external to the conduit make little appreciable difference to the voltage rise due to a fault current. A separate grounding conductor external to the conduit, when used by itself, produces a much larger voltage rise than the conduit system.

R. D. Hill, "Lightning Research," Naval Research Reviews, vol. 28, no 10, October 1-14, 1975.

A review is presented of recent research into the nature of the lightning channel. The interaction of lightning and aircraft is included. A discussion of ball lightning is included.

H. H. Hoshiko, "Helical Channel Multiplier Package Design for Space Instrumentation," Review of Scientific Instruments, (USA), vol. 46, no. 3, March 1975, pp. 331-332.

A housing for space instrumentation is described which provides magnetic shielding up to 150 Gauss.

G. K. Huddleston, G. G. Bush, "Lightning Protection for Status and Control Lines of the Mark III Instrument Landing System," 1975 IEEE Electromagnetic Compatibility Symposium Record, IEEE, New York, 1975.

The lightning and electromagnetic pulse protection requirements of the Mark III Instrument Landing System are the subject of this paper. There are approximately two hundred points that are susceptible to damage by lightning or electromagnetic pulse induced transients in this system.

The worst case surge, which accurately models 99.8% of all lightning induced surges, has a peak value of 1000 volts, a rise time of 10 microseconds and a decay time to half value of 1000 microseconds. The status and control circuitry's transistor switches, relays and dc power supplies are protected by avalanche diodes, which limit the peak voltage, and series resistors, which limit the peak current. Additionally, the dc power supplies are protected by fuses.

T. Horvath, "Gleichnaessige Sicherheitt zur Bemessung vol Blitzschutzanlagen (Uniform Safety in Designing Lightning Protection Installations)," Elektrotechnische Zeitschrift. Ausgabe B: Der Elektrotechniker, vol. 27, no. 19, September 26, 1975, pp. 526-528.

This paper is in German with an English translation of the title.

IEEE, "Bibliography of Publications Pertaining to Lightning Protection," IEEE Transactions on Power Apparatus and Systems, vol PAS-94, no. 4, July/August 1975, pp. 1241-1247.

A total of 187 papers are included in ths bibliography. The time period is prior to 1970.

E. B. Joy, L. E. Corey, "The Use of Lightning to Measure the Electromagnetic Penetration of Large Structures," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

This paper describes a novel technique for measuring the electromagnetic shielding effectiveness of physically large structures. Naturally occuring lightning is used as a source of plane waves to illuminate the structure under test. A single lightning stroke is modeled as a line of current extending from a cloud to ground. The use of this technique to determine the shielding effectiveness of a communications conduit is summarized.

H. Kaden, "Shielding Effect of Axial Metal Strips on the Magnetic and Electric Fields of a Single-Wire Line," Siemens Forschungs-und Entwicklungsberichte Research and Development Reports, vol. 4, no. 3, 1975, pp. 132-136.

The magnetostatic shielding; by a high permeability metal stip of the magnetic field of a single wire line and the electromagnetic shielding by a metal strip, of the magnetic field of a single wire line at high radio frequencies are analyzed. The technique of conformal transformations is used to solve the relevant field equations. Plots of the shield factor are given.

C. M. Kendall, "Measuring EMI Gasket Performance," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

The parameters affecting the shielding effectiveness of EMI gaskets are listed. The use of the gasket transfer impedance as a measure of quality control is proposed. The difficulty of establishing a correlation between gasket transfer impedance and shielding effectiveness is discussed.

E. S. Kesney, "Shielded Enclosures for EMC and Tempest Testing," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

A typical shielded enclosure used for Tempest testing is described. A bolted type light gauge steel system was found to be adequate in the 14 kHz to 20 GH range. For lower frequencies, the metal thickness may be increased to 11 gauge.

A. Kirkeby, "Some EMC Problems in Hospitals," Electromagnetic Compatibility 1975, Montreux, Switzerland, May 20-22, 1975, pp. 255-260.

Bioelectrical measurements are often degraded by fields generated by the mains wiring in a hospital. This paper discussed the need for and methods of low frequency electric and magnetic shielding. The use of metal screens and grounding techniques are included.

H. Knoller and J. A. Plumer, "S-3A Lightning Protection - Lightning Effects Analysis," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

An analysis of the lightning protection system of the S-3A antisubmarine warfare aircraft is given. The results of lightning simulation tests are presented for varied test conditions.

G. M. Kundel, "Introduction to Shielding of Electromagnetic Fields and the Application to EMI/RFI Gaskets," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

A brief review of electromagnetic theory is given. The importance of shielding from plane waves and magnetic field is emphasized. The use of gaskets to enhance cabinet shielding is discussed.

S. I. Kurenev and R. S. Karyakina, "Screening of Magnetic Field by Closed Shells," Izvestiya Vysshikh Uchebynykh Zavedenii, Electromekhanika, (USSR), no. 9, September 1975, pp. 911-915.

This paper is in Russian with an English translation of the title and abstract.

The magnetic shielding effectiveness of a complex configuration of closed shells is analyzed. The ratio of the magnetic scalar potential inside the screened enclosure to the magnetic scalar potential outside is calculated. A solution involving spatial harmonics, which does not require a solution of the boundary value problem, is obtained.

N. Lamb, "Electrical Phenomena Observed at Night in the Tropics from a Hercules Aircraft," Meterological Magazine, (GB), vol. 104, no. 1231, February 1975, pp. 56-57.

A report is made of intense electrical discharges that occurred on an aircraft's external instrumentation. It was surmised that these discharges were caused by lightning.

R. W. Lamp, "Guide to Spraying Plastics with Electrically Conductive Paints," Plastics Engineering, (USA), vol. 31, no. 6, June 1975, pp. 43-47.

The use of electrically conductive paints to provide structural foam with electrical grounding and electromagnetic shielding is discussed. The quality control and design testing of these paints are considered.

S. L. Larsen and D. E. Nordell, "The Measurement of Substation Ground Resistance and its Use in Determining Protection for Metallic Communications Circuits," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 5, September/October 1975, pp. 1606-1673.

A development of the characteristics of various grounding grids for power substations is given. A new measuring technique for determining the impedance of interconnected ground grids is described. Plots of the measured impedances are given.

J. D. Lee, "MIL-STD-1377 vs. MIL-STD-285 Microwave Shielding Effectiveness Measurements," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

The merits of the shielding effectiveness measuring techiques MIL-STD-1377 and MIL-STD-285 are discussed. MIL-STD-1377 is shown to be superior to MIL-STD-285. The shielding effectiveness of entire structures may be obtained with a smaller test cabinet without elaborate mounting provisions and the results are

independent of the size of the test antenna. The shielding effectiveness values found by MIL-STD-1377 are generally lower than those by MIL-STD-285.

M. Leonard, "The Clampdown on Electrical Hazards," Machine Design, vol. 47, no. 1, January 9, 1975, pp. 100-105.

Current levels that are hazardous to humans are discussed. OSHA safety standards are summarized. The human body was modeled as a 500 ohm resistor between the extremities. The practice of grounding a metal housing of a product to protect personnel is explained. Ground faults and ground fault interrupters are described.

S. Y. Liao, "Design of a Gold Film on a Glass Substrate for Maximum Light Transmittance and RF Shielding Effectiveness," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

Both analytic and experimental results are presented on the RF shielding effectiveness produced in the far field by a gold film in the frequency range of 100 MHz to 30 GHz. The RF shielding effectiveness is found to be about 19 db.

H. Linck, "Shielding of Modern Substations Against Direct Lightning Strokes," IEEE Transactions on Power Apparatus and Systems, vol. PAS-74, no. 5, September/October 1975, pp. 1674-1679.

An analytical model of the power substation shielding problem is given. The shielding failure risk was defined as the mean years per shielding failure and plots of this parameter are given.

E. A. Lindgren, "Demountable RF Shielded Enclosures," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

Single shield and double shield solid metal and wire mesh enclosures are discussed. Experimental results of the shielding effectiveness of single and double copper mesh screens are given.

P. J. Madle, "Cable and Connector Shielding Attenuation and Transfer Impedance Measurements Using Quadraxial and Quantaxial Test Methods," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

The shielding attenuation, transfer impedance and shielding effectiveness of an assembly of shielded cables and connectors is analyzed. The interdependence of these shielding criterion is discussed. Plots of the shielding attenuation of various coaxial cables as a function of frequency are given.

I. Marongiu, "Metodo di Calcolo Semplificato della Resistenza di Terra di un Sistema di Dispersori Molteplici Parallelo (Simplified Computation Method for the Determination of Resistance in a Ground Electrode System)," Elettrotecnica, vol. 62, no. 11, November 1975, pp. 993-1002.

This paper is in Italian with an English translation of the title.

An algorithm is developed for determining the impedance of a grounded electrode system. Formulae for earth voltages are given. Results are presented in tabular and graphical form.

K. J. Maxwell, "Prediction of Lightning-Induced Voltages in Aircraft Electrical Circuits," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1975.

Analytic techniques for determining the electric and magnetic fields induced in aircraft electrical circuitry by direct or nearby lightning strokes are discussed. Electromagnetic fields may penetrate an aircraft through an aperture such as a radome or canopy, or by direct diffusion through the skin. Only elliptically shaped apertures were considered. Electrical equivalent circuits of an airplane structure were developed to model the diffusion penetration mechanism. An experiment was performed to determine the voltage induced in leads inside a shielded copper box. It was found that resistive voltages predominate over magnetically induced voltages.

H. Neuhaus, "Ventilableiter und Trennfunkenstrecken im Blitzschultz (Value-Type Arrester and Spark Gap Separation in Lightning Protection)," Elektrotechnische Zeitschrift. Ausgabe B: Der Elektrotechniker, vol. 27, no. 3, November 7, 1975, pp. 623-628.

This paper is in German with an English translation of the title.

E. W. Neumann and R. A. Toomey, "Conductive Gasket," IBM Technical Disclosure Bulletin, (USA), vol. 17, no. 9, February 1975, p. 2712.

The development of a conductive gasket for electromagnetic shielding is reported. This gasket is made by coating a layer of conductive rubber onto a cloth covered gasket. It is used to make electrical contact between machine doors and frame.

F. J. Nichols, "Facts and Myths," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York.

The author states what, in his opinion, are the myths and facts regarding shielded rooms. The importance of a single or double shield and the selection of the shielding materials are discussed.

J. D. Norgard and C. L. Chen, "Lightning-Induced Transients on Buried Shielded Transmission Lines," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York.

The electromagnetic equations necessary for the prediction of transients on an underground cable due to lightning are developed. The lightning stroke is modeled as a vertical impulse of current. The transmission line model is used to model the electrical characteristics of the buried cable. Several transfer functions are defined and evaluated. No numerical results are presented.

L. L. Oh and S. D. Schneider, "Lightning Strike Performance of Thin Metal Skin," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The results of simulated lightning tests to determine the effects of swept lightning strokes on titanium, aluminum and anodised aluminum are presented. Methods of determining the fuel vapor ignition threshold for any type of fuel tank skin construction are given.

J. L. Perry, "Electrical Current Flow Damage to Advanced Composites and Integral Protective Composite Concepts," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

A description of a series of experiments with different composites is given. The composites tested were: boron filament, manufactured from a carbon monofilament substrate; metal coated boron and graphite filaments; and boron composites containing aluminum screen as an integral part of the composite.

L. N. Phillips, A. C. Cornwell, E. L. White and E. N. Jones, "Effect of Simulated Lightning Strikes on Mechanical Strength of CFRP Laminates and Sandwich Panels," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Lightning damage to metal panels used in aircraft is discussed. Both visual and mechanical damage assessment was made.

J. Phillpott, "Simulation of Lightning Currents in Relation to Measured Parameters of Natural Lightning," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Different types of current waveforms used to simulated lightning strokes are discussed. The limitations placed on the simulation waveforms by the capacitor and battery banks are emphasized. Recommendations are given for the lightning testing of various zones of an aircraft. An attempt is made to estimate the probability of the loss of an aircraft due to lightning.

J. Phillpott, P. Little, E. L. White, H. M. Ryan, C. Powell, S. J. Dale, A. Aked, D. J. Tedford and R. T. Waters, "Lightning Strike Point Location Studies on Scale Models," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Lightning simulation tests on scale models of aircrafts are reported. The electrode spacing, model scale, model position in the spark gap, impulse voltage waveshape and polarity and voltage levels were varied. Both grounded and ungrounded models were tested. The breakdown mechanism was studied.

E. T. Pierce, "Natural Lightning Parameters and their Simulation in the Laboratory," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

A summary of the state of the art understanding of the nature of lightning is given. An attempt is made to relate this to the hazards presented by lightning to aircraft and rockets. Realistic criteria for lightning simulation tests are defined.

J. A. Plumer and B. L. Perry, "An Analysis of Lightning Strikes in Airline Operation in the USA and Europe," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Lightning strike data from five USA commercial airlines was compared to similar data from European airlines. The lightning strike data was begun in 1971.

J. A. Plumer, "Lightning Effects on the NASA F-8 Digital Fly-by-Wire Airplane," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

A desription of a computer program to analyze the electromagnetic effects of lightning on a digital fly-by-wire control system is given. The data obtained can be used to minimize these lightning hazards.

A. W. Revay, Jr. and R. M. Cosel, "Lightning Simulation Tests of Communications Cables," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York.

The effect of a 11,000 ampere simulated lightning stroke on five different FAA shielded communications cables is described. A total of 47 tests were conducted. An experimental plot of sheath current as a function of the distance of the stroke from the cable was obtained.

S. T. M. Reynolds, "Lightning Protection of Supersonic Transport Aircraft," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The standard techniques for the protection of aircraft from lightning were found to be adequate for the supersonic transport. No novel techniques are required. A description of the lightning protection system of the concorde SST is given.

F. Rizk, Y. Gervais and H. Luhrmann, "Performance of Electromagnetic Shields in High Voltage Laboratories," IEEE Transactions on Power Apparatus and Systems, vol. PAS-94, no. 6, November/December 1975, pp. 2077-2083.

A circuit approach is used to calculate the shielding effectiveness of high voltage laboratories used to measure high voltage insulation characteristics. The shielding effectiveness was found to be nearly constant from 690 kHz to 1 MHz but above a few MHz rapid detoriation occurs. The possibility of intermittent bonding of the shielding plates are included in the anlaysis.

J. D. Robb, J. R. Stahmann, T. Chen and C. P. Mudd, "Swept Lightning Stroke Effects on Painted Surfaces and Composites of Helicopters and Fixed Wing Aircraft," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The use of modern weather resistant paints to protect aircraft skins from swept lightning stroke damage is discussed. The desirability of developing new paints which diffuse the lightning energy over a broad area is emphasized.

J. D. Robb, J. R. Stahmann and T. Chen, "Symmetry Effects in Electromagnetic Shielding of Aerospace Vehicles," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The electromagnetic shielding of aerospace vehicles is discussed. Counter current and symmetry current shielding are anlayzed. The theory is applied to an aircraft using box geometry, which is asymmetric, and an aircraft fuselage, which is symmetric. The results obtained are compared to lightning simulation data.

S. Rosati and G. Scalisi, "On Deep Sunk Electrical Earths for the Transformer Stations in an Electrical Supply Network," Ingegnere, (Italy), vol. 50, no. 4, April 1975, pp. 137-142.

This paper is in Italian with an English translation of the title and abstract.

The effect of the terrain on the grounding of electrical power installations is considered. Resistance contours for the city of Rome are given from which the length of grounding rods to achieve a specific ground resistance may be obtained.

P. M. Rostek, "Techniques of Shielding and Filtering Digital Computers for EMI Emissions and Susceptibility," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York.

Recommendations for a computer cabinet shielding design are given. The shielding effectiveness of a computer cabinet is determined as a function of frequency and the holes or cracks in the cabinet.

J. Severinsen, "Designer's Guide to: EMI Shielding, Part 1," EDN, vol. 20, no. 3, February 5, 1975, pp. 47-51.

The basic EMI problem is discussed in basic terms. Plots of the absorption of electromagnetic energy by different types of metals are given as a function of frequency for various metal thicknesses.

J. Severinsen, "Shield Against Electromagnetic Interference," Electromechanical Design, (USA), vol. 19, no. 5, May 1975, pp. 20-22, 24, 26.

A brief description of the electromagnetic shielding problem is given. Practical considerations in gasket design are discussed.

V. N. Shakhtarin, S. N. Pylinina and M. A. Rizhikov, "Magnetic Field in a System with Superconducting Shields," IEEE Transactions on Magnetics, (USA), vol. MAG-11, no. 2, March 1975, pp. 661-666.

A theoretical analysis of the magnetic field produced by a magnet with a superconducting shield is given. The results are evaluated for a coil with a rectangular cross section and two shields. A comparison of experimental and theoretical results is made.

S. Szpor, "Piorunochrony Przemyslowe. Napiecia Skojarzone, Bocznice Kolejowe, Dzwigi Fabryczne. (Industrial Lightning Protection. Combined Voltage, Railroad Sidings, Industrial Cranes)," Przeglad Telekomunikacynjy, (Poland), vol. 51, no. 6, June 1975, pp. 263-264.

Not available.

S. Szpor, "Piorunochrony Przemyslowe. Iskry Wtorne Na Rezystancjach Stykow I W Zwieraczach (Industrial Lightning Arrestors. Secondary Sparks on Contact Resistances and in Short-Circuited Devices)," Przeglad Telekomunikacynjy, (Poland), vol. 51, no. 8-9, September 1975, pp. 357-358.

Not available.

O. K. Trunov, "Conditions of Lightning Strikes on an Air Transport and Certain General Lightning Protection Requirements," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

Statistics on damage to aircraft caused by electrical discharges are presented. Both static electricity and lightning damage are included. This data is intended for use in developing specific requirements for lightning protection and recommendations of how to operate aircraft in static electricity areas.

E. F. Vance, "EMP-Induced Transients in Long Cables," 1975 IEEE Electromagnetic Compatibility Symposium, IEEE, New York.

The voltages and currents induced in overhead and buried cables by a nuclear electromagnetic pulse (EMP) are analyzed. Plots of these voltages and currents as functions of time are given. The use of high-current surge arrestors to protect cables and input-circuit devices to protect electronic equipment from voltage or current surges is illustrated.

J. R. Wait, "Scattering from a Break in the Shield of a Braided Coaxial Cable-Theory," Archiv fur Elektronik und Vebertragungstechik, (Germany), vol. 29, no. 11, November 1975, pp. 467-473.

A theoretical analysis of the degradation of the shielding effectiveness of a braided coaxial cable with a break in the braid is given. A circumferential break in the shield of a cylindrical coaxial was evaluated. The tangential electromagnetic fields on each side of the break were equated which yields results in terms of admittance functions.

M. J. Walton and P. H. Bootsma, "Measurement of Inner Skin Surface Temperatures of Aluminum Honeycomb Panels Subjected to Lightning Strike," 1975 Conference on Lightning and Static Electricity, Abington, Berkshire, England, April 14-17, 1975.

The results of an experiment to measure the instantaneous temperature across the inner face of a sandwichpanel while it was being struck by simulated lightning on the outer face are reported. A temperature profile of the inner panel was obtained.

W. Widmann, "Uberspannungsschutz von Transformatoren mit vorgeschaltetem Kabel bei nahen Blitzeinschlagen (Overvoltage Protection of Transformers with Superposed Cable in Case of Near Lightning Flashes), Technische Mitteilungen AEG-Telefunken, vol. 65, no. 1-2, 1975, pp. 61-66.

This paper is in German with an English translation of the title.

J. J. Yang and T. T. Yang, "On the Interaction of Magnetic Fields and Magnetic Shields," International Journal of Engineering Science, (GB), vol. 13, no. 1, January 1975, pp. 107-115.

The derivation of some general formulas for the induced and self inductances of wires inside a cylindrical ferromagnetic shell is presented. These results can be used to determine the magnetic shielding effectiveness of such a structure.

F, R. Zboril, "Aircraft Antennas on New Nonmetallic Materials," 5th European Microwave Conference, Hamburg, Germany, September 1-4, 1975, pp. 658-662.

The electrical properties of carbon and boron composites that are used to replace alloys in structures are discussed. These composites are particularly susceptible to lightning damage. For this reason, additional metallic ground planes are required for antennas composed of these composites.

1976

A. Ametani and R. Schinzinger, "Equations for Surge Impedance and Propagation Constant of Transmission Lines above Stratified Earth," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 3, May/June 1976, pp. 773-781.

A transmission line using an earth return is analyzed via a modified conformal transformation of complex variables. The bilinear Moebius function is used. The ground impedance is plotted as a function of frequency and compared with the exact solution obtained by numerical analysis.

W. C. Bloomquist, K. J. Owen and R. L. Gooch, "High-Resistance Grounded Power Systems - Why Not?," IEEE Transactions on Industry Applications, vol. IA-12, no. 6, November/December 1976, pp. 574-579.

The use of a high resistance ground for 480-, 2400- and 4160-V delta or wye 3-wire systems is proposed. Such a system will not trip on the first ground fault. This grounding technique can be useful on 3-phase 3-wire systems but is not practical 4-wire systems.

D. W. Bodle, A. J. Ghazi, M. Syed and R. Woodside, Characterization of the Electrical Environment, University of Toronto Press, Toronto, Canada, 1976.

This book concerns the effects of a hostile electrical environment on communications systems. The model of the electrical environment includes the effects of lightning, interference from high and low voltage power systems, earth potential gradients, corrosion and electromagnetic pulse.

A thorough explanation of the nature of lightning, the magnitude and shape of lightning, the magnitude and shape of lightning induced current waveforms and the effects of soil resistivity on these currents is provided. Lightning, induced damage on overhead, submarine and buried cables is emphasized.

The effects of different grounding configurations for power systems on nearly grounded and ungrounded communications systems is discussed.

J. E. Bridges, "Measurement and Use of Incremental Cable Pickup Parameters," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

An estimate of cable pickup can be obtained by determining the signal coupled into a short segment and replacing the rest of the cable with its Thevin equivalent circuit. No equations were developed or results presented.

G. W. Brown and S. Thunander, "Frequency of Distribution Arrester Discharge Currents Due to Direct Strokes," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 5, September/October 1976, pp. 1571-1577.

The "Electrogeometric Theory" of lightning performance is used to obtain a frequency distriibution of line and arrester surge currrents due to direct strokes. The effect of the shielding of the transmission line by nearly structures and natural shielding is considered. Indirect strokes were found to have a less severe effect on the distribution system.

K. F. Casey, "On the Effective Transfer Impedance of Thin Coaxial Cable Shields," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-18, no. 3, August 1976, pp. 110-117.

The effective transfer impedance of thin coasial cable shields was determined by classical transmission line analysis. A multifilar-helix shielded cable ws analyzed.

Since this paper is rather theoretical, an editorial summary follows this paper in which R. B. Schulz summarizes the gist of the paper for the applications oriented reader. Schulz, the editor, points out that Casey's results indicate that the shielding effectiveness of a thinly shielded coaxial cable is determined by the inductive and capacitive transfer immittances and the axial propagation constant.

S. J. Dale, "Breakdown in Sparkgaps Containing an Isolated Metallic Body," 4th International Conference on Gas Discharges, September 7-10, 1976, Swansea, Wales, England, pp. 295-298.

The results of a study of lightning strikes to aircraft are discussed. An aircraft is modeled as an isolated body in a sparkgap. The transfer of energy to the aircraft is caused by the breakdown of the sparkgap.

F. Dawalibi and D. Mukhedkar, "Multi Step Anaysis of Interconnected Grounding Electrodes," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 1, January/February 1976, pp. 113-119.

The determination of the current distribution throughout a system of interconnected grounding electrodes requires, in general, a numerical solution. This paper considers various algorithms for the most general problem of interconnected electrodes. The recommended algorithm, termed the "Multi Step Anaysis", has advantages with respect ot accuracy, computing and simplicity.

B. Demoulin, P. Degauque, J. Fontaine, M. Cauterman and R. Gabillard, "Theoretical Investigation and Experiment of Shielding Efficiency of a Multi-Braided Coaxial Cable," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

Coupled transmission line theory is used to analyze the voltages induced in a multi-braided cable by a disturbing current flowing on the outer braid. Theoretical

and experimental plots of the shielding parameters are given which are in rough agreement.

J. M. Fontaine, J. L. Faure and C. Gary, "Electromagnetic Field, in a High-Frequency Range, of High-Voltage Transmission Lines and its Effects on the Response of a Terminated One-Wire Transmission Line Set Near the Ground," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The noise coupled in a shielded cable from a high voltage line in frequency range 0 to 30 MHz is analyzed. The coupled in voltage is expressed in terms of Sounnerfeld integrals and their derivatives which are numerically evaluated. Only one example is given.

K. A. Gertsik and A. V. Korsuntsev, "Fundamental Principles in Protection of Overhead Direct-Current Power Transmission Lines from Internal and Lightning Overvoltages," Proceedings of the Symposium on HVDC Power Transmission, Leningrad, USSR, April 7-15, 1976 (Published by the U.S. Department of the Interior, Bonneville Power Administration, Portland, Oregon, 1976), pp. 231-268.

The lightning protection requirements for high voltage d-c power transmission lines are discussed. Formulas are given for the distribution of lightning currents, the steepness of these currents and the probability of lightning breaking through an overhead ground wire. An example of the use of these relationships to calculate the lightning protection of a power distribution system is given.

B. D. Graves, T. T. Crow and C. D. Taylor, "On the Electromagnetic Field Penetration Through Aperatures," IEEE Transaction on Electromagnetic Compatibility, vol. EMC-18, no. 4, November 1976, pp. 154-162.

The electromagnetic field coupled through an aperature in an infinite conducting plane was determined in terms of an integral equation. This integral equation was solved numerically and plots of the coupled field are given for a circular aperature. A comparison is made with experimentally measured fields.

Since this paper is a highly theoretically application of Maxwell's equations, an editorial summary is provided by R. B. Schulz in which he discusses this significance of this paper for the applications oriented reader. Namely, that this paper describes a method of determining the performance degradation due to an aperature in a shield.

E. T. B. Gross, L. B. McClung and B. W. Whittington, "Discussion of 'Ground Fault Tests on High-Resistance Grounded 13.8-kV Electrical Distribution System of Modern Large Chemical Plant - '," IEEE Transactions on Industry Applications, vol. IA-12, no. 1, January/February 1976, p. 120.

This is a short correspondence from E. T. B. Gross commenting on a paper that appeared in the September/October 1974 issue of this transactions by L. B. McClung and B. W. Whittington. Gross asks if McClung and Whittington have considered the use of resonant grounding in place of high-resistance neutral grounding. McClung and Whittington reply that they are familiar with the benefits of resonant grounding but consider this technique more applicable to a fixed parameter systems than the one they considered in their 1974 paper.

S. M. Harvey and W. J. Ponke, "Electromagnetic Shielding of a System Computer in a 230-kV Substation," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 1, January/February 1976, pp. 187-193.

The steps taken to protect a power system monitoring computer from transients produced by a nearly 230-kV line disconnect switches are described. The peak electric field in the computer room due to a disconnect switch transient was reduced from 600 volts per meter to an equipment specification value of 1 volt per meter. Cable shields were grounded at only one end. All pipes, plumbing and the steel conduits were bonded to the sheet metal shield at the point of entry into the computer room.

The recommended grounding technique for large computer systems to prevent ground loop currents is to use a radial grounding system in which logic, safety and power-neutral grounds are each connected to a single-point earth ground. For the specific computer system considered by the author, the distance between the display electronics and the central computer is so large that single-point grounding was considered undesirable and two isolated grounding systems were used.

H. Kaden, "Shielding Effect of Thin-Walled Metal Cylinders of Square Cross Section," Siemens Forschungs - und Entwicklungberichte, (Germany), vol. 5, no. 2, 1976, pp. 76-84.

The shielding effectiveness of thin-walled metal cylinders made of a high-permeability alloy is analyzed. The magnetic and electromagnetic shielding provided by such a structure is determined as a function of frequency and distance from the end of the cylinder.

C. Kendall, "Boundary Conditions: Valid Factor in Shielding Analysis," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

This paper was not received in time to be published in record of this symposium.

E. E. Kovaler, E. D. Molchanov, Y. G. Pekhterev, T. Y. Tyabova and B. I. Tikhomirov, "An Investigation of the Basic Characteristics of Electrostatic Shielding from Cosmic Radiations on the Artificial Earth Satellite COSMOS605," Cosmic Research, vol. 14, no. 1, January-February, 1976, pp. 113-118.

The creation of the electric fields as high as 10 million volts per meter for the electrostatic shielding of a spacecraft from the charged particles of cosmic space is reported. The vacuum that surrounds the spacecraft is used as the insulating medium. Direct measurements of the conduction currents on the electrostatic model were made.

J. T. Kung and M. P. Amason, "Lightning Protection Design Concepts for Advanced Composite Structures," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

Two new design concepts are introduced in this paper to minimize the vulnerability of graphite and born epoxy composite aircraft structures to lightning strokes. The isolation of the structure from lightning current paths and the use of graphite composite structures to safely conduct lightning currents is proposed. Experiments with simulated lightning were performed to verify these design concepts.

G. M. Kunkel, "An Overview of Problems Associated with the Design of Electromagnetic Shields," 1976 Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The author points out that most of the mathematical models of the shielding problems are over simplified idealizations. Specifically, a better understanding of the propagation of electromagnetic waves between wires is needed, the specific field effect when a wave strikes a shield and the types of discontinuities that provide the most effective shielding.

G. P. Leshchenko and N. M. Tysinyuk, "Operational Use of a Panoramic Lightning Recorder," Soviet Meteorology and Hydrology, (USA), no. 5, 1976, pp. 96-98.

The use of a panoramic lightning recorder at a Soviet air weather station is described. This lightning recorder is used in operational aviation weather support. The azimuthal distribution of thunderstorm centers can be determined for radii of 200 km or less. During two years of operation only one unpredicted thunderstorm occured.

S. Y. Liao, "RF Shielding Effectiveness and Light Transmission of Copper or Silver Film Coating on Plastic Substrate," IEEE Transactions on Electromagnetic Compatibility," vol. EMC-18, no. 4, November, 1976, pp. 148-153.

The conductivity and resistivity of copper or silver film coatings on plastic substrates is determined as a function of the film thickness. The shielding effectiveness of these metal film coatings is determined as a function of the surface resistance.

P. J. Madle, "System Shielding Design - A Pragmatic Approach," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The energy coupled into a shielded enclosure is estimated. The specification of the maximum values of the local electric and magnetic fields external to the shielded enclosure and the transfer impedance of the shield provides an estimate of the coupled in energy.

R. C. Marshall, "Earthing, Shielding and Filtering Problems. 1 - Unwanted Resistance in Earth Lines," Wireless World, vol. 82, no. 1488, August 1976, pp. 68-69.

The effects of unwanted resistance in the ground connection of electronic equipment that is common to both the input and output of the device are discussed. Three cases are considered: an amplifier with nonnegligible output current, the power supply ripple coupled back into the input due to incorrect grounding procedures and two amplifiers in different chassis connected to the same ground point. The situations are described, the problems defined and solutions recommended.

This is the first of four articles on grounding and shielding problems in electronic equipment.

R. C. Marshall, "Earthing, Shielding and Filtering Problems. 2 - Stray Capacitance and Feedback," Wireless World, vol. 82, no. 1489, September 1976, pp. 85-86.

The use of electromagnetic shielding to eliminate Miller effect stray capacitance from the output to the input of an electronic amplifier is discussed. The symptoms are given, the problem defined and cures suggested (including but not restricted to shielding).

R. C. Marshall, "Earthing, Shielding and Filtering Problems. 3 - Pick-up Problems in Electrically-adverse Environments," Wireless World, vol. 82, no. 1491, November 1976, pp. 73-75.

The elimination of hum or high frequency signals coupled into an electronic amplifier by stray capacitance from the input to other objects or the input leads acting as an antenna is the subject of this paper. One of the cures recommended is to place a grounded non-ferrous shield around the input circuit.

R. C. Marshall, "Earthing, Shielding and Filtering Problems. 4 - Magnetic Pickup Problems," Wireless World, vol. 82, no. 1492, December 1976, pp. 65-66.

Grounding and shielding techniques for the elimination of magnetic pickup are described. Methods of reducing the area of the wire loop, such as twisting the

conductors, are given. Enclosing power transformers in magnetic shields is discussed.

D. J. Melnold, S. A. Annestrand, F. A. Denbrock and K. R. Shah, "Basic Principles of Switching Surge, Fault Surge and Lightning Protection of HVDC Lines," Proceeding of the Symposium on HVDC Power Transmission, Leningrad, VSSR, April 7-15, 1976, (Published by the U.S. Department of the Interior Bonneville Power Administration, Portland, Oregon, 1976), pp. 211-229.

The lightning protection requirements for ± 400 kV d-c power transmission lines are discussed. Surge capacitors are used to limit overvoltages induced by lightning. Problems involving the use of sparkgaps lead to an emphasis on surge capacitors. The use of one or two overhead ground wires to divert lightning strokes to ground is recommended. The number of lightning failures is plotted as a function of tower footing resistance.

C. Menemenlis, H. Anis and G. Harbec, "Phase-to-Phase Insulation Part I: Generalized Effects of Stress Parameters and Gap Geometry," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 2, March/April 1976, pp. 643-649.

The phase-to-phase insulation response is determined by the magnitude and phase of the two phase-to-ground voltages. This paper investigates this relationship. Plots of the probability of breakdown are given.

C. Menemenlis, H. Anis and G. Harbec, "Phase-to-Phase Insulation Part II: Required Clearances and Coordination with Phase-to-Ground Insulation," IEEE Transactions on Power Apparatus and System, vol. PAS-95, no. 2, March/April 1976, pp. 651-657.

The air insulation of a high voltage power systems is optimized by studying the overall behavior of the gap formed by phase-to-phase and phase-to-ground voltages. This paper continues the subject studied in Part I. The analysis is both experimental and statistical.

P. E. Merewether and T. F. Ezell, "The Effect of Mutual Inductance and Mutual Capacitance on the Transient Response of Braided-Shield Coaxial Cables," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-18, no. 1, February 1976, pp. 15-20.

The classical transmission line equations are formulated for a braided-shield coaxial cable. In addition to the usual mutual inductance and capacitance between the inner and outer conductors of the coaxial cable, the mutual inductance and capacitance between the outer conductor and the braided cable shield is considered. The resulting expressions are compared to experimental measurements made on a RG-214 cable with a shielding braid.

The authors calculated the voltage that would be induced on a 50 ohm load connected by a 75 foot length of RG-214 braided-shield cable to a lightning stroke that produced a current of 20,000 amps on the cable shield. They found that a voltage of 16 kV across the 50 ohm load would be produced by such a lightning stroke.

D. F. Miller, "Application Guide for Shunt Capacitors on Industrial Distribution Systems at Medium Voltage Levels," IEEE Transactions on Industry Applications, vol. IA-12, no. 5, September/October 1976, pp. 444-459.

The use of capacitor banks to improve the power factor of heavily inductive loads is discussed. The ungrounded and grounded surge capacitor bank configurations are examined. The capacitor cases may also be connected to ground.

A. M. Mousa, "Shielding of High-Voltage and Extra-High-Voltage Substations," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 4, July/August 1976, pp. 1303-1310.

The protection of electrical substations from lightning strokes is the subject of this paper. Both ground wires and masts are used. The Gilman-Whitehead electrogeometric model is used to provide application curves for the design of the shielding of substations.

M. Nakagawa and K. Iwamoto, "Earth-Return Impedance for the Multi-Layer Case," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 2, March/April 1976, pp. 671-676.

The problem of a transmission line which uses a ground return is analyzed. The ground return is modeled as a multi-layer earth where each layer has a different permittivity, permeability and resistivity. The Hertzian potential formulations is used and the resistivity is assumed to vary exponentially with depth.

H. Neuhaus and W. G. V. Baeckmann, "Blitzschutzmassnahmen in Gasverdichterstationen fuer Steuer-und Ragelanlagen (Lightning Protection in Gas Compressors Stations of Monitoring and Control Systems)," GWF-Gas/Erdgas, vol. 117, no. 1, January 1976, pp. 28-34.

This paper is in German with an English translation of the title. The GWF in the journal title may be listed as Gas Wasserfach.

The use of diodes and spark gap tubes to protect instruments connected by underground cables from transients induced by lightning is illustrated.

F. J. Nichols, "Aspects of VLF Shielding and Fabrication," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The special design considerations and fabrications required for VLF shielding, 20 Hz to 10 kHz, is discussed. At low frequencies, magnetic shield is the predominate concern. Typical applications for Tempest and EMP requirements are illustrated.

V. M. Novikov and P. I. Romashena, "Magnetostatic Shielding of a Scintillation Counter," Instruments and Experimental Techniques, vol. 19, no. 5, part 2, September-October 1976, pp. 1524-1525.

The fabrication of a three-layer permalloy shield with non-magnetic interlayers made of copper foil is described. This magnetostatic shield is designed to reduce a magnetic field less than one Orsted by a factor greater than one hundred.

P. Osvath, G. Kezdi and I. Zoltan, "A Method of Testing and Qualifying Shielded Low-Frequency Cables," Periodica Polytechnica, (Electrical Engineering), (Hungary), vol. 20, no. 4, 1976, pp. 417-432.

The shielding problem is outlined. A procedure for measuring the shielding effectiveness of different types of cables is explained. For frequencies less than 10 kHz, it was found that cables shielded with conductive plastic are superior to those with braided shielding with regard to the shielding of electric fields. For frequencies less than 1 MHz, the electric shielding properties of foil shielding were found to the most favorable. Regarding the shielding of magnetic fields, the performance of braided cables was found to be superior by an order of magnitude to either foil shielding or conductive plastic shielding. Additionally, braided cables were found to be superior to the other two types by an order of magnitude with respect to pulse shielding. Oscillograms of the measured pulse disturbance sensitivity of these cables are given.

H. W. Ott, Noise Reduction Techniques in Electronic Systems, New York: John Wiley and Sons, 1976.

This book contains sections which describe how the proper use of grounding and shielding can be used to reduce noise in electronic circuits. These techniques are applicable from audio frequencies to VHF with the most emphasis placed on low to mid-frequency noise reduction.

Electric and magnetic field shielding are discussed. The principle of shielded cables, both coaxial cables and twisted pairs, are examined. The shielding factor is defined.

The principles of safety and signal grounding are covered. The relative merits of single and multipoint grounds are discussed. Reasons for grounding or floating the cable shield of a coaxial cable are given. Shield grounding at high frequencies is analyzed. The nature and origin of ground loops are discussed.

G. Pellegrini, A. Raino and C. Reynaud, "EMC Problems in H.V. Substations," 1976 IEEE Electromagnetic Compatibility Symposium Record, IEEE, New York, 1976.

The grounding, bonding and shielding practices used to minimize EMC problems in a 420 kV substation is outlined. Cables interconnecting each unshielded kiosk or control room must have their shield bonded at both ends to the ground plane while cables connected to shielded kiosks or control rooms are bonded at only one end.

S. S. Perepelkin and E. V. Minenko, "Magnetic Shielding by Superconducting Shells," Soviet Physics Technical Physics, vol. 21, no. 11, November 1976, pp. 1422-1425.

The shielding effectiveness of superconducting shells used to shield experimental devices from magnetic fields is analyzed. The Ginzburg-Landau equations are used to calculate the shielding coefficient as a function of the shell shape and the direction of the external magnetic field.

E. T. Pierce, "Winter Thunderstorms in Japan - A Hazard to Aviation," Naval Research Reviews, vol. 29, no. 6, June 1976, pp. 12-16.

Some unusual features of Japanese winter storms are discussed. Although the rate of lightning strokes is low, they are quite intense. Lightning flashes are often induced by aircraft flying into clouds.

E. I. Portnov, "Measuring the Contact Resistance of Cable Sheaths and Lightning-Protection Strands," Telecommunications and Radio Engineering, vol. 30-31, no. 7, July 1976, pp. 39-42.

The contact resistance of a cable or a lightning-protection strand, in contact with the ground over its whole length, is analyzed using a three-electrode method. Theoretically calculated and experimentally measured values of the contact resistance are given for two different cables.

T. B. A. Senior, "Electromagnetic Field Penetration into a Cylindrical Cavity," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-18, no. 2, May 1976, pp. 71-73.

The electromagnetic fields coupled into a rectangular slit in cylindrical cavity was calculated by numerical solutions of an integral equation. Plots are given of the peak of the axial electric field as a function of the fractional radius of the cylinder (in terms of a wavelength) and slit size. In an editorial summary that follows this paper by R. B. Schulz, it is pointed out that this problem formulation can be used to determine the shielding effectiveness of such a structure.

C. D. Skouby, "Effects of Advanced Composites on Shielding and Antenna Performance," 1976 Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The shielding effectiveness of composite panels in the frequency range of 50 kHz to 18 GHz was examined for different fabrication details. It was found, that although the shielding of radial metal is much greater, the shielding provided by composite panels is large enough so that in most cases, the leakage through the joints or seams will be the limiting factor in the shielding effectiveness of the structure.

To evaluate the affect of a composite structure on an antenna pattern, several antenna patterns were measured using the composite as a ground plane.

J. Shaw, "Lightning Protection of Aircraft Fuel Caps," Society of Automotive Engineers, Preprint No. 760486 for the Business Aircraft Meeting, April 6-9, 1976, Wichita, Kansas.

Procedures for lightning protection of both the aircraft filler cap and adapter are given. The aircraft is divided into three zones which are determined by the probability of a direct lightning strike. The correct grounding and installation of adapters in metallic and non-metallic structures is described. A bonding strap is used to connect the adapter to the metal portion of the aircraft. The installations are tested according to the procedures given in MIL-C-38373, MIL-B-5087, MIL-L-38363 and FAA Circular AC20-53. These testing procedures are summarized.

P. Snigier, "Fusion energy: will experiments in ball lightning provide the key," EDN, April 20, 1976, pp. 17-18.

This article describes project Telsa which produced artificial ball lightning with potentials as large as 20 million volts and provides a brief explanation of the hazards of ball lightning.

S. Stoller, "In-Plant Generation-Design Considerations for Industrial Facilities," IEEE Transactions on Industry Applications, vol. IA-12, no. 3, May/June 1976, pp. 226-231.

Pertinent factors in the design of in-plant generation systems for industrial facilities are considered. One of these is the generator neutral grounding technique. The factors determining whether reactance grounding, resistance grounding, distribution transformer grounding or a grounding transformer will be used to limit the ground fault current are discussed.

D. Strawe, "Shielding Characteristics of Advanced Composites," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

The results of a program to investigate the shielding effectiveness of advanced composites is presented. Expressions are given for the electric and magnetic field inside a shielded enclosure in terms of the inducted surface currents and charges and the shielding effectiveness of the composite materials. Experimental plots of the shielding parameters as a function of frequency are included.

A. L. Streater, "Lightning Protection of Water Systems," Journal of the American Water Works Association, vol. 68, no. 7, July 1976, pp. 360-365.

A simple explanation of lightning phenomenon is given and techniques for the protection of water works systems from lightning surges are discussed. The effects of lightning surges on electrical equipment connected to neutral ground and true ground (submersible motors in well water). The use of lightning arrestors is discussed. It is recommended that a metallic connection always be made between the arrestor ground terminal and the frame of the device it is to protect and that this device is as close to the protector as is practical.

J. G. Sverak, "Optimized Grounding Grid Design Using Variable Spacing Technique," IEEE Transactions on Power Apparatus and Systems, vol. PAS-95, no. 1, January/February 1976, pp. 362-374.

The shape of a physically large grounding mat may be better approximated as convex than plane. A convex surface is difficult to analyze with established techniques. Therefore, this paper modifies the established technique described in IEEE Guide No. 80. A recursive point by point integration of surface gradients throughout the mesh is made and plots of the gradient of the electric field are given. Some FORTRAN computer programs are included.

J. W. Thomasson and D. M. Ginsberg, "Magnetic Field Shielding by a Superconducting Cylindrical Tube of Finite Length," Review of Scientific Instruments, vol. 47, no. 3, March 1976, pp. 387-388.

The use of a superconducting cylindrical tube to shield against an external magnetic field is described. Since the tube is of finite length, the shielding is imperfect because the ends of the tube are open. This shielding degradation due to a finite length of the cylinder is analyzed.

R. K. Traeger and E. F. Ehrman, "The Lightning Arrestor Connection," IEEE Transactions on Parts, Hybirds and Packaging, vol. PHP-12, no. 2, June 1976, pp. 89-94.

The modificiation of a multipin connector to include lightning arresting features is described. The design basis and concept are reviewed. This lightning arrestor connector was subjected to simulated lightning surges of 500 kV per microsecond at a current of over 200 kA and was found to be effective under all

tests. The insulation resistance of the connector was over 100 M ohm and the voltage limited on all pins to approximately 1000 V.

G. Vogt, "Gesichtspunkte zur Auslegung der niederohmigen Sternpunkterdung in krafwerken mit grosser Blockleistung (Design of the Low-Resistance Neutral Earthing in Power Stations with a High Block Output)," Elektrie, vol. 30, no. 5, 1976, pp. 264-266.

This paper is in German with an English translation of the title and abstract.

The use of low-resistance neutral grounding permitts the selective determination of ground faults in cable systems. Ground fault currents must be limited if the permissible contact voltage is not to be exceeded. The optimization of the design of an efficient neutral point impedance is discussed.

J. Walsh, "Some Electromagnetic Theory Considerations as Applied to Shielding Problems," 1976 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1976.

This paper was not received in time for publication in record of this symposium.

W. S. Watkins, "Grounding and Bonding Electrical Equipment," Plant Engineering, vol. 30, no. 15, July 22, 1976, pp. 116-119.

This article is the first of two tutorial articles on grounding and bonding of electrical equipment. The author points out that the National Electrical Code does not clearly distinguish between bonding and grounding. The difference is explained. It is explained that the earth is seldom suitable as a ground-fault path for industrial systems.

W. S. Watkins, "Grounding and Bonding Electrical Equipment," Plant Engineering, (Barrington, Ill.) vol. 30, no. 16, August 5, 1976, pp. 89-91.

This article is the second of two tutorial articles on grounding and bonding of electrical equipment. It is emphasized that proper grounding and bonding are important even if an industrial system is energized by an ungrounded delta. The bonding of separate power sources and the bonding and grounding of separately derived systems is discussed.

V. V. Zakutin and A. M. Shenderovich, "Control of Space Distribution of a Pulsed Magnetic Field by Shielding Individual Sectors of the Solenoid," Instruments and Experimental Techniques, vol. 19, no. 5, part 2, September-October 1976, pp. 1522-1523.

The creation of a pulsed magnetic field by shielding parts of the turns of a solenoid is described. The solenoid is excited by bank of capacitors and a spark gap. This paper is entirely experimental but can be used to predict the effect that a pulsed magnetic field would have on a partially shielded solenoid.

N. I. Zavada, G. G. Gevorkyan, V. I. Lyamin and A. V. Pilipenko, "Protection from Electromagnetic Interference for Operation of Powerful Pulse-Radiation Generators," Instruments and Experimental Techniques, vol. 19, no. 4, part 2, July-August 1976, pp. 1110-1112.

The use of a grid-type shield to reduce the fields generated by a pulse-voltage generator is described. The computed field reduction factor was approximately one million while the actual field reduction factor was one hundred for the example problem considered by the authors. The equations used to calculate the field reduction are found in G. Kaden's 1957 book titled "Electromagnetic Shields."

1977

E. M. Allan and A. L. McKean, "138 kV Prefab Capacitive-Graded Joint for Oil-Filled Cable Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-96, no. 1, January/February 1977, pp. 20-26.

The development of a new prefabricated 138 kV joint for oil-filled cables is described. These joints have both electrostatic shields and splice shields.

H. M. Altepeter, "How to Combat Plant Trouble Caused by Electrical Sources," Telephony, (USA), vol. 193, no. 24, December 12, 1977, pp. 40, 44, 46.

The effects of inadequate protection of telephone cables is discussed. Inspection of some cables' sheath continuity, bonding and grounding revealed that although physical bonds, clamps and straps existed they had been rendered useless due to the use of incorrect materials, tools and methods. The difficulty of measuring the ground resistance is discussed. The use of bonds between power system grounds and telephone grounds is recommended.

Anon, "New Findings Challenge Lightning-Protection Grounding, Current-Measurement Methods," Power, vol. 121, no. 7, July 1977, pp. 76-80.

The implication of some of the papers presented at the 1977 IEEE Industrial and Commercial Power System Technical Conference is discussed. Raising the height of a lightning rod may not increase the protection zone. Lightning rods higher than 100 meters may not provide protection for lower nearby object due to the nature of the stepped leader in a lightning stroke.

Whether or not to use low resistance grounding of the power system neutral is discussed. Applications where high resistance grounding may be desirable are discussed.

A. Asta, "Impianti di Terra, Elettrodi Marini. Principi di Comportamento e di Calcolo (Ground Installations, Marine Electrodes. Principles of Behavior and Calculation), Elettrotecnia, vol. 64, no. 6, June 1977, pp. 455-476.

This paper is in Italian with an English translation of the title and abstract.

The use of ground plant (installations) and marine electrodes to ground electrical systems is described. The historical contributions of Maxwell, Howe, et al. is summarized as well as that of recent Italian researchers in the analysis of this problem. The transmission line equations are used to determine the variation of voltage and current along the electrodes. Calculation of the ground resistance and capacitance is given. The behavior in nonhomogeneous ground is considered. The effect of corrosion is considered.

D. J. Bem and W. Waszkis, "Numerical Map of Ground Conductivity in Poland," Rozprawy Electrotechniczne, vol. 23, no. 4, 1977, pp. 871-877.

This paper is in Polish with an English translation of the title and abstract.

A technique for plotting a numerical map of ground conductivity is described. This conductivity profile data is used as a basis for ground wave field strength calculations.

R. L. Boggess, "Aircraft Lightning Vulnerability Testing," Proceeding of the IEEE 1977 National Aerospace and Electronics Conference, May 17-19, 1977, pp. 282-285.

The interior of an aircraft is protected from lightning induced damage by the metal skin which acts as a Faraday cage. If the skin is punctured by burn-through or arc-over, ohmic heating of the material may cause significant damage. The use of proper bonding techniques to preserve the integrity of the skin of the aircraft is discussed. An electric circuit model of an aircraft skin is given and values for lightning indued currents are calculated using this model.

M. Bouchard, F. Dawalibi and D. Mukhedkar, "Survey on Ground Resistance and Earth Resistivity Measurements," IEEE Power Engineering Society, Winter Meeting, January 30 - February 4, 1977, New York.

The results of an IEEE survey regarding the earth resistivity, resistance and impedance measurement techniques currently in use among various electric utilities around the world is discussed. The "four-point" method using four equally spaced electrodes to make earth resistivity measurements is normally used with the exception of utilities in the U.S.S.R., South Africa and Australia.

W. E. Burpee and N. B. Carson, "Skin Effect Current Tracing," IEEE Transactions on Industry Applications, vol. IA-13, no. 2, March/April 1977, pp. 130-133.

The electrical tracing of a 20-inch diameter by 4-mile long pipeline used for the transport of #6 fuel oil is described. Shielded cables are used in connection with the electrical tracing. It was found that to prevent current from returning along the shield, that it was necessary to ground the shield at one end and insulate it at the other.

B. J. C. Burrows, C. Luther and P. Pownall, "Induced Voltages in Full Size Aircraft at 10" A/S," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE New York, 1977.

Experimentally measured induced voltages on the fuselage of an aircraft due to simulated lightning are presented. Current pulses as high as 100 kiloamperes per microsecond were used. An oscillogram of the electric field measured at the rear of the fuselage is given. These experimentally measured results are compared to theoretically predicted results.

W. G. Butters and D. W. Clifford, "Lightning Induced Electrical Transient Testing on Aircraft Wiring System," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The results of simulated lightning tests conducted on aircraft are reported. The parameter of interst is the magnitude of electrical transients induced on internal wiring by a lightning stroke. The lightning current was modeled as a double exponential. A basic study of coupling mechanisms was made. It was found that most of the signals sensed during low level currents are not magnetically coupled from the driving waveform. It was concluded that magnetic coupling tests should be made at only high current levels.

V. Carrescia, "Earth Measurements - Norms and Legislation," Elettrificazione, (Italy), no. 6, June 1977, pp. 243-253.

This paper is in Italian with an English translation of the title and abstract.

A panel discussion on electrical equipment, the grounding requirements for this equipment and the related problem of ground resistance measurement techniques is reported. Ground resistance instrumentation and measuring techniques are given for electronic equipment, control circuits, power supplies and medical equipment.

R. Castenschiold, "Ground-Fault Protection of Electrical Systems with Emergency or Standby Power," IEEE Transactions on Industry Applications, vol. IA-13, no. 6, November/December 1977, pp. 517-523.

Multiple ground connections and unbalanced loads may cause improper ground fault sensing and cause nuisance tripping of circuit breakers. Various approaches, such as isolation by the use of transformers, are proposed to improve ground fault sensing.

D. C. Chang, R. J. Prehoda and R. M. Swink, "Design Considerations Concerning Electromagnetic Penetration into Long, Cylindrical Enclosures at High Frequencies," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The shielding properties of cylindrical enclosures are discussed in this paper. A statistical description of the response of long, cylindrical enclosure is given in terms of the cummulative probability density of the induced current. The frequency range is from 80 to 120 MHz. Arbitrary angles of incidence are considered.

T. Y. Chou and A. T. Adams, "The Coupling of Electromagnetic Waves Through Long Slots," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 2, May 1977, pp. 65-73.

The coupling of an electromagnetic wave through long slots in an infinite plane conducting screen is analyzed by the method of moments for arbitrary polarizations and angles of incidence. Plots of the diffracted field are given and the transmission coefficient is plotted as a function of slot width in wavelengths.

An editorial summary by R. B. Schulz follows this paper. Chou and Adams' results may be used to determine the shielding degradation due to long slots in a shield.

J. C. Corbin, Jr., "Protection of Systems Avionics Against Atmospheric Electricity Hazards - Lightning and Static Electricity," Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, Ohio, May 17-19, 1977, pp. 842-849.

Since, on the average, lightning strikes an aircraft during every 3000 hours of flying time, the determination of the electromagnetic field coupled through the skin of the aircraft by lightning induced currents on the outer hull is of prime importance to system avionics. This paper deals with methods of measuring these coupled in fields and hardening the structure to resist this coupling. Some measures taken to harden the structure were shielding cables in various parts of the aircraft and improving the bonding lines, pneumatic lines and some mechanical shafts. By hardening the structure it was possible to eliminate some 35,000 to 40,000 diodes from the avionics equipment.

L. E. Crawford and M. S. Griffith, "A Closer Look at 'The Facts of Life' in Ground Mat Design," Industrial Applications Society Annual Meeting, October 2-6, 1977, Los Angeles, California, pp. 79-87.

This paper discusses the use of several new algorithms for the design of ground mats for power systems. The use of these algorithms to optimize ground mat design is considered.

M. L. Crawford and C. L. Thomas, "Converting a Rectangular Shielded Enclosure into a TEM Transmission Cell for EMI Measurements," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The modifications required to convert a rectangular shield enclosure into a TEM mode EMI test chamber are described. Type N input and output connectors were attached at opposite ends of the enclosure. The center plate of the enclosure was connected to a single input/output connector at one end with the other end terminated internally into a 50 ohm matched impedance.

E. G. Crosby and F. C. Hornbeck, "Plastic with Conductive and Magnetic Particles for Electromagnetic Shielding," IBM Technical Disclosure Bulletin, (USA), vol. 20, no. 3, August 1977, p. 1091.

A plastic maerial that contains particles of magnetic or conductive material is described. This imbedded plastic is used to cover structures and provide electromagnetic shielding.

E. G. Crosby and C. Nuccio, "Conductive Seal for Electromagnetic Shielding in Electrical Enclosure," IBM Technical Disclosure Bulletin, vol. 20, no. 1, June 1977, pp. 282-283.

Drawings of a conductive seal for electromagnetic shielding are given. Conductive particles, such as metallized dielectric fibers, are used to provide the seal with sufficient conductivity for electromagnetic shielding. The seal and an angle part made of flexible elastomer are described.

F. Dawalibi and D. Mukhedkar, "Resistance Calculation of Interconnected Grounding Electrodes," IEEE Transactions on Power Apparatus and Systems, vol. PAS-96, no. 1, January/February 1977, pp. 59-65.

An expression for the potential induced on one electrode by the others in an array of interconnected grounding electrodes is given. The integral is evaluated along the path of an interconnected electrode buried in a two layer soil. A general formula for the earth resistance is derived and evaluated for typical array of interconnected grounding electrodes.

W. J. DeBonte and A. D. Butherus, "Magnetically Permeable Adhesives and Adhesive-Joined Shield Structures," IEEE Transactions on Magnetics, vol. MAG-13, no. 5, September 1977, pp. 1376-1378.

The use of magnetically permeable adhesives to cojoin multisection magnetic shields for magnetic bubble memory packages is discussed. The use of these adhesives is preferable to welding in that welding degrades the permeability of the shielding material and requires protruding tabs. A novel technique for magnetically orienting the adhesive to enhance its effective permeability is described. Relative permeabilities as high as 10 can be achieved with a subsequent increase in the shielding efficiency by a factor of 4 compared to a welded shield design.

H. W. Denny, "Grounding as a System's Design Parameter," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

This paper recommends that grounding requirements be considered collectively and tradeoffs effected between circuit parameters, equipment shielding, system configuration, signal interfacing and signal grounding while still meeting the electrical safety and lightning requirements. Four examples of improper ground connections that produce stray power currents are given. The functional roles of grounding networks are defined. The possibility of the use of double insulation rather than grounding is discussed. Because of the complexity of the

grounding requirements, strict adherence to a set of rules or truisms may be counterproductive.

J. R. Dunki-Jacobs, "The Reality of High-Resistance Grounding," IEEE Transactions on Industry Applications, vol. IA-13, no. 5, September/October 1977, pp. 469-475.

The use of high-resistance system neutral grounding has been limited to the continuous process industries. It is anticipated that this grounding technique will find wider acceptance at low voltages. Above 15-kV, high resistance grounding should not be used.

J. R. Eaton, R. P. Merritt and E. F. Rice, "Electric Power Engineering in an Artic Environment," IEEE Transactions on Power Apparatus and Systems, vol. PAS-96, no. 1, January/February 1977, pp. 74-79.

The special requirements that a power system design demand for operation in an artic environment are discussed. The ground resistivity increases as the temperature decreases. It may be difficult to obtain a low resistance ground in an artic environment.

K. H. Feist, "Erdung-Massnahme zum Schutz Elektrisher Anlagen und der Umwelt (Grounding - A Measure to Protect Electric Installations and the Environment)," Elektrotechnische Zeitshrift Ausgabe B., vol. 29, no. 18, September 2, 1977, pp. 605-607.

This article is in German with an English translation of the title and abstract.

The excellent safety record of the electrical power industry may be attributed to a strick adherence to safety rules such as those detailed in the VDE regulations. The grounding of equipment and components by a connection to a grounding system is one of the protective methods used to protect equipment and eliminate hazardous voltages. Protective grounding systems are designed to avoid hazards even when subjected to direct ground faults. The principles of grounding are discussed and the effects of a ground fault are considered for several system configurations.

O. P. Gandhi, E. L. Hunt and J. A. D'Andrea, "Deposition of Electromagnetic Energy in Animals and in Models of Man with and without Grounding and Reflection Effects," Radio Science, vol. 12, no. 6, November-December 1977, pp. 39-47.

The rate at which electromagnetic energy is absorbed by models of human being differs depending on whether the model is grounded or ungrounded. Plots are given of the rate of absorption as a function of frequency. When grounded, peak absorption occurs at a frequency about one-half the value for the ungrounded condition.

J. A. Gason, "Protective Against Electric Shock by Indirect Contact in LV Installations," Bulletin de la Society Royale Belge des Electriciens, (Belgium), vol. 93, no. 3, July-September 1977, pp. 101-115.

This paper is in French with an English translation of the title and abstract.

This paper concerns the Belgium laws regarding safety demands for electrical equipment. Only grounding connections and the grounding of the frames of electrical apparatus in well defined conditions are required by law. The author recommends new legislation regarding electrical safety of which he is the author.

J. E. Godts, "Lightning Probability Damage and Hardening Requirements," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The signal levels coupled into cables for ground systems by lightning strokes is the subject of this paper. The magnetic field coupled into a cable by a lightning current is calculated from Maxwell's fourth equation. Statistics on lightning strike probabilities are then used to determine the induced current distribution.

R. H. Golde, Editor, Lightning, vol. 1, Academic Press, New York, 1977.

This book has 17 authors with Golde as the editor and one of the authors. The history and physics of lightning and thunderstorms are covered in extensive detail. Techniques for measuring the temporal characteristics and electromagnetic fields of lightning as well as the wave shapes of lightning induced currents are given. The incidence of lightning as a function of space and time is analyzed. A discussion of ball lightning is included.

R. H. Golde, Editor, Lightning, vol. 2, Academic Press, New York, 1977.

This book has 12 authors with Golde as the editor and one of the authors. Lightning protection is considered in the second volume of this two volume book. The use of lightning conductors for the protection of structures is explained. Grounding conductors for lightning strokes, and the expressions for resistance of different types of grounding grids are given.

A section dealing with the protection of aircraft from lightning is included. The frequency of strikes and the distribution of points struck is tabulated. It was determined that the wing tip and antennas are the parts of an aircraft most frequently struck. A check list for possible lightning entry on damage points is given. The use of protection devices, such as zener diodes to protect the aircraft's avionics is included.

The lightning protection of telecommunications cabies, whether overhead or underground, is discussed. The ability of a cable to withstand lightning damage depends on the transfer impedance of cable sheath and the dielectric strength of the insulation. A discussion of these parameters for the more common types of paired cables is included.

V. G. Gol'dshtein, A. V. Pokrovskii and F. K. Khalilov, "Comparison of Calculated and Model Investigations of Atmospheric Overvoltages at 100 kV Substations," Power Engineering, (Academy of Science USSR), (USA), vol. 15, no. 3, 1977, pp. 70-79.

The parameter required for the lightning protection of 110 kV power system substations are determined in the paper by direct calculation and full scale modeling and a comparison between these two techniques is given. Algorithms for the analysis of the propagation of waves of overvoltage on a power system induced by lightning are given. Experimental data measured at a 110 kV substation with a substation lightning protection analyzer and a transient analyzer is given.

R. A. Greenwell, "Fiber Optics Costs Models for the A-7 Aircraft," Fiber and Integrated Optics, (USA), vol. 1, no. 2, 1977, pp. 197-225.

The possibility of using fiber optics for electrical connections instead of the conventional wire circuits is discussed. The lightning strike vulnerability of fiber optics is low.

K. Grohmann and D. Hechtfischer, "Magnetic Shielding by Superconducting Simple and Coaxial Cylinders: A Comparison," Cryogenics, vol. 17, no. 10, October 1977, pp. 570-581.

This paper analyzes the magnetic shielding provided by single or coaxial cylinders of finite length. The Maxwell-London formulation is used. LaPlace's equation is solved by expanding the solution in a double infinite series in the cylindrical coordinates. Experiments were performed to determine the shielding effectiveness of this geometry. The flux at the axis of the cylinder is plotted as a function of the length of the cylinder.

J. R. Gumley, C. G. Invernizzo and M. Khaled, "Lightning Protection - A Proven System," Fire Technology, vol. 13, no. 2, May 1977, pp. 114-120.

A new type of lightning protection system is proposed. The physical nature of a lightning stroke is discussed. An electrode constituting the air terminal, an ionizing source, is used to attract a leader by providing a streamer. The use of an outer screen shield to prevent the electrification of nearby objects is discussed.

H. Hahn, "Assembly, Testing and Operating Electrical Equipment, III," Signal and Schiene, (Germany), vol. 21, no. 7, July 1977, pp. 236-237.

This paper is in German with an English translation of the title and abstract.

Included in this paper is the grounding requirements for 1,000 V AC and 1,500 V DC electrical equipment.

M. Hajnal and L. Vajta, "Noise Signal Rejection of the Analog Input of a Process Control Computer," Meres es Automatika, (Hungary), vol. 25, no. 9, 1977, pp. 321-325.

This paper is in Hungarian with an English translation of the title and abstract.

The use of grounding and electromagnetic shielding to reduce the sensitivity of process control computers to electrical noise signals is discussed. Some examples that illustrates the basic considerations are given.

A. W. Hanson, "Recent Development in High Current Testing Techniques for Lightning Simulation," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

A summary of techniques for the generation of simulated lightning waveforms is made. Circuit diagrams for these waveform generators are given. Techniques for testing aircraft for susceptibility to lightning damage are discussed.

R. A. Harvie, "Avoiding Hazards from Earth Current in Industrial Plants," IEEE Transactions on Industry Applications, vol. IA-13, no. 3, May/June 1977, pp. 207-214.

Ground faults may raise an industrial plant grounding system to hazardous levels. This paper recommends the use of IEEE Publication 80-1961, "Guide for Safety in Alternating Current Substation Grounding," to assure safety.

D. A. Hill and J. R. Wait, "Electromagnetic Scattering From an Unloaded Rectangular Wire Mesh Located Near the Air-Ground Interface," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 4, November 1977, pp. 402-406.

This paper is an extension of the author's earlier paper which appeared in Radio Science in 1976. This paper present graphically the numerical solution for the magnitude and phase of the reflection coefficient of an unloaded rectangular wire mesh above a conducting ground as a function of the angle of incidence of an impringing electromagnetic wave. As such, this paper provides information about the shielding effectiveness of such a structure.

D. A. Hill and J. R. Wait, "Electromagnetic Surface Wave Propagation Over a Bonded Wire Mesh," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 1, February 1977, pp. 2-13.

The propagation of an electromagnetic surface wave on a square mesh of intersecting parallel wires is analyzed. The periodicity of the wire mesh structure is used to invoke Floquet's theorem to express the current distribution on the wire

mesh. The mode equation for the propagation constant is evaluated numerically. The expression for the propagation constant as a function of mesh spacing (expressed in wavelengths) can be used to determine the shielding effectiveness of wire meshs.

E. M. Honig, Jr., "Electromagnetic Shielding Effectiveness of Steel Sheets with Partly Welded Seams," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 4, November 1977, pp. 377-382.

The degradation in the shielding effectiveness of welded steel enclosures due to a single welding flaw is experimentally examined in paper. Plots of the shielding effectiveness as a function of the slot size are given for the frequency range of 10 kHz to 10 GHz. Four forms of incomplete welds in 11-gauge steel plates are considered.

R. D. Jones, "On the Use of Tailored Return-Stroke Current Representation to Simplify the Analysis of Lightning Effects on Systems," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 2, May 1977, pp. 95-96.

The lightning return-stroke current is usually modeled as a double exponential, i.e. the difference of two exponentials. An alternative representation is proposed which the author terms the modified exponential. Plots of these two lightning return-stroke currents representations shows good agreement for a short interval following the lightning stroke.

D. R. Kelso, "Lightning Protection of Telephone Cables in Areas of High Soil Resistivity - Part I: The Overhead Earth Wire Techniques," The Telecommunication Journal of Australia, vol. 27, no. 1, 1977, pp. 35-43.

A technique for the protection of telephone cables from lightning in areas with high soil resistivity is described and conventional buried cables are either ineffective or prohibitively expensive. An overhead earthwire is used. Cumulative distribution curves for lightning flashover are given as a function of pole footing resistance and used to design a specific system.

K. J. S. Khunkhun, J. L. Koepfinger and M. V. Haddad, "Resonant Grounding (Ground Fault Neutralizer) of a Unit Connected Generator," IEEE Transactions on Power Apparatus and Systems, vol. PAS-96, no. 2, March/April 1977, pp. 550-559.

The advantage of resonant over high resistance grounding are discussed. Application procedures for resonant grounding of generator neutrals in a modern power plant are given.

D. G. Kim, G. A. Dubro, L. P. Tessler and R. L. Boggess, "Transmission Line Theory Applied to Aircraft Lightning Interactions," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

Transmission line theory was used to model the interaction between lightning and aircraft. The double exponential model for the lightning stroke current was used. An analog computer solution of the transmission line differential equation is given in terms of oscillograms of current on the skin of the aircraft. It was found that the current waveform rise time decreases rapidly as the distance from the arc initiation point increases.

H. Koettnitz and W. Naumann, "Isolationskoordination and Blitzschutz (Insulation Coordination and Lightning Protection)," Elektrie, vol. 31, no. 4, 1977, pp. 201-203.

This paper is in German with only an English translation of the title.

L. L. Kolenskii, Y. A. Medvedev and B. M. Stepanov, "Shielding of Pulsed Electromagnetic Fields by Metallic Shells," Power Engineering, (New York), vol. 15, no. 1, 1977, pp. 94-106.

A theoretical analysis of the shielding properties of various metallic shells which are situated in a dielectric or conducting medium and subjected to pulsed electromagnetic fields is presented. The shields investigated have various shapes and thicknesses and the incident electromagnetic fields have different polarizations. Low frequency, high frequency and pulsed electromagnetic fields are considered. Shielding coefficients for some simple charges are obtained and the electromagnetic field induced in the cavity is calculated using both a diffusion representation and a relaxationl representation. No comparison with experimental results is given.

C. H. Kuist, "EMR Shielding of Conductive Gaskets Under Vibration," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The effects of vibration on electrically conductive gaskets used for electromagnetic shielding in the microwave frequency range are reported in this paper. It was found that silver coated glass filled gaskets were degraded by as much as 54 dB (in terms of shielding effectiveness with no vibration) while silver plated copper filled gaskets were degraded by only 13 dB. Plots of field leakage and degradation in shielding effectiveness of gaskets as a function of vibration are given.

S. Y. Liao, "Light Transmission and RF Shielding Effectiveness of a Metallic-Film Coating on a Plastic Substrate," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The shielding properties of metallic-film coatings in the RF range is reported. Expressions for the reflection and transmission coefficients of these coatings were developed. A plot of the shielding effectiveness as a function of the surface resistance is plotted as a function of film thickness for different metals.

P. F. Little, A. W. Hanson and J. A. Dobbing, "Arcs on Metal Sheets in Simulated Lightning Discharges," 1977 IEEE Electromagnetic Compatibility Sympsoium, IEEE, New York, 1977.

The length of time required for current pulses to melt metal sheets was measured and reported in this paper. From this data the minimum metal thickness required for lightning protection may be determined. Aluminum sheets with a thickness of 2 mm were tested at current levels of 1.5 kA.

G. Lohrke, "The Protection Effect of Reduction Conductors in Telecommunications Plastic Cables Against External Current Fields," Fernmeldetechnik, (Germany), vol. 17, no. 5, 1977, pp. 170-173.

This paper is in German with an English translation of the title and abstract.

The use of reduction conductors to provide electromagnetic shielding is discussed. Formulae and plots of attenuation versus frequency are given for reduction conductors and copper braid screens. These shields are used in the audio and radio frequency range.

D. J. Love, F. Tajaddodi and W. C. Bloomquist, "Discussion of 'High Resistance Grounded Power Systems - Why Not?'," IEEE Transactions on Industry Applications, vol. IA-13, no. 6, November/December 1977, pp. 627-629.

Love and Tajaddodi criticize Bloomquist's 1976 paper on high resistance grounding. Both the form and lack of justification of some of the conclusions are questioned.

R. Malewski, D. Train and A. Dechamplain, "Cavity Resonance Effect in Large HV Laboratories Equipped with Electromagnetic Shield," IEEE Transactions on Power Apparatus and Systems, vol. PAS-96, no. 6, November/December 1977, pp. 1863-1871.

A screen room for making delicate measurements of electromagnetic quantities is described. Although the electromagnetic shielding is adequate for low and medium voltage levels, it was found that when a shielded room is located near high voltage sources that is may behave as a cavity oscillator. Methods of increasing the shielding effectiveness with nonmagnetic resistive coatings are discussed.

P. R. McBrayer, C. D. Skouby and G. L. Weinstock, "Lightning Attachment Characteristics for Metal/Composite Materials," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The susceptibility of composite materials which are used on aircraft to lightning damage is discussed. A graphite epoxy composite was tested and found to have sufficiently high conductivity to permit normal charge transfer and streamering during the attachment phase of a lightning stroke.

G. L. Maxam, "Field Penetration by Diffusion into a Conducting Shell," 1977 IEEE Electromagnetic Symposium, IEEE, New York, 1977.

The low frequency magnetic shielding properties of cylindrical shells constructed of magnetic materials are analyzed. The magnetic vector potential inside the cylindrical shell is determined from the induced current distribution on the shell. The magnetic field inside the cylinder is determined from this magnetic vector potential. Plots of the theoretically predicted and experimentally measured fields are given with poor agreement.

E. I. Minsker, "Use of Earthing and Neutral Grounding Techniques to Protect Machine Tools from Fire Damage Due to Electric Currents," Machines and Tooling, (GB), vol. 48, no. 1, 1977, pp. 18-23.

The grounding practices and standards currently used in the Soviet Union for power distribution systems, control circuits and lighting circuits are discussed. Examples of circuits for connecting electrical equipment to ground are given. The protection of personnel from electrical hazards is emphasized with 42 volts taken as the maximum permissible safe voltage.

R. Morrison, Grounding and Shielding Techniques in Instrumentation, John Wiley & Sons, New York, 1977.

This book covers grounding and shielding concepts for the protection of electronic equipment. The principles of electrostatics, capacitance and energy storage are reviewed and applied to the practical electrostatic and electromagnetic shielding of instruments. Considerations required for power entrances and transformers for instrumentation are given. The coupling mechanisms and special requirements for differential amplifiers are covered. The relative merits of grounding versus floating signal lines are discussed. Magnetic fields and techniques for shielding magnetic fields are also discussed.

K. Mukas, K. Kamiike, N. Fujioka and Y. Kiyotani, "Lightning Protection for Microwave Relay Station," Review of the Electrical Communications Laboratories, (Tokyo), vol. 25, no. 5-6, May-June 1977, pp. 487-504.

The results of a three year study of lightning damage to the Nippon Telegraph and Telephone Corporation's microwave relay stations are reported. Microwave relay stations are located on the tops of mountains and often suffer direct lightning strokes. The use of lightning rods to minimize damage is discussed. Techniques for the protection of electronic equipment from lightning induced damage are given. The effect of grounding resistance on lightning damage frequency was found to be small and a new standard grounding method is proposed.

E. Mumme, A. Anderson and E. Schulte, "High Current Lightning Test of Space Shuttle External Tank Lightning Protection System," Ninth Conference on Space Simulation, Proceedings, Los Angeles, California, April 26-28, 1977, pp. 327-343. Published by NASA, Goddard Space Flight Center, Greenbelt, Maryland (N79-19036).

A proposed lightning protection system for the Space Shuttle is described. Simulated lightning studies showed that certain high resistance paint strips were quite effective in diverting 50 kA lightning surges. Only the direct effects of lightning are considered rathr than secondary effects such as currents induced on wiring. The model used for the lightning surges has a 200 kA first return stroke surge and a 50 kA second return stroke surge.

J. E. Nanevicz, R. T. Bly, Jr. and R. C. Adamo, "Airborne Measurement of the Electromagnetic Environment Near Thunderstorm Cells," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

Experimentally measured lightning data on a NASA Learjet test aircraft during a thunderstorm is presented. It was found that electromagnetic pulses having durations of several minutes were created near an active thunderstorm cell. A real time spectrum analyzer was used to determine the relative frequency content of the lightning generated electromagnetic field.

G. Nozza, "Particular Environments' Choice of Protection Measures and Associated Equipment," Elettrificazione, (Italy), no. 10, October 1977, pp. 457-462.

This paper is in Italian with an English translation of the title and abstract.

The use of grounding to reduce the risk of explosion, fire or other hazards in accordance with IEC Standard No. 364 is discussed. Requirements for shipyards are included.

C. Nuccio and D. Planthaber, "Conductive Seal for Electromagnetic Shielding," IBM Technical Disclosure Bulletin, (USA), vol. 20, no. 1, June 1977, p. 281.

A seal to provide electromagnetic shielding between openings between nonmoveable panels is described. It consist of a rubber strip laminated to a metal

foil. It is intended for use with data processing equipment housed in cabinets with openings between panels.

M. Ozegovic, "Optimum Treatment of Neutral Point in High Voltage Transmission Regarding Short Circuit Currents," Elektrotehnika, Zagreb, (Yugoslavia), vol. 20, no. 3, 1977, pp. 181-195.

This paper is in Croatian with an English translation of the title and abstract.

A field investigation to determine the number and locations of neutral grounds in a high voltage power transmission network with a solidly grounded neutral point was made. A numerical solution is recommended.

G. Pfieffer and F. Hirsch, "Bemessung des Blitzschutzes von Hochspannungsfreileitungen (The Lightning Protection of High Voltage Aerial Conductors)," (IWK) International Wissenschaftliches Kolloquim, 22, Vortragsreihe, Published by Technische Hochschule Ilmenau (East Germany), 1977, vol. 1, pp. 29-32.

This paper is in German with an English translation of the title and abstract.

An integrated philosophy of lightning protection is presented. The primary concern is aerial conductors operating in the 110-380 kV range.

J. A. Plumer, "Transient Analysis Testing of Aircraft to Determine the Electrical Effects of Lightning - Pros and Cons of the Technique," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

Only the abstract is published.

A lightning transient analysis test for the determination of the susceptibility of avionics equipment to lightning damage is described. Low level current pulses are used to simulate lightning and a linear extrapolation of the results is made.

A. Rashid, "A Mathematical Method of Calculating and Measuring the Shielding Effectiveness of Cylindrical Enclosures," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The shielding effectiveness of cylindrical structures is examined by expanding the incident and reflected waves in terms of cylindrical wave functions and solving the electromagnetic equations for the induced field. From these equations the predicted shielding effectiveness is calculated and compared with experimentally measured results.

V. Re, "How to Measure Contact and Earth Voltages," Elettrificazone, (Italy), no. 10, October 1977, pp. 445-456.

This paper is in Italian with an English translation of the title and abstract.

The grounding protection of electrical equipment operating at rated voltages of greater than 1000 V is discussed. Measured values of contact and earth voltages are tabulated.

A. L. Richard, Jr., "Ground Fault Protection of Low-Voltage Equipment for Solidly Grounded Wye Electrical Services," IEEE Transactions on Industry Applications, vol. IA-13, no. 5, September/October 1977, pp. 461-468.

The shortcomings of ground-fault protection sensors on 277/480-V systems is described. This paper proposes the use of current limiting fuses in conjunction with the shunt trip switch and ground-fault relay to minimize equipment damage and down time.

F. A. M. Rizk, "Low-Frequency Shielding Effectiveness of a Double Cylinder Enclosure," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 1, February 1977, pp. 14-21.

The resultant electromagnetic field induced inside a long double cylinder shield is determined through the solution of the Maxwell field equations. A transmission line analogy is developed. The field equations are solved numerically. Plots are given of the shielding effectiveness as a function of shield thickness in skin depths.

This paper is followed by an editorial summary by R. B. Schulz. The significance of Rizk's analysis is summarized for the applications oriented reader.

J. D. Robb, T. Chen and W. Walker, "Integral Fuel Tank Skin Material Heating from Swept Simulated Lightning Discharges," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The results of an experiment to determine the "hot spot" temperture on a metal fuel tank caused by a simulated lightning discharge are reported. An infra red scanning camera was used to locate the "hot spot." Aluminum, titanium and stainless steel were tested.

W. D. Rust and P. R. Krehbiel, "Microwave Radiometric Detection of Corona from Chaff within Thunderstorms," Journal of Geophysical Research, (USA), vol. 82, no. 27, September 20, 1977, pp. 3945-3950.

A microwave radiometer that can be used to detect the presence of lightning is described. This instrument operates at a frequency of 3 GHz and detects the high frequency radiation generated by the corona.

S. Safavi-Naini, S. Lee and R. Mittra, "Transmission of an EM Wave Through the Aperture of a Cylindrical Cavity," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 2, May 1977, pp. 74-81.

The penetration of an electromagnetic field through an aperture on a cylindrical structure is analyzed by the method of moments. The expression for the coupled field is evaluated numerically and plots of the normalized energy density inside the cavity as a function of frequency are given. The only aperture for which plots are given is rectangular.

An editorial summary by R. B. Schulz follows this paper. The authors' analysis may be used to determine the shielding degradation of a rectangular aperture in a cylindrical structure.

H. H. Sandager, "Sensitive Circuits Require Transient Surge Protection," EDN, February 20, 1977, pp. 113-117.

This article discusses how to ground equipment to minimize overvoltage caused by transient surges. The recommendations are: interconnect cabinet grounds which are then connected to earth ground, ground only one end of a shield to break ground loops, never place signal-carrying wires in the same cable with power wires and when two or more shielded cables are placed in the same cable they should each be covered with an insulator. After covering the grounding aspects of the transient surge problem, various electronic remedies are examined.

G. J. Sellers, "METGLAS^{R} Alloys: An Answer to Low Frequency Magnetic Shielding," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

A new amorphous metal alloy for use in low frequency magnetic shielding is described. Plots of the shielding ratio as a function of the applied magnetic field for spiraled layers are given. Attenuation of 20-40 dB for 60 Hz magnetic fields can be achieved.

V. I. Shchutskii, "Point Electrode for Measuring the Specific Resistance of the Ground," Iznestiya Vysshiky Uchebnykh Zavedenii, Gornyi Zhurnal, no. 10, 1977, pp. 114-115.

This paper is in Russian with an English translation of the title and abstract.

The construction and operation of an instrument for the measurement of the specific resistance of soil is described. A split tubular steel electrode is used which can be lowered down a cylindrical borehole. At any depth the electrode can be expanded tightly against the wall of the bore hole when measurements are to be made thus minimizing errors due to stepwise irregularities in a geoelectric cross-section.

D. R. Skinner, "Lightning Protection for an Oilfield Automation and Instrumentation System," Journal of Petroleum Technology, November 1977, pp. 1405-1409.

The lightning protective system for the automation and instrumentation system of an oilfield situated on flat, high plains is described. The primary protective device is the spark gap which is used to protect both analog and digital circuits. Spark gaps prevent high surges of voltage, induced by lightning on underground cables, from damaging low-voltage equipment used in the automation of a large waterflood project. Auxiliary devices include Zener diodes and limiting resistors to limit voltages pulses until the spark gap actuates. It was found that the installation of the lightning protective devices lowered the device down from 16.6% to 0.13% during the thunderstorm season of 1974.

This paper is also published in the Proceedings of the Society of Petroleum Engineers - AIME 1977 Permian Basin Oil and Gas Recovery Conference, Midland, Texas, March 10-11, 1977.

H. I. Stanback, Jr., "Predicting Damage from 277-V Single Phase to Ground Arcing Faults," IEEE Transactions on Industry Applications, vol. IA-13, no. 4, July/August 1977, pp. 307-314.

Laboratory tests of single phase 277-V arcing to ground faults were performed. A separation of 1 to 4 inches from the bus bars to ground at current levels of 3000 to 26,000 A yielded an emphirical formulae for the damage as a function of current and time. The use of ground fault protectors to minimize damage is discussed.

E. Suss, "Bestimmung der symmetrischen Impedanzen fur Einleiterkabel fur die Kurzschlusstromberechnung in niederohmig geerdeten Netzen (The Determination of Symmetrical Impedances for Single-Core Cables to Calculate Short-Circuit Currents in Low-Resistance Earthed Networks)," Elektrie, vol. 31, no. 8, 1977, pp. 412-414.

This paper is in German with an English translation of the title and abstract.

The calculation and measurement of the symmetrical cable impedances when a low resistance neutral ground is used is discussed. An example is illustrated.

T. Suzuki and K. Miyake, "Experimental Study of Breakdown Voltage-Time Characteristics of Large Air Gaps with Lightning Impulses," IEEE Transactions on Power Apparatus and Sytems, vol. PAS-96, no. 1, January/February 1977, pp. 227-233.

An experiment to investigate the breakdown phenomenon for rod-plane and rod-rod air gaps was performed. The gap spacing was varied from 1 to 5 meters. It was empirically determined that the variance of the breakdown time follows a log normal probability distribution. The effect of streamers and leaders on the breakdown time was investigated.

P. Szommer, "On the Earthing of Reinforced Concrete Foundations," Villamossag, (Hungary), vol. 25, no. 12, December 1977, pp. 372-375.

This paper is in Hungarian with an English translation of the title and abstract.

It was determined that reinforced concrete foundations are useful as a natural grounding media. This was established by thermal and electrical experiments. The voltage rise on a steel mesh for short circuit current flow was measured. Calculations based on these measurements indicate that currents due to short circuits or lightning will have no concomitant thermal damage.

K. Takagi, "Breakdown Characteristics Under Steep-Front Impulsive Voltages," Researches of the Electrotechnical Laboratory, (Japan), no. 774, December 1977, pp. 1-148.

A technique for generating a steep-front impulse high voltage to simulate lightning and of measuring accurately this voltage is discussed. The application is the lightning protection of power lines. Using this impulse voltage, the breakdown characteristics of different insulators was investigated and a guide to insulation design developed.

M. Takanashi and S. Shirakawa, "Switching Overvoltage of Current-Limiting Fuses and Operating Duties of Lightning Arresters in Distribution Systems," IEEE Power Engineering Society, Winter Meeting, January 30 - February 4, 1977, New York.

The switching volages generated when current-limiting fuses open to interrupt high fault currents was experimentally examined. The energy consumption of a lightning arrester for the destruction limit is plotted. It is recommended that the highest voltage lightning arrester that will just suffice to protect system insulation be used when the arrester will be used in a severe discharge duty situation.

J. D. Tranen, R. A. Hedin, J. J. Minnick and K. W. Priest, "Lightning Protection Requirements of SF/Sub 6/Substation Determined by Hybrid Simulator," Proceedings of the American Power Conference, vol. 39, April 18-20, 1977, Chicagom, Illinois, pp. 1288-1294.

The determination of the lightning protection requirements of a 115-kV/345-kV substation via the use of a hybrid computer simulation is described. It was found that the steepest lightning wavefront may not produce the largest substation voltage.

Vance, Coupling to Shielded Cables, John Wiley & Sons, New York, 1977.

The coupling of electromagnetic energy into above ground and buried shielded cables it the subject of this book. The electrical properties of soil are discussed

and the equations for the propagation of electromagnetic waves above and below ground are given. These equations are then used to predict the distribution of current and voltage on above and below ground cables. Coupling through cable shields is analyzed for different types of shields. Transfer impedances and admittances for these shields are plotted as functions of shield thickness and frequency for different shield materials.

A review of this book by J. R. Wait is included in the August 1979 IEEE Antennas and Propagation Society Newsletter.

Z. S. Verina, O. A. Lunev, S. A. Sokolov and A. V. Kuznetsov, "Composite Protection of Cables Against Corrosion, Lightning and Electromagnetic Effects," Telecommunications and Radio Engineering, vol. 31-32, no. 7, July 1977, pp. 19-23.

The tradeoffs between the requirement that the jacket of the cable should be grounded at small periodic intervals to reduce the voltage induced by lightning and the requirement that the jacket should be insulated from ground to minimize corrosion are discussed. It is recommended that the insulator be made out of conducting plastic. The use of diodes to limit surge currents is discussed. Experimental results for various types of cables are presented.

A. J. Visek, "Antenna or Ground?" EDN, April 20, 1977, pp. 15-16.

In this letter to the editor of EDN, Visek states his disagreement with Sandager's article on transient-surge protection that appeared in the February 20, 1977 edition of EDN, Sandager said that shields should be grounded at only one end to break ground loops, Visek states that while a shield grounded at one end may break ground loops, it acts as an antenna for RF signals. Thus, a shield grounded at both ends permits shunting of RF energy to ground and reduces coupled in RFI.

J. R. Wait and D. A. Hill, "Electromagnetic Shielding of Sources Within a Metal-Cased Bore Hole," IEEE Transactions on Geoscience Electronics, vol. GE-15, no. 2, April 1977, pp 108-112.

A metal-cased bore hole is modeled as infinitely long right circular cylinder surrounded by a thin concentric ring of metal embedded in a homogeneous rock formation. The solution of Maxwell's equations in cylindrical coordinate is obtained. Plots of the ratio of the internal to external electromagnetic field are given as a function of frequency.

J. R. Wait, "Electromagnetic Field Analysis for a Coaxial Cable with Periodic Slots," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-19, no. 1, February 1977, pp. 7-13.

This paper analyzes the penetration by an electromagnetic wave of a cylindrical structure with a periodic array of circumferential slots. The Hertz

potential formulation is used to obtain an expression for the electric and magnetic fields in each slot. An expression for the effective admittance is derived.

D. S. Whitfield, "Electric Supply Authority Earth Faults and Induced Voltages on Communications Lines," New Zealand Energy Journal, vol. 50, no. 6, June 25, 1977, pp. 87-92.

A brief presentation of the problem of voltages being induced in communications lines by faults in power systems is given. Approximations of ground fault currents are given.

G. Wuttke, "Doppelerdschlussstroeme in Mittelspannungskabelnetzen (Double Earth Shortcircuited Currents in Medium-Voltage Cable System)," Elektrie, vol. 31, no. 8, 1977, pp. 402-406.

This paper is in German with only an English translation of the title and abstract.

In medium-voltage cable systems with insulated or inductively grounded neutral, the shortcircuit current flowing during a double earth shortcircuit is the highest current to which metal sheaths and concentric conductors of power cables are subjected. This shortcircuit current is analyzed in this paper.

V. M. Yurinov and N. V. Silin, "The Use of Analog Ladder Circuits for Calculating Multilayer Fields," Power Engineering, (Academy of Science USSR), (USA), vol. 15, no. 2, 1977, pp. 78-84.

The shielding properties of multilayer shields are analyzed using the theory of analogue ladder circuits to solve the pertinent two dimensional electromagnetic field problem. An estimate of the accuracy of this analysis is given.

C. Wu and D. K. Cheng, "Field Distribution Inside a Box with Aperture," 1977 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1977.

The theoretical shielding properties of a rectangular, hollow, conducting box with a single aperture are investigated. The method of moments is used to solve the integral equations for the coupled in field. Plots of the calculated field are given for different ratios of the wavelength to box dimensions.

J. E. Zimmerman, "SQUID Instruments and Shielding for Low-Level Magnetic Measurements," Journal of Applied Physics, vol. 48, no. 2, February 1977, pp. 702-710.

A thick-walled aluminum enclosure which provides low-frequency shielding for biomagnetic measurements is described. The attenuation of low-frequency ac magnetic fields is proportional to frequency when the frequency is greater than 1/3 Hertz. If the aluminum enclosure has an approximately chosen symmetry, fluctuations in an external uniform field will not induce ac field gradients at the center of symmetry of the enclosure.

1978

F. E. Acker and P. S. Coulon, "A Procedure for Stray-Voltage Surveys in Underground Coal Mines," Proceedings of the Fourth West Virginia University Conference on Coal Mine Electrotechnology, August 2-4, 1978, Morgantown, West Virginia, Published by the IEEE, New York (Cat. N 78CH1386-2 IA).

The stray voltages that arise between grounded equipment in an underground mine and the local earth is the subject of this paper. A procedure for identifying stray-voltages sources for those cases not resolved by normal maintenance activities is given. The stray-voltage waveforms were anlayzed and a spectral correlation established with mining activity and equipment operation. Recommendations for the reduction of stray voltages are given.

F. G. Aliev, I. I. Iskakov, M.V. Kostenko and F. K. Khalilov, "On the Reliability of Lightning Protection for 35 and 110 kV Substations," Power Engineering, vol. 16, no. 6, 1978, pp. 63-68.

Twenty years of data on the operation of lightning-protection circuits is summarized. The conventional Leningrad Polytechnic Institute method and a numerical technique were used to determine substation lightning protection reliability. Program flowcharts for these calculations are given. It was concluded that the Leningrad Polytechnic Institute method is unsuitable for practical reliability index calculated by the numerical technique gave satisfactory agreement with the data.

E. B. Al'tshuler and M. A. Anerbukh, "Electrical Parameters of Long Pipes above Ground Level," Elektrichestvo, (USSR), no. 1, January 1978, pp. 26-30.

This paper is in Russian with an English translation of the title and abstract.

An analysis of the electromagnetic fields in and around an elevated pipe which is insulated from the frozen ground by supports is made. Economic considerations involved in grounding installations where the ground is permanently frozen are discussed and includes the case for which snow will be on the ground during the winter. Pertinent formulae for the determination of the primary parameters regarding the height of the pipes above the ground are given for both the case of a uniform and two layer earth.

S. M. Apollonskii, "On Calculating Thin-Walled Conducting Spherical Shields," Power Engineering, (Academy Science USSR), (USA), vol. 16, no. 1, 1978, pp. 56-64.

The shielding properties of thin-walled conducting spherical shields are investigated through the solution of the appropriate Maxwell equations. Sufficient generality is incorporated into the mathematical model to permit a nonuniform electrical conductivity in the shield. A dipole of arbitrary orientation was used to illuminate the shield. It was determined that the shielding efficiency depends not only on the diameter of the shielding sphere and its electrical characteristics, but

also on the placement and orientation of the dipole. It was found that if there is a zonal nonuniformity in the electrical conductivity of the shield that the shielding is enhanced. A comparison with experimental data is given.

A. Bedrossian, "Industrial Interferences. II. Reducing the Interferences," Analyses MG. Revue Technique Merlin Gerin, (France), no. 17, 1978, pp. 1-8.

This paper is in French with an English translation of the title and abstract.

Techniques for the evaluation of electromagnetic interference levels and shielding measures are discussed. Optimum shielding conditions are expressed as a function of the external perturbing field and the distance between source and sink.

R. R. Beer and R. A. Nelson, "Practice and Accepted Rules of Shielding Power Cables," IEEE Transactions on Industry Applications, vol. IA-14, no. 4, July/August 1978, pp. 352-356.

A brief history of power cable shielding is given. Some types of shields and reasons for shielding are given. Since a large shield current may result if shields are grounded or bonded at more than one point, it is recommended that one end be insulated. An alternative technique for minimizing the shield current, cross-bonding shields, is discussed.

J. L. Bennett and G. R. Sima, "Electric Shock Prevention," Proceedings of the Fourth West Virginia University Conference on Coal Mine Electrotechnology, August 2-4, 1978, Morgantown, West Virginia, Published by the IEEE, New York (Cat. N 78CH1386 2 IA).

The grounding system used in underground mines for the protection of equipment and personnel is discussed. Safety grounding diodes are used to shunt dangerous voltages levels which may appear on DC powered mining equipment to ground. The number of diodes required depends on the horsepower of the machine. Failure modes of grounding diodes are included. Typical earth contact resistances encountered in underground mines are presented.

G. W. Benz, "A Practical Solution for Telephone Noise Problems Related to Power Line Capacitors," Conference Record of the 1978 National Telecommunications Conference, Birmingham, Alabama, December 3-6, 1978.

The use of proper grounding, bonding and shielding techniques to reduce the magnetic inductive coupling from three phase power lines to parallel telephone lines is mentioned in this paper. This unwanted coupling is increased by the use of grounded power factor correction capacitors on the power distribution system.

T. Bernstein and T. S. Reynolds, "Protecting the Royal Navy from Lightning - William Snow Harris and His Struggle with the British Admiralty for Fixed Lightning Conductors," IEEE Transactions on Education, vol. E-21, no. 1, February 1978.

This paper presents a detailed history of lightning protection practices used on board British naval vessels from Benjamin Franklin's invention of the lightning rod in 1752 to 1850 when practically all of these vessels had Harris' conductors. A Harris conductor is a fixed lightning rod mounted on the mast of the ship routed along the aft side of the mast down through the hull to copper sheathing mounted on the bottom of the ship. No theoretical conjectures are advanced or experimental results presented on the nature of lightning or lightning protection.

F. J. Bias, "Some Effects of Grounding and Bonding Requirements on Cable Television Systems," Third Annual Conference of CATV Reliability, March 7-8, 1978, St. Louis, Missouri, pp. 67-71.

The bonding and grounding requirements for CATV networks are complicated by numerous electrical codes and government regulations. This paper suggests that compliance with these requirements can be met by adhering to the grounding and bonding practices of telephone and power company pole attachment agreements.

W. Bogajewski, J. Lorenc and M. Mackowiak, "Analiza Zagrozenia Porazeniowego W Miejscu Jednofazowego Zwarcia Z Ziennia W Sieci Napowietrznej Sredniego Napiecia Wyposazonej W Doziemniki. (Analysis of Electric Shock Hazard in a Spot of Single-Phase Ground Fault in an Overhead Medium-Voltage Network Equipped with a Grounding Electrode)," Archiwum Elektrotechniki, (Warsaw), vol. 27, no. 4, 1978, pp. 917-925.

This paper is in Polish with an English translation of the title and abstract.

Factors effecting the electric shock hazard at the location of a single-phase ground fault on a medium voltage network with an insulated or compensated neutral which is provided with earth electrodes are analyzed. Basic theoretical relationships are developed and experimental verification is presented. Conditions leading to the reduction of electric shock hazard at the location of a single-phase ground fault are included.

R. Boll, "Magnetic Materials in Switching and Protective Devices," Journal of Magnetism and Magnetic Materials, (Netherlands), vol. 9, no. 1-3, October-November 1978, pp. 130-146.

This paper is in German with an English translation of the title and abstract.

A survey of magnetic material ranging from extremely soft to extremely hard, that may be used for magnetic shielding is given.

P. K. Bondyopadhyay, "Electromagnetic Field Penetration Into a Spherical Cavity - A New Approach," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

This paper develops equations which can be used to evaluate the shielding degradation due to an aperture in a spherical enclosure. Maxwell's equations are solved in spherical coordinates coupled in fields are calculated numerically and plotted.

D. Boobalan, "Lightning," Electrical India, vol. 18, no. 16, August 31, 1978, pp. 14-16.

The physical mechanism of lightning phenomenon is discussed. Topics covered are: the charging mechanism, the nature of the lightning stroke and the effects on lightning protection systems.

W. L. Braun, "A Reliable and Reproducible Technique for Evaluating the Shielding Effectiveness of CATV Apparatus," Annual NCTA (National Cable Television Association) Convention, 27th, (Published by NCTA, Washington, D.C.), New Orleans, LA, April 30 - May 3, 1978, pp. 99-105.

A technique for measuring the shielding effectiveness of connectors used in cable TV apparatus is described. A swept frequency range of 5-300 MHz is employed to measure shielding levels over a range of 150 dB. A screen room is not required. The experimental configuration used is illustrated along with oscillograms of the measured radiation leakage of the connectors as a function of frequency.

J. Brettle, "Electrical Bonding Problems in Aircraft," Proceedings of the Conference on Electromagnetic Compatibility, April 4-7, 1978, Guildford, England, pp. 229-237.

The general requirements for electrical bonding in aircraft are discussed with specific consideration to requirements produced by lightning conduction and static grounding.

B. Bridger, Jr., "The How's and Why's of High-Resistance Grounding," Electrical Construction and Maintenance, (USA), vol. 77, no. 4, April 1978, pp. 82-88.

Whether to use solid, low resistance, high resistance or no grounding of an A-C power transmission and distribution system is the subject of this paper. The advantages and disadvantages of these different grounding techniques is explained. High resistance grounding has the advantages that the flash hazard to personnel during a ground fault is minimized and the arcing fault damage to equipment during the fault is also minimized regardless of the location of the fault. But, with high resistance grounding, a method of detecting, locating and removing the fault promptly must be included.

G. W. Brown, "Lightning Performance I: Shielding Failures," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 1, January/February 1978, pp. 33-38.

A new technique for determining shielding failure (the failure of a shield wire to prevent a lightning stroke from striking a power line) and shielding failure outage rates is presented. Shielding failure is approximately a function of only the maximum strike distance. This paper, essentially, presents an approximation for the maximum strike distance which is valid if the difference in the heights of the power line and shield wire is greater than half the maximum strike distance. Using this approximation for the maximum strike distance, the shielding failure outage rate is calculated and found to compare favorably with measured values.

G. W. Brown, "Lightning Performance-II Updating Backflash Calculations," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 1, January/February 1978, pp. 39-52.

A technique for determining the backflash performance of extremely high voltage transmission lines is presented. The effects of corona, bound charges, stroke location along the span between transmission towers, the joint probability distribution of the rate of rise of stroke current and its crest magnitude, frequency distribution of footing resistance, terrain type, stroke location and system voltage are included in the system model. The tower top voltage is determined as a function of the rate of rise of the stroke current. The footing resistance was assumed to have an exponential distribution. The probability of flashover is determined as a function of the footing resistance.

A discussion of this paper follows by E. R. Whithead, A. M. Mousa and J. J. LaForest. Some of Brown's assumptions are critized and factors other than those considered in Brown's model are discussed.

G. W. Brown, "Joint Frequency Distribution of Stroke Current Rates of Rise and Crest Magnitude of Transmission Lines," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 1, January/February 1978, pp. 53-58.

The probability density function of lightning stroke current and the rate of rise of the stroke current is the subject of this paper. Both are shown to be well fit to a log-normal density. The mean and standard deviation of the stroke current and the rate of rise of stroke current is given.

This paper is followed by a discussion by A. M. Mousa which elaborates on the experimental data used by Brown.

P. G. Brown, I. B. Johnson and J. R. Stevenson, "Generator Neutral Grounding - Some Aspects of Application for Distribution Transformer with Secondary Resistor and Resonant Types," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 3, May/June 1978, pp. 683-694.

Two techniques of grounding the neutral of a generator were analyzed on a network analyzer. These two techniques were a distribution transformer with secondary resistor grounding and resonant grounding. High resistance grounding was found to exhibit a relatively fast exponential return to normal while resonant grounding had a slow return to normal.

L. E. Burnett, J. W. Cartwright, B. Ramratnam and V. Caleca, "Safety Considerations of Joints in Towers Utilizing Corrosion-Resistant Alloy Steels," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 5, September/October 1978, pp. 1501-1508.

This paper examines voltages induced on transmission line towers to determine whether they present a safety hazard to personnel. These voltages are caused by currents, induced by the power lines on the tower structure, flowing through high resistance joints. One of the factors that influence the currents on the tower structure is the current in the overhead ground wires on top of the transmission line towers. These ground wire currents were measured and presented in tabular form.

K. Burton, "How to Locate and Rectify Earth Faults," Electrical Times, (GB), no. 4492, September 29, 1978, p. 12.

Not available.

C. M. Butler, "A Review of Electromagnetic Diffraction by Small Apertures in Conducting Surfaces," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

A review of mathematical techniques used to calculate the electromagnetic field diffracted by small apertures in conducting surfaces is made. This is a tutorial paper. These techniques may be used to determine the shielding effectiveness of various structures.

K. F. Casey, "Advanced Composite Materials and Electromagnetic Shielding," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

An analysis of composite materials used in electromagnetic shielding is given. The composite panels were modeled as uniaxially anisotropic conductive or dielectric media. A bonded-mesh screen of composite panels was modeled as an equivalent sheet impedance operator with both resistive and reactive components which is spatially dispersive. The conductivity and permittivity dyadics were obtained for the composite materials and from these the sheet impedances were calculated. It was found that conductive composites are low-pass media and a bonded-mesh screen or a poorly conductive composite panel is a high-pass structure.

K. F. Casey and E. F. Vance, "EMP Coupling Through Cable Shields," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 1, February 1978, pp. 100-106.

A summary of recent research in the electromagnetic shielding of coaxial cables is given. Both tabular shielded cables and shields with apertures such as a braided wire shield are discussed. The hugh electromagnetic fields generated by a nuclear EMP requires that all cables be adequately shielded.

R. Cerasoli, "Electrical Installations for Computer Rooms," Elettrificazione, (Italy), no. 1. January 1978, pp. 24-30.

This paper is in Italian with an English translation of the title and abstract.

The quality, availability and method of distribution are considered to be the most important criteria for the electrical supply for computer installations. Various types of performance degradations are examined. Proper grounding techniques are analyzed.

R. Cercisoli, "Electrical Installations for Computer Rooms," Elettrificazione, (Italy), no. 7, July 1978, pp. 309-313.

This paper is in Italian with an English translation of the title and abstract.

Practical experience in providing power for computer rooms, including proper grounding of the system, is summarized.

P. A. Chamorel, "Calculation of the Electrical Characteristics of HV Cables at Industrial Frequencies," Bulletin de l'Association Swisse des Electriciens (Organe Commun de l'Association Swisse des Electriciens ASE) et de l'Union des Centrales Swisses d'Electricite (VCS), (Switzerland), vol. 69, no. 2, January 28, 1978, pp. 77-82.

Although the title of the journal that this paper appears in is French, this paper is in German with an English translation of the title and abstract.

The effects of grounding on the longitudinal and transverse characteristics of unipolar and multipolar power cable feeders are discussed.

E. Cinieri and A. Fumi, "Sulle Sovratensioni Indotte dal Fulmine nelle Linee Elettriche d'Energia (Overvoltages Caused by Lightning in Electric Lines)," Energia Elettrica, vol. 55, no. 9, September 1978, pp. 404-410.

This article is in Italian with an English translation of the title and abstract.

The intensity and form of the overvoltage waves induced in an overhead electrical line by lightning are discussed in this article. The principle parameters

are the intensity and duration of the front of lightning current, the altitude of the line above earth and others. The retarded potentials are used to obtain an expression for the electric field intensity which is integrated to yield the voltage induced on the line as a function of distance and time in accordance with the transmission line equations. The results obtained may be used to evaluate the hazards of lightning to electrical lines.

D. W. Clifford, "The Impact of the Total Lightning Environment on Aircraft Flight Control Systems," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The effects of lightning induced transients on aircraft avionics are the subjects of this paper. In addition to the rapidly changing magnetic fields induced by the return stroke, the electric field changes and radiated RF fields induced by lightning are also incorporated into the model. Simulated lightning tests were performed. A plot of the induced voltage on a RG174 coaxial cable as a function of the rate of change of the electric field is given.

W. L. Cooley, A. Christman and H. W. Hill, "Remote Grounding of Large Surface Electrical Equipment," Proceedings of the Fourth West Virginia University Conference on Coal Mine Electrotechnology, August 2-4, 1978, Morgantown, West Virginia, Published by the IEEE, New York (Cat. N 78CH1386-2 IA).

An electrical grounding system for the protection of mine personnel above or below ground is presented. A low resistance ground bed is connected through a current-limiting resistor to the neutral point of the transformer secondary winding to ground the system. Step and touch potentials are determined. The effect of a lightning strike to large surface electrical equipment is discussed.

W. F. Cooper, Electrical Safety Engineering, Butterworth, London, England, 1978.

This book describes proper and safe operating procedures for electrical industrial apparatus. Grounding techniques to prevent electrical shock are discussed.

J. C. Corbin, Jr. and D. F. Strawe, "Electromagnetic Coupling Analysis of a Learjet Aircraft in a Lightning," Proceedings of the IEEE 1978 National Aerospace and Electronics Conference, Dayton, Ohio, May 16-18, 1978, New York, N.Y., 1978, pp. 644-648.

The coupling of electromagnetic energy from a lightning stroke to the interior of a Learjet is the subject of this paper. An experiment was performed in which electric and magnetic field sensors, as well as skin current sensors, were placed inside a Learjet to measure the coupled in energy. Electromagnetic and electric circuit models were developed to model the coupling mechanism. Measured data, from both actual lightning and simulated lightning, is compared to

theoretical predictions using the double exponential model for lightning strokes. The comparison is favorable.

M. L. Crawford, J. L. Workman and C. L. Thomas, "Expanding the Bandwidth of TEM Cells for EMC Measurements," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 3, August 1978, pp. 368-375.

This paper describes a modification of a TEM (transverse electromagnetic) cell used to measure electromagnetic shielding parameters. Tests performed with RF-absorbing material show that the maximum useable upper frequency may be extended by a factor of two. Plots of the VSWR (voltage standing wave ratio), the electric field strength at the center of the test zone and the ratio of the coupled to radiated power as functions of frequence are given.

J. C. Cronin, R. G. Colclaser and R. F. Lehman, "Transient Lightning Overvoltage Protection Requirements for a 500 kV Gas-Insulated Substation," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 1, January/February 1978, pp. 68-78.

An insulation coordination study of a 500 kV gas-insulated substation is reported. The effect of the overhead line connected to the substation is considered. The amplitude and rise time of incoming overvoltages due to lightning or 60 Hz switching surges is predicted. It was found that the highest overvoltages were induced when the incoming wave encountered open switches inside the substation. The induced overvoltages are plotted as functions of time and tower footing resistance.

A discussion of this paper follows by J. J. Mimmick, R. A. Hedin, K. W. Priest, S. A. Miske, M. R. Stanback and K. Peterson which is essentially complementary.

M. Darveniza and F. Edmondson, "Lightning and the Perth-Geraldton 132 kV Line," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 2, March/April 1978, pp. 632-638.

The lightning protection devices used on a 132 kV power line between Perth and Geraldton Australia is described. Wooden poles are used to support the power lines. A comparison of the observed and predicted frequency of lightning strikes, flashovers and damage to the lines is given covering a three year period.

F. Dawalibi and D. Mukhedkar, "Transferred Earth Potentials in Power Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 1, January/February 1978, pp. 90-101.

An analytic technique for the determination the influence of buried metallic objects on the performance of power system grounds is presented. Of particular

interest is the safety hazard that may occur if high voltages are coupled from power system grounds to conducts, pipes, rails, metallic fences, etc. The method of cylindrical conductors is numerically solved and plots of the voltage induced on various buried metallic objects are given.

A discussion of this paper follows by M. A. Rahman which suggests that the authors technique may be extended to nonconducting plastic-type which are used in grounding.

C. P. DeLong and W. L. Cooley, "Measurement of Rail Bond Impedance," Proceeding of the Fourth West Virginia University Conference on Coal Mine Electrotechnology, August 2-4, 1978, Morgantown, West Virginia, Published by the IEEE, New York (Cat. N78CH1386-2 IA).

In some underground mines the metal rails for haulage carts are used as the return conductor in the mine power system. Each rail must be electrically bonded to the adjacent rails to minimize the resistance of this return conductor.

This paper examines the three techniques of providing rail bonds: direct weld, adhesive chemical bond and wire rail-bond. A block diagram of a instrumentation system (which is mounted on the haulage carts) for the determination of faulty bonds is given.

S. Demircioglu, A. J. Dinnin and L. P. Morin, "Improved Electrical Protection Scheme for Digital Carrier Systems," Conference Record of the 1978 National Telecommunications Conference, Birmingham, Alabama, December 3-6, 1978.

The protection of digital data transmission systems from lightning is discussed. A lightning strike may induce a voltage in the cable shield that exceeds the dielectric strength of the shield-to-core insulation. The use of protective devices such as carbon block protectors, zener diodes and low voltage gas tubes in numerous configurations is given. Cable breakdown probabilities are plotted as a function of the breakdown voltage for various values of the soil resistivity.

W. K. Dick and H. R. Holliday, "Impulse and Alternating Current Tests on Grounding Electrodes in Soil Environment," IEEE Transactions on Power Systems and Apparatus, vol. PAS-97, no. 1, January/February 1978, pp. 102-108.

Experimental data on the performance of grounding electrodes in a soil environment is presented. Sinusoidal excitation of different magnitudes and impulsive excitation were used. Plots of the impressed voltage and resulting current are given. Plots of the earth surface potential as a function of the distance from the grounding electrode are also given. The ground resistance was found to be lower than the static (DC) resistance for all excitations. The grounding electrodes that were tested were: galvanized steel and copper-jacketed steel, single and multiple rods, pole bottom ground plates, concrete encased conductors and concentric neutral conductor of primary underground cables.

B. C. Dillon and H. E. Watkins, "Transient Protection for Controlled Access System," IBM Technical Disclosure Bulletin, (USA), vol. 21, no. 3, August 1978, pp. 904-905.

The use of a transient protection circuit to protect the driver card of controlled access system readers from lightning induced transients coupled through telephone cable entrances is described.

J. A. Dobbing, A. W. Hanson and P. F. Little, "Simulated Lightning Attachments to Aircraft Skins," 5th International Conference on Gas Discharges, Liverpool, England, September 11-14, 1978, pp. 289-292.

The effects of lightning strikes on the skin of an aircraft are discussed. The frequency of lightning strikes is a determining factor in the selection of the thickness of the skin. The necessity of producing waveforms to simulate lightning is discussed.

D. Dyson, "Shielding Electrical Connectors," Electron, (GB), no. 145, October 10, 1978, p. 40.

The development of a novel technique, "iris concept" which permits a connector adapter system to have an electromagnetic shielding effectiveness not less than the interconnecting cable is reported. This technique may also be used for conduit, cable or loose wire boundless.

R. P. Fieux, C. H. Gary, B. P. Hutzler, A. R. Eybert-Bernard, P. L. Hubert, A. C. Meesters, P. H. Perrous, J. H. Hamelin and J. M. Person, "Research on Artificially Triggered Lightning in France," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 3, May/June 1978, pp. 725-733.

The results of a 1973 French project to produce artifical lightning by means of wires and rockets are reported. The triggering procedure is explained and the measured electromagnetic fields tabulated. The induced artifical lightning was found to be similar to natural lightning.

E. M. Freeman and M. H. S. El-Markabi, "A Simplified Computational Technique for Longitudinal H-Field Shielding," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 4, November 1978, pp. 514-516.

The longitudinal H field shielding of a set of coaxial circularly cylindrical tubes is determined. The tubes are modeled as a nonuniform transmission line. The shielding ratio is calculated using this transmission line equivalent. The experimental and theoretical shielding ratio are plotted as functions of frequency for the range 100 Hz to 10 kHz and the agreement is good. The authors point out that this problem formulation obviates Bessel functions.

J. Golinski, K. Lalus-Newrat and S. Nagnajewicz, "Impulse Characteristics of SF/Sub 6 Insulation systems," Przeglad Telekomunikacynjy, (Poland), vol. 54, no. 5, May 1978, pp. 207-216.

This paper is in Polish with an English translation of the title and abstract.

The lightning protection of metal clad SF/Sub 6 switchgear circuits is discussed. A comparison of the impulsive characteristics of model circuits with the protective characteristics of lightning arresters is given.

G. L. Graves and L. Anderson, "Laboratory Testing of Lightning and EMP Susceptibility of Avionic Systems," Proceedings of the IEEE 1978 National Aerospace and Electronics Conference NAECON 78, Dayton, Ohio, May 16-18, 1978, pp. 70-73.

A facility for the lightning and EMP susceptibility testing of the avionic systems of an aircraft is described. Included is a list of test equipment, waveform generators, etc. The results of a test of a digital automatic flight control system are reported.

B. R. Gupta and B. Thapar, "Inductance of Square Grids," Journal of the Institution of Engineers (India) Electrical Engineering Division, vol. 58, pt. EL-6, June 1978, pp. 320-323.

An analysis of the inductance of square grids with uniform square meshes is given. The resulting expressions are used to calculate the impedance of grounding mats for power substations.

B. R. Gupta and B. Thapar, "Characteristics of Steel Grounding Electrodes," Journal of the Institution of Engineers, (India), vol. 59, December 1978, pp. 170-174.

An analysis of grounding electrodes is given. It was found that when the length of the grounding electrodes is long that the effective length is limited by the electrode resistance and inductance. Several configurations of grounding electrodes are considered. Plots of the grounding impedance as a function of the length with the soil resistivity as a parameter are given.

G. Harz, "The Ratchet Screw as a Connecting Element in Prefabricated Indoor Switchagear," Elektrotechnische Zeitschrift ETZ A, (Germany), vol. 99, no. 2, February 1978, pp. 89-92.

This paper is in German with an English translation of the title and abstract.

The screwed connections used for the structure and casing must meet certain standards if the grounding of the constructional components is to be adequate. It is

the conclusion of this paper that ratchet screws are eminently suitable for this purpose.

W. Hauschild, "Construction of a High-Voltage Laboratory by the Department of Mechanical Engineering and Electrical, University of Damascus," Elektrie, (Germany), vol. 32, no. 3, 1978, pp. 124-127.

This paper is in German with an English translation of the title and abstract.

The grounding technique used at the high voltage laboratory at the University of Damascus is described.

P. Hasse, "Measures and Devices for the Overvoltage Protection of Electrical Equipment," Elektromeister and Deutsches Elektrohandwerk, (Germany), vol. 53, no. 9, May 1978, pp. 704-707.

This paper is in German with an English translation of the title and abstract.

This paper describes the grounding and bonding techniques used to protect electronic data processing equipment and remote control equipment from overvoltages caused by lightning. Protective devices which are currently available for overvoltage protection are discussed.

P. Hasse and J. Wiesinger, "Lightning Protection Applications," Elektrotechnische Zeitschrift ETZA, vol. 99, no. 12, December 1978, p. 760.

This paper is in German with an English translation of the title and abstract.

A model for analyzing buildings with lightning protection conductors is presented.

R. F. Hess, "Properties of Induced Transients Associated with EM Fields Produced by Lightning or Other Relatively Slow Rise-Time EMP," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The components of the voltage transients appearing in aircraft wiring due to lightning are examined. A numerical algorithm to evaluate currents induced on a thin wire scatterer was used. Plots of the induced currents as a function of time are given.

D. A. Hill and J. R. Wait, "Electromagnetic Surface-Wave Propagation Over a Rectangular-Bonded Wire Mesh," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 4, November 1978, pp. 488-494.

The propagation of an electromagnetic surface wave on a rectangular-bonded wire mesh of infinite extent is considered. The interwire spacing is different, in general, for the two intersecting perpendicular arrays. Floquet's theorem is invoked to determine the propagation constant as a function of frequency, interwire spacing and angle of incidence. The rectangular-bonded wire mesh structure was found to be highly anisotropic and, therefore, the shielding effectiveness of this structure will be highly sensitive to orientation.

Corrections to this article appear in vol. EMC-21, no. 3, p. 276.

E. Hoehne, "Die Gefahrdung von Kraftwerksgeneratoren durch vom Netz einlaufende Blitzinpulsspannungen (Dangers to which Power Station Generators are Exposed by Lightning Impulse Voltages Entering from the Mains)," Elektrie, vol. 32, no. 9, 1978, pp. 477-481.

This paper is in German with only an English translation of the title and abstract.

When lightning strikes the main line of a power system, an overvoltage is transferred by machine transformers to the generator. A technique of calculating such an overvoltage is presented. An example is numerically evaluated and the results are compared with insulation characteristics.

T. Horvath, "A Practical Method of Standardizing the Protective Effect of Lightning Air-Terminations," Elektrotechnische Zeitschrift ETZ A, (Germany), vol. 99, no. 11, November 1978, pp. 661-663.

This paper is in German with an English translation of the title and abstract

The probability of a lightning stroke is related to the distribution for lightning induced currents in this paper. The arrangement of lightning rods is determined by the sphere of protection which is determined by either the failure rate or the lightning rate.

G. S. Jean and Y. Latour, "Importance of Artificial Aging of High Tension Lightning Arrestors," IEEE Canadian Communications and Power Conference, October 18-20, 1978, Montreal, Canada, pp. 495-498.

The results of ageing tests on lightning arrestors for power systems operating at 108 kV and 72 kV are reported. A total of 650 tests were made.

H. Kaden, "Open Circularly Cylindrical Metal Strip as Shield and Return Circuit of a Single-Wire Line," Simens Forschungs-und Entwicklungsberichte (Research and Developments Report), (Germany), vol. 7, no. 2, 1978, pp. 82-90.

An analysis of the electromagnetic shielding of the field of a single-wire line by a metal strip is made. It was found that a plane metal strip has a greater shielding effect than a bent strip. The inductance and capacitance are calculated as functions of the aperture angle. The theory of conformal transformations was used to solve magnetostatic and electromagnetic equations.

K. M. Kalangium, "Shield Grounds on Shielded Twisted Pair Single Point Ground Circuits," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The effects of improper shield grounds on shielded twisted pair wiring are examined when the wiring is used in a single point circuit ground configuration. If the shield grounds are improper, low frequency magnetic fields may be coupled into the circuit producing an undesired disturbance. However, the desired grounding scheme depends on the purpose of the shield. Shields used for protection against low-frequency electric fields must have only one ground point.

K. Kamiike and N. Eguchi, "Lightning Protection for Microwave Relay Station," Japan Telecommunications Review, vol. 20, no. 1, January 1978, pp. 63-70.

A three year study of lightning damage to microwave relay stations-over which 100% of Japan's television program traffic and 50% of its telephone traffic are carried - is reported. Since these relay stations are normally located near the summit of mountains, lightning strikes are common. A total of 620 strike routes were analyzed with lightning strike current peak values estimated as high as 100 kA. Damage to the power equipment itself and the repeaters which use solid state type telecommunications equipment was found. The relationship between lightning damage and isokeraunic levels is illustrated.

The lightning protection technique utilized is to reduce the grounding impedance and to improve the bond between ground and ground wiring. Methods of decreasing the ground resistance are discussed.

The use of ZnO resistors to protect transistor type voltage relays from lightning surges is also discussed.

A. Karpati, I. Csaba, I. Ipsits and I. Hermann, "Overvoltage Protection of Inverters Against Atmospheric Overvoltages," Elektrotechnika, (Hungary), vol. 71, no. 10, October 1978, pp. 333-339.

This paper is in Hungarian with an English translation of the title and abstract.

The use of rectifier overvoltage protection to protect the primary of power system transformers from single-sided lightning strokes is discussed.

J. C. Klouda, "Practical Electromagnetic Shielding of Plastic Cases," Journal of Cellular Plastics, vol. 14, no. 1, January-February 1978, pp. 33-41.

Structural foam materials, such as plastic, are finding applications as housings for electronic equipment. These materials are lighter and cheaper than metal but, unfortunately, provide no electromagnetic shield-ing. This paper discusses methods of providing the structural foam material with additives which provide electromagnetic shielding. The techniques discussed are: spray plating, flame spray, conductive coatings, vacuum metalizing and cathode sputtering. The shielding effectiveness of these various techniques were measured and plotted as a function of frequency from 1 to 1000 megahertz. The electric arc discharge shielding effectiveness was also measured. The effects of humidity and electrostatic discharges are discussed. The cost per square foot of various types of coatings is given.

This paper is also published in the Proceedings of the SPI Structural Foam Conference, 5th, Scottsdale, Arizona, May 23-25, 1977.

M. Kobayashi, "Gapless Surge Arrester (SORESTER) for 500 kV System," Meiden Review, (International Edition), (Japan), no. 2, 1978, pp. 1-4.

A gapless surge arrestor for use on 500 kV power systems is described. The device is a zinc-oxide varistor which provide protection against multiple lightning surges.

J. L. Koepfinger, D. C. Bacvarov and R. G. Rocamora, "The Surge Protection of an SF_6 Gas-Insulated Substation Supplied by Pipe-Type Cables," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 6, November/December, 1978, pp. 2282-2288.

The lightning protection requirements of high voltage power distribution substations are discussed. A method of calculating the maximum rate of rise of incoming lightning surges is given. A lightning strike to an overhead line is modeled as a source injecting current into a surge impedance. Plots of induced voltage as a function of time are given.

N. F. Kotlyarenko, Y. V. Sobolev and A. I. Bazhenov, "Protection of DC Pulse Rail Circuits from Electrochemical Effects," Antomatika, Telemekhanika i Svyaz, (USSR), no. 9, September 1978, pp. 11-13.

This paper is in Russian with an English translation of the title and abstract.

The grounding of rails in an electrical railway network to reduce undersirable electrochemical effects is described.

D. Kramarczyk, H. Blume, K. Heinloth, H. Michels, "Shielding a High Magnetic Field with a Superconducting Tube," Nuclear Instruments and Methods, vol. 157, no. 1, November 15, 1978, pp. 71-73.

The use of superconducting tubes to shield transverse magnetic fields is described. The tubes were 40 cm long with an internal diameter of 3 cm. Several layers of a lead-tin alloy were used to cover the superconducting tube. An external transverse magnetic field of 1.9 T (Telsa) was reduced to less than 0.1 mT.

G. Kunkel, "Corrosion Effects on Field Penetration Through Apertures," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The degradation in the electromagnetic shielding effectiveness of strucutres due to corrosion of the walls of the structure is discussed. Corrosion may create new apertures, enlarge old ones, reduce wall thicknesses and alter the electromagnetic properties of the wall. Transfer impedances are plotted as a function of frequency for various metals that were aged for one year.

V. P. Larionov, V. G. Agapov and I. M. Sergieuskaya, "Lightning Protection of Aircraft Radar System and Dielectric Fairing," Elektrichestvo, (USSR), no. 3, March 1978, pp. 83-85.

This paper is in Russian with an English translation of the title and abstract.

Procedures, developed by both analytic and experimental methods for the reduction of the construction effort required to provide aircraft radar systems and dielectric fairings with lightning protection are presented. The lightning stroke probability was found to have an upper bound of 0.001 for the radar systems and 0.01 for the dielectric fairing. The number of rails required, their size and location on the fairing is stated.

J. P. Larrere, J. Leroy and J. Pieltin, "Protection des Arteres de Distribution Rurales Contre les Orages. Contribution a e'Etude du Phenomene Orageux. Protection Contre les Surtensions des Transformateurs de Distribution MT/BT et des Abonnes Basse Tension (Protection of Rural Distribution Systems Against Lightning. Contribution to the Study of Lightning Phenomena. Protection Against Overvoltages)," Electricite de France Direction des Etudes et Recherches, Bulletin, Series B: Reseaux Electriques, Materiels Electriques, no. 1, 1978, pp. 73-93.

This paper is in French with an English translation of the title and abstract.

The effects of lightning storms on rural low and high voltage distribution systems is empirically analyzed using ten years of data. A statistical characterization of the wave shapes of the lightning overvoltages was obtained. Some recommended procedures for the protection of electrical networks from lightning are given.

R. H. Lee, "Protection Zone for Buildings Against Lightning Strokes Using Transmission Line Protection Practice," IEEE Transactions on Industry Applications, vol. IA-14, no. 6, November/December 1978, pp. 465-470.

Plots of the protection zone provided by a vertical lightning rod as a function of the height of the rod, the height of the building and the horizontal distance of the building from the rod are given. A history of the different theories concerning the shape of the protection zone is

A discussion of this paper is also included. D. F. Shankle and A. Greenwood question Lee's figures.

P. F. Little, "Transmission Line Representation of a Lightning Return Stroke," Journal of Physics D, (GB), vol. 11, no. 13, September 11, 1978, pp. 1893-1910.

The lightning channel is modeled as a classical transmission line with a distributed inductance and capacitance per unit length. The parameter values are obtained from an assumed initial electrostatic field distribution. The predicted variation of current as a function of height is calculated and the implications for assessing the hazards to aircraft are discussed.

D. J. Lone, "Ground Fault Protection for Electric Utility Generating Station Medium Voltage Auxiliary Power Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 2, March/April 1978, pp. 583-586.

Techniques of grounding the neutral of a medium voltage auxiliary power system are discussed. The grounding techniques covered are: reactor, ground fault neutralizer, high resistance ground, low resistance ground and solid ground. Ground fault detection methods and recommended protection techniques are also covered.

D. Mackerras, "Prediction of Lightning Incidence and Effects in Electrical Systems," Institution of Engineers, Australia, Electrical Engineering Transactions, (Australia), vol. EE-14, no. 2, 1978, pp. 73-77.

Statistics on Australian thunderstorms including lightning flash are reported in this paper. Seasonal, diurnal and meteorological factors are included and a prediction of the mean rate of occurrence of lightning strikes to a given system is presented based on these statistics.

P. J. Madle, "Introduction to Field Penetration," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The electromagnetic shielding problem is discussed in general terms. The method by which shields reduce field levels, the effects of the geometry and the relative importance of the parameters are discussed. Different coupling mechanisms are given.

V. E. Manni, "Evaluating Motor Ground Insulation for Improved Operating Reliability," IEEE Transactions on Industry Applications, vol. IA-14, no. 5, September/October 1978, pp. 402-407.

Dielectric ground wall insulation for electric motors is discussed. Plots of dielectric leakage current as a function of time and impressed voltage are given.

P. S. Maruvada and G. Harbec, "Capacitive Power Tap-Off from Transmission Lines Using Ground Wires: Calculation of the Equivalent Circuit Parameters," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 4, July/August 1978, pp. 1194-1201.

This paper examines the possibility of using the capacitive coupling between the ground wire and phase conductors of a transmission line to supply small loads in remote regions along the line. An equivalent circuit for the case of one or two ground wires is obtained and analyzed. When two ground wires are used, it is recommended that one be earthed and insulating the other for power tap-off.

T. R. McComb, H. Linck, E. A. Cherney and W. Janischewskyj, "Lightning Research at the CN Tower in Toronto," IEEE Canadian Communications and Power Conference, October 18-20, 1978, Montreal, Canada, pp. 345-348.

The measurement of lightning currents on a tower and the effect of reflection on these currents are reported in this paper. A network of lightning flash counters was used to obtain these measurement. The measured lightning data may be used to design insulation coordination of power systems and lightning protection systems for tall structures.

N. A. Melikov, R. K. Musaev and F. L. Khydyrov, "How Altitude Above Sea Level Influences the Main Characteristics of Lightning (Transmission Line Protection)," Elektrichestvo, (USSR), no. 3, March 1978, pp. 77-79.

This paper is in Russian with an English translation of the title and abstract.

Some experimentally measured lightning statistics (the amplitude and rise time for the current waveforms) are tabulated as a function of altitude above sea level. From sea level to an elevation of 350 m it was found that the amplitude and steepness decrease considerably while from 350 m to 1,000 m the statistics are approximately stationary. No data was taken above 1,000 m.

H. A. Mendez, "Shielding Theory of Enclosures with Apertures," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 2, May 1978, pp. 296-305.

The electromagnetic fields outside of a metallic enclosure with apertures due to sources within the enclosure is the subject of this paper. This radiating structure is considered to be either a cavity with a small aperture in the wall or a waveguide short-circuited at one end and open at the other. The magnetic vector

potential produced by a center-driven thin dipole antenna is calculated from which the electric and magnetic field vectors are determined. It is assumed that the structure does not alter the current distribution on the wire. The fields produced by a square loop antenna are also determined. The induced-EMF method is used to determine the input impedance of a dipole antenna inside a cavity with apertures. The insertion loss of rectangular shielding boxes with apertures is cal-culated. An experiment was performed and the agreement with the theoretical results is fair.

Since this paper is highly theoretical, an editorial summary by R. B. Schulz follows which explains its contribution to the applications oriented reader.

S. O. Mitropol'skaya, "Studying Natural Earthing of a Working Dredge (Open Cast Mine)," Izvestiya Vyshiky Uchebnykh Zavedenii, Gornyi Zhurnal, (USSR), no. 5, 1978, pp. 54-57.

This paper is in Russian with an English translation of the title and abstract.

Since the boundary between the metal surface of a dredge pontoon and water is considerably larger than that between an artificial grounding electrode and ground, this article recommends that natural grounding be used for open cast mines and placer dredges. Plots are given of the grounding resistance, contact and step voltages for a natural earth for mines located in the Urals and the far East of the Soviet Union. The relationship between the electrical safety of the dredge and the properties of the electrical bond between the pontoon and water are discussed.

S. O. Mitropol'skaya, "Analyzing the Conditions for Electrical Safety within the Working Area of a Dredger," Izvestiya Vysshiky Uchebnykh Zavedenii, Gornyi Zhurnal, (USSR), no. 9, 1978, pp. 98-100.

This paper is in Russian with an English translation of the title and abstract.

The safety of power supply circuits for excavators and dredgers used in the Soviet mining industry are the subject of this paper. Calculations of the ground resistance and step voltage for the case of natural grounding and also for the most likely geoelectric parameters of the ground in the working area are given. A typical accident is described. The protected area provided by grounding system is determined.

K. F. Moore and R. S. Nelson, "A Low Voltage Lightning Arrestor Connector," Eleventh Annual Connector Symposium Proceedings, October 25-26, 1978, Cherry Hill, New Jersey, pp. 249-266.

The protection of the electronic components of a military weapons systems from lightning induced voltage surges is the subject of this paper. These surges may be as large as 1450 volts and are shunted to ground by the gaseous breakdown of a number of spark gap tubes surrounding the connector contacts.

A. J. Mullen, "Field Penetration of Shielding Barriers, Low Frequency Effects," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

Low frequency and static magnetic shielding are discussed. Below 100 Hz for iron and 300 Hz for copper, low reluctance magnetic paths are required for magnetic shielding. The solution of the magnetostatic equations is given for several simple geometries. It was found that geometries that introduce discontinuities may degrade the magnetic shielding.

D. Muliawan, H. Ruttgers and F. Kubli, "Interference Effect of Infusion Pumps in Monitoring of Birth by Cardiotocography," Biomedizinische Technik, (Germany), vol. 23, suppl. 54/1-2, May 31 - June 3, 1978, Stuttgart, Germany.

This paper is in German with an English translation of the title and abstract.

Interference with tocographs monitoring births by improperly grounded infusion pumps is reported in this paper.

A. D. Napoli, M. D. Stefano, C. Mazzetti and U. Ratti, "Criterio di Esposizione per la Protezione delle Strutture dalle Fulminzaioni di Origine Atmosferica (Criterion of Exposure for the Protection of Structures from Lightning), Elettrotecnica, vol. 65, no. 1, January 1978, pp. 7-23.

This paper is in Italian with an English translation of the title and abstract.

The protection of structures from lightning is examined beginning with the concept of exposure which is given a definition and an evaluation criterion. This paper is divided into two parts. In the first part, the concept of exposure is expressed in terms of exposure area so that a correlation between the characteristics of structures and the potential damage that lightning may have on these structures and the adjacent area. The second part of this paper examines the use of lightning protectors to decrease the exposure area. The efficiency of various lightning protection systems is evaluated.

W. Naumann, "Ursachen und Haufung von Blitzeinschlagen (Causes and Accumulation of Lightning Strikes)," Elektrie, vol. 32, no. 5, 1978, pp. 251-254.

This paper is in German with only an English translation of the title and abstract.

The fan-ball model is presented to explain the cumulative distribution function of lightning strikes.

A. V. Naumov, "Features of Earthing Structures and Equipment in Railway Systems," Avtomatika, Telemekhanika i Svyaz, (USSR), no. 9, September 1978, pp. 8-11.

This paper is in Russian with an English translation of the title and abstract.

A contacting network which is grounded to rails less than 5 meters from the structure is used to obtain a ground impedance of less than 0.5 ohms and this network is used to ground equipment. Various techniques for bonding the object to be grounded to the contacting network are discussed. The problems caused by the interaction of the grounding and cathodic protection systems are discussed. The unique problems of grounding A.C. railway electrical distribution networks are discussed.

G. Nozza, "IEC Standards in the Checking of Electrical Distribution," Elettrificazione, (Italy), no. 7, July 1978, pp. 314-318.

This paper is in Italian with an English translation of the title and abstract.

This paper considers IEC Standard No. 364 which pertains to low voltage power distribution systems. Included in this standard are methods for testing ground conductor continuity and determining ground resistance.

B. T. Olenchuk and W. L. Cooley, "Monitoring Electrical Ground Bed Corrosion," Proceedings of the Fourth West Virginia University Conference on Coal Mine Electrotechnology, August 2-4, 1978, Morgantown, West Virginia, Published by the IEEE, New York (Cat. N 78CH1386-2 IA).

The degradation of power system electrical grounds in underground mines due to the corrosion of the grounding rods is discussed. Non-invasive techniques of measuring ground bed corrosion are analyzed: ground bed-to-soil potential, bed resistance, current integrations, bed resistance and ultrasonics. The latter three techniques are considered to be the most reliable and feasible.

Z. Ormandlaky, "The Use of Concrete Foundation as Earth in Electrical Protective Systems," Villamossag, (Hungary), vol. 26, no. 6, June 1978, pp. 188-190.

This paper is in Hungarian with an English translation of the title and abstract.

Theoretical considerations involved in grounding are outlined and the design of a grounding system for use in industrial buildings using reinforced or ordinary concrete foundations is discussed. Sizes required for lightning rods are surveyed. The routing of the grounding system used in these buildings are discussed. An example is given using a concrete foundation as ground.

R. K. Panclay, J. C. Westh and J. Harri, "The Electrical Equipment of the Combined Gas-Steam Turbine Plant Donge," Polytechnisch Tijdschrift Elektrotechniek Elektronica, (Netherlands), vol. 33, no. 4, 1978, pp. 223-227.

This paper is in Dutch with an English translation of the title and abstract.

A power generating plant, known as the Donge Plant, which uses a 88 MW gas turbo-generator is described. Included in this description is the technique used to ground the stator.

J. C. Parker, Jr., "The Phasor Voltage Plot - A New Diagnostic Measurement Technique for Inductive Coupling," Conference Record of the 1978 National Telecommunications Conference, Birmingham, Alabama, December 3-6, 1978.

The use of a multi-ground neutral on a power distribution system to reduce interference inductively coupled by this power system into parallel telephone lines is discussed. Substantial cancellation in magnetic induction may be obtained by balancing the load on each phase of a three phase system. Instrumentation for measuring both the amplitude and phase of this voltage induced in phone lines is discussed.

W. Pejas, "Magnetische Abschirmung Eines Korrigierten Elektronenmikroskops. (Magnetic Shielding on an Electron Microscope)," Optik (Stuttgart), vol. 50, no. 1, February 1978, pp. 61-72.

This paper is in German with only an English translation of the title and abstract.

Methods of shielding on unround electron-optical corrector from magnetic fields are discussed.

G. Pfeiffer and D. Bernet, "Zur Berechnung der durch Blitzstroeme in Gebauden (Calculation of Contact Voltages Caused by Lightning Currents in Buildings)," Elektrie, vol. 32, no. 7, 1978, pp. 380-383.

This paper is in German with only an English translation of the title and abstract.

A technique to calculate the contact voltages of buildings whose lightning protective system consists of a roof structure and supports with individual earth plates are given. Two cases are considered. The first case is characterized by the maximum earth-plate lightning currents and rise time. The second case is characterized by equal lightning-current distribution on all supports and the decay time to half value. This technique was applied to a light-metal construction and indicated that the possibility of injury to humans must be accepted.

J. A. Plumer and L. C. Hoots, "Lightning Protection with Segmented Diverters," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The use of segmented diveters to protect radomes and other dielectric structures against puncture from direct lightning strokes is discussed. These segmented strokes is discussed. These segmented diverters are positioned so that they intercept a strike before streamers emanating from interval conductors have time to puncture the wall of the protected structure. The diverters were tested with simulated lightning.

A. A. Regotti and R. D. Valentine, "Grounding and Relaying for Pipeline Pump Protection," IEEE Transactions on Industry Applications, vol. IA-14, no. 1, January/February 1978, pp. 27-32.

The pipeline pump drive motors have grounding and relaying requirements that are generally equivalent to the protection requirements of large ac motors. Therefore, the grounding and protective relaying practices for large ac squirrel cage motors are reviewed in this paper.

J. D. Robb, T. Chen, W. Werner and G. Young, "The Parallel-Plate Transmission Line for Lightning Electromagnetic Effects Testing of Electronics Systems," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The use of a parallel plate transmission line to generate voltage transients to simulate lightning is discussed. Such a transmission line produces a uniform and predictable electromagnetic field. Diagrams of the constructed lightning simulator are given. Such a simulator most accurately models the lightning induced electromagnetic fields that occur in an aircraft.

Z. Rous, "New Components for Protecting Communications Equipment Against Overvoltages," Sdelovaci Technika, (Czechoslovakia), vol. 26, no. 10, October 1978, pp. 393-394.

This paper is in Czech with an English translation of the title and abstract.

The use of avalanche bipolar diodes and special varistors to protect communications equipment from atmospheric overvoltages is discussed. Ordinary diodes and Zever diodes were found to be insufficient. The voltage and current characteristics of these devices are compared.

H. J. Rusch, "Protection of Insulators in Stays of Radiating Antenna Masts," Funkschau, (Germany), vol. 50, no. 24, November 17, 1978, pp. 1206-1207.

The arcs induced on antennas may be maintained by the antenna broadcast radiation. This paper describes a technique of sensing the presence of a lightning induced arc and inhibiting transmission until the cessation of this arc.

A. Schei and J. Huse, "Currents Through Surge Arrestors Due to Lightning with Main Reference to Distribution Systems," Electra, (France), no. 58, May 1978, pp. 41-79.

This paper concerns lightning currents induced on power systems. It was found that the highest currents occur on systems operating at 24 kV or below. Above 123 kV, arrestor failures due to lightning rarely occur. A Monte Carlo simulation of the performance of a power system with grounded and ungrounded crossarms without ground wires is given.

G. J. Sellers, J. P. Dismukes, Y. Shiau, J. J. Krstamsky, R. E. Sharp and J. W. Kincaid, Jr., "Flexible Braids for Improved Magnetic Shielding of Cables," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The magnetic shielding effectiveness of ferromagnetic, amorphous metal alloy ribons is examined. It was found that in the frequency range from 60 to 400 Hz and applied field strengths from 0.01 to 10 oersteds that a shielding effectiveness in the range of 25 dB was obtainable.

Y. Shiau, J. Bridges and G. J. Sellers, "Wide-Band High Performance Very Flexible Coaxial Cable Shiel[illegible]," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

The shielding effectiveness of two basic cable designs was investigated. Namely, a RG-8 cable have one added amorphous metal braid and a modified RG-9 cable with two added amorphous metal braid were the cables tested. The addition of this additional braid produces a significant enhancement of the low frequency magnetic shielding effectiveness and high frequency transfer impedance. Plots of the measured transfer impedance as a function of frequency are given.

R. P. Sitter, "RFI-What It Is and How to Control It. Part II: Reduction of Interference," Instrumentation Technology, vol. 25, no. 10, October 1978, pp. 59-65.

This is the second of a two part article. The first part dealt with sources of electromagnetic interference. The second part deals with techniques for reducing the level of electromagnetic interference. Included are proper grounding, bonding and shielding techniques. The absorption loss for various metals is tabulated and formulae given to determine shield integrity. At radio frequencies, all metal cases are strapped to a ground plane to which all return currents flow. The use of metal pipes as an electrical ground is discussed. The importance of bonding together shield components, filter ground connections, the shield and the primary and the filter box to the shield is emphasized. Different grounding techniques are illustrated.

T. Skoulikidis and A. Tsakopoulos, "New Automatic Lightning Conductor Method of Applying Cathodic Protection to Metallic and Reinforced Concrete Constructions: Use of Atmospheric Electricity," British Corrosion Journal, vol. 13, no. 3, 1978, pp. 130-135.

A technique of using lightning to supply cathodic protection to prevent corrosion of large metallic objects embedded in the earth is described. Lightning conductors are connected to these metallic objects by means of diodes which permit only the absorption of electrons which provides the cathodic protection.

J. J. Soltys, "Maintaining EMI/RFI Shielding Integrity of Equipment Enclosures with Conductive Gasketing," 1978 IEEE Electromagnetic Compatibility Symposium, IEE, New York, 1978.

Methods of using various types of gaskets to enhance the shielding properties of enclosures are discussed. The objectives of electromagnetic shielding are discussed. No equations are developed or parameters plotted. Practical considerations in the construction of a shielded enclosure are emphasized.

A. B. Sorensen, "Screen Damping Coaxial Cables," Elektronik, (Denmark), no. 2, February 1978, pp. 5-6,8,10-11.

This paper is in Danish with an English translation of the title and abstract.

An introduction to electromagnetic shielding systems for the reduction of interference in coaxial cable connections between electronic equipment is presented. The analysis is approximate and considers only the dominant factors.

H. Stockmann, "Blitzschutz und Elektronische Einrichtungen (Lightning Protection and Electronic Equipment)," Elektrie, vol. 32, no. 7, 1978, pp. 376-379.

This paper is in German with only an English translation of the title and abstract.

The damage to electronic devices caused by lightning is not limited to puncture of the insulation. There may also be inadmissible power conversions. If lightning protective devices were installed on the circuit, this would not occur. The coupling of lightning induced transients into tubes with a small coupling resistance is considered.

P. Struzewski, "Lightning Stroke Point and Crest Current Dependence in Atmospheric Discharges Selectivity Evaluation," Wiadomsci Elektrotechniczne, (Poland), vol. 46, no. 13, July 1978, pp. 348-350.

This paper is in Polish with an English translation of the title and abstract.

Amplitude probability distributions for lightning strokes are reported. This lightning data can be used to design protection for power systems. A comparison of Polish and American lightning data is made. The interdependence between the lightning stroke point and crest currents was examined.

J. Suchoki, "Characteristic Impedance of a Lightning Channel and the Results for the Protection of High Structures," Elektrotechnische Zeitschrift ETZ A, (Germany), vol. 99, no. 11, November 1978, pp. 669-671.

This paper is in German with an English translation of the title and abstract.

A new technique for measuring the speed of lightning discharges is reported. The interaction of lightning and high structures is discussed. The production of a secondary wave which is produced by a reflection from the base of a total structure struck by lightning and the interaction of this secondary wave with the primary wave are described. This interaction may increase the effective height of the structure.

D. L. Swindler, "Modified Differential Ground Fault Protection Systems Suitable for Multiple Source Service Equipment Having Sources with Multiple Grounding," IEEE Industrial and Commercial Power Systems Technical Conference, June 6-8, 1978, Cincinnati, Ohio, pp. 95-117.

An explanation of how the grounding requirements for power system generators can be met without the use of 4 pole transfer switches and switched neutrals is given.

S. Szpor, "Inductive Voltage on a Chimney Caused by a Lightning Stroke," Archiwum Elektrotechniki, (Poland), vol. 27, no. 3, 1978, pp. 495-503.

This paper is in French with an English translation of the title and abstract.

The effect of an after-spark on the chimney of an industrial building caused by a lateral lightning stroke is discussed. The interrelation between surge currents, inductive voltages and the drainage conductors is considered. A technique for lightning protection involving lateral connections is presented.

C. D. Taylor and J. P. Castillo, "On Electromagnetic-Field Excitation of Unshielded Multiconductors," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 4, November 1978, pp. 495-500.

The electromagnetic field coupled into unshielded multiconductor cables above a ground plane by an impringing electromagnetic plane wave is considered as a problem in quasi-static circuit theory, transmission line theory and wire antenna theory. The induced currents are plotted as functions from 1 to 100 MHz.

R. J. Troup, "Logic Circuit Designs to Reduce EMI Emissions," 1978 Midcon Technical Papers, Dallas, Texas, December 12-14, 1978.

Electrical grounding, bonding and shielding practices to reduce electromagnetic interference are among the topics discussed. The interference is decreased by reducing emissions from the source and decreasing the susceptibility of the receiver.

K. R. Umashankar and J. R. Wait, "Electromagnetic Coupling to an Infinite Cable Placed Behind a Slot-Perforated Screen," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 3, August 1978, pp. 406-411.

The coupling of an impringing electromagnetic wave through a ground plane with a narrow slot to a cable behind the ground plane is considered. Plots are given of distribution of the axial-slot magnetic current and the electric current on the cable. The equations developed in this paper can be used to determine the shielding effectiveness of a cable placed inside an enclosure with slots.

B. V. Vasil'ev, V. K. Ignatovich and E. V. Kolychena, "Shielding of Weak Fields by Superconducting Shells," Soviet Physics Technical Physics, vol. 23, no. 9, September 1978, pp. 1100-1103.

The magnetic shielding properties of superconducting shells are examined. A method for calculating the magnetic field distribution near a superconducting shell is presented. Both longitudinal and transverse external fields are considered. The calculated shielding coefficient and the experimentally measured shielding coefficient for a superconducting cylinder used for SQUID measurements are well correlated.

R. Verma, A. Merand and P. Barbeau, "Design of a Low Resistance Grounding System for a Hydro-Electric Plant Located on Highly Resistive Soils," IEEE Transactions on Power Apparatus and Systems, vol. PAS-97, no. 5, September/October 1978, pp. 1760-1768.

A technique to reduce the ground resistance of a hydro-electric generation and transmission complex located on a highly resistive rock-bed terrain is presented. Nearby available volumes of water and low resistivity soils, such as clay, are used to reduce the high resistance to ground of the plant. The grounding grid is described. The effect of water on the resistivity of concrete is included in the analysis.

L. C. Walko, K. J. Maxwell, J. G. Schneider and A. V. Serrano, "Recent Advanced in Indirect Lightning Effects Research," 1978 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1978.

Recent advances in testing aircraft lightning susceptibility using simulated lightning are reported. Circuits for the generation of high voltage and current waveforms to simulate lightning are given. A transfer function analysis of the coupling of lightning induced disturbances into the interior of an aircraft is performed. Plots of the voltage measured inside an aircraft as a function of the current on the skin are included.

L. Wiechula and P. Wiechula, "Insulation Resistance Digital Measurement," Pomiary Automatyka Kontrola, (Poland), vol. 24, no. 5, May 1978, pp. 131-132.

This paper is in Polish with an English translation of the title and abstract.

A technique of digitally measuring insulation resistance which accounts for the nonlinearity of the resistance, large voltage and the grounding of one terminal of the circuit under test is presented. An example is given using the CAMAC system.

J. Wiesinger, "The Calculation of the Impulse Earth Resistance of Deep Earth Electrodes and of Surface Electrodes," Elektrotechnische Zeitschrift ETZ A, (Germany), vol. 99, no. 11, November 1978, pp. 659-661.

This paper is in German with an English translation of the title and abstract.

Currents induced in the ground by lightning are analyzed by modeling the ground rods and wires as transmission lines with a surge impedance that is represented as a PI-recurrent network of series inductivities and cross resistances. This model is then used to determine the resistance of ground rods.

T. Wu and L. L. Tsai, "Low-Frequency Shielding Properties of Conducting Cylindrical Shells of Arbitrary Cross Section," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-20, no. 2, May 1978, pp. 349-351.

An integral equation formulation is used to determine the low-frequency shielding properties of conducting cylindrical shells. The method of moments is used to solve this equation. The authors use the term "cylindrical" in its most general sense which includes cylinders with rectangular cross sections. The effect of slots in the shell walls is considered. Plots of the shielding effectiveness as a function of frequency are given.

1979

A. Anderson and E. Mumme, "Lightning Protection Design External Tank (Space Shuttle)," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The lightning protection system used to protect the Space Shuttle from lightning damage during liftoff is discussed. The protection scheme consists of a lightning rod on the forward most point of the external tank of the space shuttle and numerous continually grounded one inch wide conductive strips applied circumferentially at various stations on the shuttle.

J. G. Anderson, "How to Protect Rigs from Lightning Damage," Oil and Gas Journal, vol. 77, no. 35, August 27, 1979, pp. 100-102.

The use of bonding metallic components in oil rigs and grounding the bonded structure through a low resistance electrode to minimize lightning damage is discussed. The use of surge protectors (spark gaps, lightning arresters on transient suppressors) for the protection of sensitive electronic equipment is recommended. The use of isolation transformers to reduce lightning induced overvoltages and the importance of minimizing the area of inductive loops is also discussed.

A physical model of the lightning phenomenon is explained. An algorithm for the calculation of the probability of a lightning flash to an oil rig is developed. An isokeraumic map of the United States is included.

Anon, "Grounding Electric Shovels, Cranes and Other Mobile Equipment," National Safety News, vol. 120, no. 3, September 1979, pp. 79-82.

Procedures for grounding mobile equipment are discussed. It is recommended that the resistance of the grounding circuit not exceed three ohms. A diagram of a safe grounded neutral system is given. Voltage and currents levels that present hazards to personnel are discussed.

Anon, "Lightning Surge Protection of TV Translators," ABU Technical Review, (Japan), no. 60, January 1979, pp. 27-34.

There is no author listed for this paper.

Lightning damage to the solid state circuitry of TV translators is the subject of this paper. Techniques recommended for the lightning protection of this equipment are: isolation transformers, separation terminal-boards and the use of optic fiber transmission lines.

R. L. Araujo, H. G. Assumpcao, W. A. C. Triginelli and M. A. Almeida, "Behavior of High Resistivity Soils in a Tropical Area," IEEE Transactions on Power Systems and Apparatus, vol. PAS-98, no. 6, November/December 1979, pp. 2076-2082.

The variation of soil resistivity with various geological parameters in tropical areas is the subject of this paper. The soil resistivity determines the caliber of the grounding system. The soil resistivity is plotted as a function of moisture content for various South American sites.

H. Bauer, "Zur Berechnung von Blitzeinschlaghaufigkeiten fur Ausgewahlte und beliebige Objekte (To the Calculation of Frequency of Lightning Points of Impact for Selected and Arbitrary Objects)," Elektrie, vol. 33, no. 6, 1979, pp. 292-295.

This paper is in German with only an English translation of the title and abstract.

The probabilities of the occurence of different types of lightning strokes is determined for several objects. Binomial and Poisson distributions are used to model the lightning process.

N. S. Beloglazova, "Lightning Protectors for Low-Voltage AC Lines," Automatika, Telemekhanika i Svyaz, (USSR), no. 1, January 1979, pp. 15-18.

This paper is in Russian with an English translation of the title and abstract.

The operation and installation of discharge devices for lightning protection on 220/380 volt lines is described.

L. Bisiach and D. Cappellieri, "La Valutazione della Tensione Totale di Terra per Guasto in una Rete di Cani MT a Neutro Isolato (Evaluation of the Total Earthed Voltage as a Result of Breakdown in an Insulated Neutral MV Cable Network)," Energia Elettrica, vol. 56, no. 6, June 1979, pp. 293-297.

This article is in Italian with an English translation of the title and abstract.

This article discusses the ground fault voltage in a substation supplied by an insulated neutral cable network during a single phase ground fault. The use of protective devices to limit this voltage to a non-dangerous value is included. Experimental evidence is presented to justify the theoretical technique.

R. Blais and J. Belanger, "Lightning Direction Display," IEEE Power Engineering Society Winter Meeting, New York, N.Y., February 4-9, 1979, (Published for the IEEE Power Engineering Society by the IEEE, New York, N.Y.), Paper A 79 046-6.

A simple radio lightning direction finder is described. It is small and cheap and intended for the use of transmission line maintenance crews.

D. G. Bodnar, H. W. Denny and B. M. Jenkins, "Shielding Effectiveness Measurements on Conductive Plastics," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

A detailed description of a test facility that was constructed for measuring the shielding effectiveness of conductively loaded plastic panels is given. Plots of the shielding effectiveness versus frequency of various plastic panels are given. It was found that certain materials exhibit a negative shielding effectiveness. The frequency range for which measurements were taken was from 10 MHz to 1,000 MHz.

D. G. Bodnar and H. W. Denny, "Use of Internal Conductive Materials for Electromagnetic Shielding of Structural Foams," Society of Plastics Engineers, Inc., 37th Annual Technical Conference, New Orleans, LA, May 7-10, 1979, pp. 762-765.

A technique of supplying structural foam housings for equipment with a conductive material to provide electromagnetic shielding is discussed. The conductive material considered in this paper are: carbon/graphite fibers, metal coated glass fibers and metallic powders. The carbon/graphite fibers were recommended.

J. P. Brainard and L. A. Andrews, "Dielectric Stimulated Arcs in Lightning-Arrestors Connectors," IEEE Transactions on Components, Hybrids and Manufacturing Technology, vol. CHMT-2, no. 3, September 1979, pp. 309-316.

The results of an experimental study of the breakdown mechanisms in lightning arrestors are reported. It was determined that when a solid insulator surface bridges adjacent electrodes that the breakdown mechanism involves a surface flashover across the insulator. Oscillograms of measured breakdown voltage as a function of time are given.

W. Braun, "Hidden Earth Connections for Lightning Conductors," Elektrotechnische Zeitschrift ETZ, (Germany), vol. 100, no. 14, July 1979, pp. 752-754.

Requirement for building earth grounds are discussed. The necessity of protecting these grounds from corrosion and displacement is covered. It is recommended that grounding rods be made of steel or copper covered by lead to minimize corrosion and mounted between 0.5 and 9 meters deep to provide a low resistance ground. Some typical measured resistances are provided. The special grounding problems presented by swimming pools, antenna masts and aircraft stands are included.

J. Brettle and M. W. Baskerville, "Electrical Bonding in Aircraft," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The different types of electrical bonds required for aircraft are discussed. Bonds differ in the current levels that may be expected and the frequency range of these currents. Included is a discussion of the bonding of carbon fibre composite materials.

Y. Brunet, "Electromagnetic Shields in Cryogenic AC Generators," Revue Generale de l'Electricite, (France), vol. 88, no. 2, February 1979, pp. 134-140.

This paper is in French with an English translation of the title and abstract.

Different types of electromagnetic shielding systems for the protection of the field windings of superconductor generators from magnetic flux variations are compared.

R. Castenschiold, "Grounding Practices for Alternate Power Sources," Specifying Engineer, vol. 41, no. 4, April 1979, pp. 167-172.

The proper grounding of emergency and standby electric power systems is discussed. Ground currents and ground fault sensing are especially important in a power system with a continuity of power requirement. The lightning protection of this type of power system is discussed. The use of a grounding reactor is recommended.

A. M. Christman, "Lightning Performance of Vertical Antenna Ground Systems, IEEE Transactions on Broadcasting, vol. BC-25, no. 1, March 1979, pp. 25-29.

This paper discusses the use of a vertical antenna, used for standard AM broadcasts, as a lightning rod. Typically 120 buried radials, each of which is one quarter of a wavelength at the frequency of transmission, are connected to the vertical antenna to form the grounding system. A formulae for the calculations of the resistance of the radial wire counterpoise is given. Methods of measuring soil resistivity are given. A table of measured data on lightning is included.

D. W. Clifford and K. S. Zeisel, "Evaluation of Lightning-Induced Transients in Aircraft Using High-Voltage Shock Excitation Techniques," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

A test setup for lightning simulation is described. A high voltage generator is used to simulate the effects of nearby lightning, stepped-leader attachment and return stroke discharge. Oscillograms of the measured fields are given.

D. W. Clifford, E. P. Krider and M. A. Uman, "A Case for Submicrosecond Rise-Time Lightning Current Pulses for Use in Aircraft Induced-Coupling Studies," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The results of recent direct and indirect measurements of lightning return stroke currents are presented. It was discovered that the rise time of lightning currents may be smaller than previously published values.

J. C. Corbin, Jr., "Lightning Simulation Testing of Aerospace Vehicles and Hardware," Proceeding of the IEEE 1979 National Aerospace and Electronics Conference NAECON 1979, Dayton, Ohio, May 15-17, 1979, pp. 525-531.

The currently used measurement techniques for lightning simulation testing of aerospace vehicles and hardware are discussed. Some new measurement techniques (pulse testing and swept frequency) are recommended and a new military and NATO standard for lightning testing examined.

L. E. Crawford and M. S. Griffith, "A Closer Look at 'the Facts of Life' in Ground Mat Design," IEEE Transactions on Industry Applications, vol. IA-15, no. 3, May/June 1979, pp. 241-250.

The application of numerical techniques via digital computers to the subject of the design of ground mats for the protection of personnel near an electrically conductive object tied to a ground mat under the influence of a major ground fault is examined. Computer programs that have been developed for this purpose are discussed. The material covered in this paper will appear in a new IEEE publication, #399 (the "Brown" book) by this IEEE transactions.

J. Dabkowski and A. Taflove, "Mitigation of Buried Pipeline Voltages Due to 60 Hz AC Inductive Coupling Part II - Pipeline Grounding Methods," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 5, September/October 1979, pp. 1814-1823.

Grounding practices for the reduction of voltages induced on underground gas transmission by nearby AC power lines is discussed. Transmission line analysis is used to analyze the propagation of voltage waveforms along the buried gas pipeline. It was found that the most desirable location for grounds is at the voltage maximums.

A discussion of this paper follows it by A. L. Verhiel, J. E. Drakos, A. Akhtar, L. Yu and R. E. Aker. The authors are asked to clarify certain points.

C. F. Darby and P. Hammond, "A Patient Virtual Earth and Electrical-Interference Monitor," Medical and Biological Engineering and Computing, vol. 17, no. 1, January 1979, pp. 107-109.

An instrument for placing a medical patient at virtual earth potential is described. Virtual earth rather than actual earth is required to prevent subjecting the patient to the hazards of electrocution. It is desirable to ground the patient to

minimize the electrostatically or electromagnetically induced interference with small amplitude electrophysiological signals.

M. Darveniza, M. A. Sargent, G. J. Limbourn, L. A. Choy, R. O. Caldwell, J. R. Currie, B.C. Holcombe, R. H. Stillman and R. Froud, "Modeling for Lightning Performance Calculations," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 1900-1908.

This paper summarizes the lightning research and lightning protection for power systems studies at the Unviersity of Queensland in Australia for the period 1966-1975. Empirical formulas for the ground flash density and frequency of lightning strokes to substations are given. The electromagnetic model for the mechanism of the lightning stroke is employed. The effects of tower footing resistance and corona are incorporated into the model. The need for a better understanding of the physical mechanism of lightning phenomena is stressed.

F. Dawalibi and D. Mukhedkar, "Parametric Analysis of Grounding Grids," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 5, September/October 1979, pp. 1659-1668.

The performance of grounding grids in two-layer soils is analyzed numerically. The calculated grounding resistances, step and touch potentials are displayed graphically. It was concluded that step potentials are lower than touch potentials and that grids composed of parallel conductors are more effective than mesh grids.

A discussion of this paper by C. J. Blattner and P. Kouteynikoff follows this paper. The discussion is primarily complementary.

F. Dawalibi and D. Mukhedkar, "Resistance Measurement of Large Grounding Systems," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 2348-2354.

Problems associated with the "fall-of-potential" method of measuring the resistance of a large grounding grid are discussed. A typical grounding grid embedded in a two layer soil is used as the model. Plots of measured resistance as a function of probe position are given.

F. Dawalibi and D. Mukhedkar, "Influence of Ground Rods on Grounding Grids," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 2089-2098.

A mathematical analysis of a substation grounding system consisting of arrays of interconnected ground rods is given. A two layer soil model is employed. The ground system resistance, touch voltage, step voltage and current density on the ground rods are determined for various types of ground rod configurations.

B. Demoulin, P. Deganque and R. Gabillard, "Transient Response of Braided-Wire Shields," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The results of time domain measurements to determine the shielding properties of braided coaxial cables are reported. A theoretical analysis which models the cable as a transmission line is presented. Measured pulse transmission characteristics are illustrated by various oscillograms.

E. P. Dick, C. C. Erven and S. M. Harney, "Grounding System Test for Analysis of Fault-Induced Voltages on Communications Cables," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 2115-2125.

This paper addresses the problem of excessive energy being coupled into communications and control cables for a substation by a nearby line to ground fault. A systematic study of the performance of the grounding system and interconnecting low voltage cables of a large power complex under simulated injection 5 to 10 Hz away from the power system frequency was used to simulate the line to ground fault.

G. Dike, R. Wallenberg and J. Birkin, "Electromagnetic Relationships Between Shielding Effectiveness and Transfer Impedance," 1979 Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

Some derivations required to determine the electric and magnetic shielding effectiveness of composite materials are given. These are related to the shielding effectiveness. Plots of the experimentally measured and theoretically predicted shielding effectiveness for various composite materials are given for the frequency range 10 kHz to 100 MHz.

M. Dolezal, F. Posmura and J. Balika, "Overvoltage Protection of Metal-Enclosed Substations Properties of Style GZS MA 97 Value-Type Lightning Arresters," Energetika, (Czechoslovakia), vol. 29, no. 2, 1979, pp. 49-51.

This paper is in Czech with an English translation of the title and abstract.

The use of style GZS MA 97 lightning arresters (made in Poland) for the overvoltage protection of 123 KV metal enclosed substations is described. Reliability tests are proposed.

C. S. Droste, R. T. Zeitler and J. L. Daboid, "A Lightning Protection Program for the F-16 Fly-by-Wire System," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The lightning protection requirements of the avionics of a F-16 aircraft are discussed. An F-16 was subjected to simulated lightning having a peak current of 260 and 3,000 amps and the results extrapolated to a worst case of 200,000 amps. A double exponential model was used for the current.

M. Feydt, "Berechnung der Erdungsimpedanz naturlicher Fundamenterder (Calculation of the Earthing Impedance of Natural Foundation Earth Electrodes)," Elektrie, vol. 33, no. 7, 1979, pp. 339-341.

This paper is in German with only an English translation of the title and abstract.

The use of the natural ground that a building structure provides is discussed. The need to calculate the ground impedance prior to the erection of the building is emphasied. A rapid technique for the calculation of the ground impedance is given which does not require a numerical solution.

M. Fibier, "Erdungen Allgemein und Unter Beruecksichtigung Spezieller Anforderungen fuer Blitzschutzanlagen (Grounding in General and also when Taking Account the Special Requirements for Lightning Protection Installations)," Elektrizitaetswirtschaft, vol. 78, no. 8, April 17, 1979, pp. 298-301.

This paper is in German with an English translation of the title and abstract.

This paper emphasizes the difference between the lightning protection requirements of medium and low voltage power distribution systems. The effects of low and large lightning currents are quite different. A simple technique for determining the grounding requirements is given.

G. Franceschetti, "Fundamentals of Steady-State Transient Electromagnetic Fields in Shielding Enclosures," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-21, no. 4, November 1979, pp. 335-348.

This paper presents a theoretical analysis of the electromagnetic shielding of an enclosure without apertures or gaskets. The three region problem cosisting of the interior of the enclosure, the walls of the enclosure and the exterior of the enclosure where the applied field is present - is reduced to an equivalent two region problem by accounting for the effect of the enclosure wall by a current sheet and charge layer at the boundary of the two regions. The assumption is valid when the spatial pulsewidths (time duration of the pulse times the speed of light) is much smaller than the thickness of the enclosure walls. An integral equation for the field inside the enclosure is obtained from Maxwell's equations and solved numerically. An electric circuit equivalent of the field problem is given. Excellent agreement with experimental data is reported by the author.

A discussion of this paper by R. B. Schulz follows the paper which explains its significance for applications oriented readers.

R. K. Golka, "Long Arc Simulated Lightning Attachment Testing Using a 150 kW Tesla Coil," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The use of a Telsa Coil to prduce simulated lightning is discussed. Telsa Coils have the ability to create short duration arcs that are relatively long that may be accurate models of lightning.

R. J. Heppe, "Step Potentials and Body Currents Near Grounds in Two-Layer Earth," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 1, January/February 1979, pp. 45-59.

The safety calculations for grounding electrodes is presented using a two-layer model for the ground (the conductivity of each layer is different). The top layer may be wet or frozen while the bottom layer may be dry or thawed. Step potentials and body current plots are given. It was shown that a person dragging a long metal object or two people carrying such an object can experience a larger current than a person merely walking on the surface near a ground electrode.

This paper is followed by a discussion by R. McSweeny, G. B. Niles and J. G. Sverak which expands on Heppe's analysis.

R. D. Hill, "A Survey of Lightning Energy Estimates," Reviews of Geophysics and Space Physics, vol. 17, no. 1, February 1979, pp. 155-164.

The results of a survey which attempts to classify lightning and compare the various techniques used to measure the energy dissipated in the return stroke is reported. A plot of the cumulative frequency of occurence of lightning as a function of peak stroke current is given. The double exponential model for the lightning current is discussed. Energy dissipations as high as 10 billion joules with an exchange of 20 coulombs of charge in one lightning flash have been estiamted.

The IEEE Power System Communications Committee, "Sumary of a Guide for Determining the Maximum Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault," IEEE Transactions on Power Apparatus and Systems," vol. PAS-98, no. 1, January/February 1979, pp. 72-73.

This paper is a report by the IEEE Power System Communications Committee on power station potential rises and for induced voltages. It is a summary of the IEEE Standards Committee Project No. P367 proposed Guide which provides maximum voltages. It is intended for engineers in both the telephone and power companies who have the responsibility for prescribing the protection schemes for wire line communications for electric power stations. It is available as IEEE Standard No. 78-367.

E. B. Joy, A. P. Meliopoulos and R. P. Webb, "Touch and Step Calculation for Substation Grounding Systems," IEEE Power Engineering Society Winter Meeting, New York, N.Y., February 4-9, 1979, (Published for the IEEE Power Engineering Society by the IEEE , New York), Paper A 79 052-2.

A numerical algorithm for the computation of surface potentials, ground current distribution and grounding resistance associated with substation ground mats embedded in a two layer earth is presented. This analytic technique is applicable to rectilinear mats with or without ground rods. An analysis of example grounding systems in reference to IEEE Standard 80-1976 is given.

M. J. Kemper, "Electrical Design Requirements for Electrode Boilers for Nuclear Plants," Power Engineering, (USA), vol. 83, no. 2, February 1979, pp. 74-76.

The connection and grounding methods used for electrode boilers for nuclear power plants are discussed. Two possible means of connecting the electrode boiler neutral to a low resistance grounded 13.8 kV system are illustrated. The contrasting requirements for safety grounding and grounding to minimize power system are discussed.

A. Kohler, "Noise in Signal Cables by Power Frequency Magnetic Induction," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 4, July/August 1979, pp. 1227-1232.

The voltages induced in coaxial cables and twisted pairs of conductors by power frequency lines is analyzed. It was found that twisted pairs are superior to coaxial cables. In one meter of RG 58 cable, the induced voltages were found to be 45 times that induced in a twisted pair. Oscillograms of the induced voltages in the different cables tested are given.

Shielding against power frequency magnetic fields was found to be useful only if the shield is constructed of a combination of ferromagnetic material inside of a low resistance nonmagnetic material. The shielding effect of a braided copper or steel conductor against power frequencies was found to be very small.

J. P. Kosiarski, "The Use of Electrically Conductive Organic Surface Coatings for Shielding and Grounding of Plastic Enclosures," The Society of the Plastics Industry, Inc., Reinforced Plastics/Composites Institute, 34th Annual Technical Conference, New Orleans, LA, January 30 - February 2, 1979, Section 19-F, pp. 1-4.

Methods of providing plastic housings for electronics equipment with electromagnetic shielding are discussed. These techniques are: vacuum metalizing, flame/arc spraying, conductive plastics and conductive coatings. The requirements that conductive coats must satisfy are listed. Plots of the shielding effectiveness versus frequency of plastic housings coated with different types of acrylic paints are given.

J. T. Kung and M. P. Amason, "Electrical Conductive Characteristics of Graphite Composite Structures," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The use of graphite composite structures to provide lightning protection for aircrafts is described. An electrical equivalent circuit of a graphite composite panel is given. Lightning current flow patterns on graphite composite panels are presented. The resistance properties of these graphite composites are discussed.

D. A. Hill, "Electromagnetic Wave Propagation Along a Pair of Rectangular Bonded Wire Meshes, IEEE Transactions on Electromagnetic Compatibility, vol. EMC-21, no. 2, May 1979, pp. 114-121.

The propagation of an electromagnetic wave between two wire meshes is analyzed. The two arrays of wire mesh are perpendicular and not necessarily square but, in general, rectangular. The two arrays are not bonded together. An expression for the propagation constant is obtained and numerically constant and field distributions are given. This paper can be used to evaluate the shielding effectiveness of a double wire mesh where the two meshes are orthogonal and floating.

K. S. H. Lee and G. Bedrosian, "Diffusive Electromagnetic Penetration into Metallic Enclosures," IEEE Transactions on Antennas and Propagation, vol. AP-27, no. 2, March 1979, pp. 194-198.

This paper examines the diffusion of electromagnetic energy through a metallic enclosure. The skin depth of the material from which the enclosure is made is assumed to be sufficiently small so that the dominant diffusion mechanism is low frequency magnetic field. The problems analyzed are: parallel plates, spherical shell and cylindrical shell with the magnetic field parallel and perpendicular to the axis of the cylinder. The magnetic field inside the metallic enclosure is plotted as a function of time and the shielding effectiveness is plotted as a function of frequency penetration of an electromagnetic pulse (EMP) into a metallic enclosure is discussed.

R. H. Lee, "Lightning Protection of Buildings," IEEE Transactions on Industry Applications, vol. IA-15, no. 3, May/June 1979, pp. 236-240.

This is an extension of the author's 1977 paper at the IEEE Industrial and Commercial Power Systems Conference. The radius of protection provided by a diverter element is examined for different basis insulation levels. Actual lightning strokes and not models were used in this investigation.

S. C. Lee, K. K. Lim, M. Meiappoa and A. C. Liew, "Determination of Lightning Current Using Frame Aerials," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 5, September/October 1979, pp. 1669-1675.

A technique of measuring lightning currents by measuring the magnetic fields produced by these currents is described. A frame antenna with copper wire wound to the wooden frame was used to sense the magnetic field produced by lightning. A brass wire mesh was used to shield the antenna from electric fields produced by lightning.

An equation for the current of the first lightning return stroke as a function of the measured magnetic field is derived. It was assumed that the lightning channel is vertical with no branches, the earth is an infinitely conducting plane, the return stroke wavefront travels upward with an exponentially decaying velocity, the current is uniform below the return stroke wavefront and the current above the return stroke is negligible. The current waveform as a function of time is plotted. A comparison with results obtained by other authors is included.

Following this paper is a discussion of it by M. A. Uman. Uman criticizes botht the experimental technique used and model chosen by the authors.

V. N. Manohar and R. P. Nagar, "Design of Steel Earthing Grids in India," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 2126-2134.

Ten years of experience in designing steel grounding grids in India is summarized in this paper. Situations for which steel grounding grids are preferable to copper grids are explained. Formulas for calculating the size of grounding condutors are given. The effects of electrochemical corrosion are included.

A. R. Martin and S. E. Emert, "Shielding Effectiveness of Long Cables," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

A technique for measuring the shielding effectiveness of long cables is discussed. The method used is a revised triaxial. The common assumption that doubling the length of the cable decreases the shielding effectiveness by a factor of two was found to be false.

P. McBrayer and B. Showalter, "RF Compatibility-Environment to Component Part," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

Electromagnetic shielding requirements for a naval aircraft are discussed. Plots of shielding attenuation as a function of frequency are given for a graphite epoxy composite and a filter pin connector. The lightning tests for these connectors are described.

W. S. McCormick, "The Analysis and Identification of Flux-Induced Voltage Transients on Low-Loss Transmission Lines with Application to the Lightning-

Transient-Analysis (LTA) Problem," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-21, no. 1, February 1979, pp. 13-19.

The coupling of a lightning induced transient through an aperture on an aircraft to interval avionics cabling is considered. A linear systems identification technique, based on the impulse response, to define the nature and location of the dominant excitations on the fuselage of the aircraft is proposed. This time domain technique was used in the lightning transient analysis of the USAF F111.

J. McDermott, "EMI Shielding and Protective Components," EDN, Vol. 24, no. 16, September 5, 1979, pp. 165-176.

Electromagnetic shielding is reviewed. The use of sheet-metal enclosures and molded-plastic cabinets and housings for shielding is described. Shielding both sources of EMI and susceptible circuits is discussed. The use of gaskets to seal out dust, moisture and EMI from enclosures is described. Magnetic shielding using ferromagnetic devices and sheet stock is also discussed.

This is a state of the art paper on practical techniques and hardware for electromagnetic shielding. A list of fifty American companies that manufacture components for electromagnetic shielding is given.

E. Montandon, "Lightning Protection of Mains-Supplied Equipment (Remote Telephone Installations)," Technishce Mitteibingen PTT (Bulletin Technique PTT, Bolletino Tecnico PTT), (Switzerland), vol. 57, no. 4, April 1979, pp. 137-145.

This paper is in German and French with an English translation of the title and abstract.

The lightning protection requirements of telephone equipment requires the careful coordination of the grounding system, insulation strength and surge arrestors which is the subject of this paper.

M. Fibier, "General Experience Taking Into Account the Special Requirements for Lightning Protection Installations," Elektrizitaetswirtschaft, (Germany), vol. 78, no. 8, April 17, 1979, pp. 298-301.

This paper is in German with an English translation of the title and abstract.

This paper deals with the grounding of medium and low voltage power systems for lightning protection. The effect of heavy lightning currents differs from that of low lightning currents requiring different grounding requirements. A simplified technique for the calculation of ground installations is given.

K. Miyazaki, E. Hashimoto and Y. Inoue, "Electromagnetic Induction in Communication Lines Laid Along Bridges and Shielding Effects of Bridges," IEEE Transac-

tions on Power Apparatus and Systems, vol. PAS-98, no. 1, January/February 1979, pp. 275-278.

The electromagnetic coupling from a 220 kV power line to a coaxial communications cable 200 meters away was measured and is presented in tabular form. The coaxial communications cable was mounted on a bridge over sea water and had a measured shielding factor of 0.19. An attempt is made to calculate the shielding effectiveness of this bridge. The impedance to ground of the bridge was very small because its metallic supports extend into seawater.

J. Nahman and S. Skuletich, "Resistances to Ground and Mesh Voltages of Ground Grids," Proceedings of the Institution of Electrical Engineers, (GB), vol. 126, no. 1, January 1979, pp. 57-61.

The results of a numerical analysis of a variety of square and rectangular grounding grids is presented. Plots of the grid resistances and mesh voltage factors are given. Approximate fomulas for these parameters are given.

M. Nakagawa, "Ground Return Effects in Current Measurement of Overhead Power Lines," IEEE Power Engineering Society Winter Meeting, New York, N.Y., February 4-9, 1979, (Published for the IEEE Power Engineering Society by the IEEE, New York, N.Y.), Paper A 79 056-3.

The theoretical expressions for the magnetic fields produced by earth-return currents are derived and the numerical evaluation of these expressions given. The desirability of considering the effect of the earth-return current on the current in the overhead power line is discussed.

O. M. Nilov, G. V. Pudkova and Y. A. Tverdov, "High-Voltage Protection for Electronic Equipment," Instruments and Experimental Techniques, vol. 22, no. 2, part 2, March-April 1979, pp. 589-590.

The voltage breakdown properties of a thin enamel-covered wire are used to make a high voltage protection device for the protection of monitoring and control circuits from high votlages and radio receivers from lightning. When voltages greater than the breakdown voltage for enamel insulation 150-400 V are applied, the input to sensitive circuitry is shorted to ground.

J. D. Nordgard and C. Chen, "Lightning-Induced Transients on Buried Shielded Transmission Lines," IEEE Transactions on Electromagnetic Compatibility, vol. EMC-21, no. 3, August 1979, pp. 171-181.

The voltages and currents induced in a buried shielded coaxial cable are calculated. The current pulse produced by the lightning stroke is modeled as a double exponential. A lossly dielectric layer is assumed to be around the cable to account for the plastic jacket usually used on buried cables. The fields produced by

a vertical or horizontal electric dipole above a flat earth are determined using the Hertz potential formulation. Plots of the induced voltage as a function of time after the lightning stroke and horizontal distance from the point of impact are given.

R. S. Nowell and K. W. Priest, Jr., "Lightning Protection of 500 kV Air Insulated Substations-Revisited," 7th IEEE Power Engineering Society Transmission and Distribution Conference and Exposition, April 1-6, 1979, Atlanta, GA, pp. 569-576.

Lightning protection requirements for a 500/230/46 kV power substation are reviewed. Graphs and tables of votlages induced at substations by lightning are presented. It was recommended that lightning surge arrestors be placed on the ring bus to protect major equipment. This study was prompted by extensive damage to a specific substation caused by a direct lightning stroke.

H. N. Nunnally, R. P. Webb, E. B. Joy and A. P. Meliopoulos, "Computer Simulation for Determining Step and Touch Potentials Resulting from Faults or Open Neutrals in URD Cable," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 3, May/June 1979, pp. 1130-1136.

An algorithm for the computation of step and touch potentials resulting from a fault or open neutral in an underground cable is given. The ground rods and arcs are modeled as segments with zero radial impedance. The problem is analyzed for different numbers and configurations of ground rods in a two layer earth.

H. W. Ott, "Ground - A Path for Current Flow," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

This paper is concerned with the actual path taken by the ground current in an electrical network in returning to the source. In many cases, the path taken by the ground current determines the susceptibility of circuit to electromagnetic interference. The use of a decoupling capacitor to eliminate unwanted interference is illustrated.

F. Pardini, "La Protezione Contro Guasti di Terra nelle Reti in B.T. per Servizio Industriale (Ground Fault Protection in Low Voltage Distribution Systems - Protective Devices)," Elettrotecnica, vol. 56, no. 2, February 1979, pp. 87-95.

This article is in Italian with an English translation of the title and abstract.

Line to ground faults which are characterized by high resistance, high energy dissipation at the fault location and intermittent origin. Relays designed to protect against phase to phase faults are not always effective against line to ground faults. Various ground fault protective systems are analyzed and illustrated.

C. R. Paul, "Effect of Pigtails on Coupling to Shielded Wires," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

This paper defines a "pigtail" to be an exposed section of a shielded wire. The effect of these pigtails on the shielding effectiveness of cables is evaluated experimentally. Plots of votlage transfer ratios as functions of frequency are given. The frequency range was from 100 Hz to 1 MHz. A low frequency model of the coupling mechanism is developed.

R. A. Pearlman, "Lightning Near Fields Generated by Return Stroke Current," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

An analysis of the near electromagnetic field induced by a lightning return stroke is given. The double exponential model of the lightning current is used. The predicted near fields and rate of change of these fields are plotted as functions of time for various distances from the lightning return stroke.

Z. Pesta, "Storms and Lightning Protection," Elektrotechnik, (Czechoslovakia), vol. 34, no. 2, February 1979, pp. 41-45.

This paper is in Czech with an English translation of the title and abstract.

The standards for lightning protection of buildings used in Czechoslovakia are discussed. Illustrations of various type of lightnings rods are given.

J. A. Plumer, "A Design Guide for Lightning Protection of Aircraft," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

Sets of checklists are provided for the lightning protection of aircraft. All parts of an aircraft that are susceptible to lightning damage are included (antennas, radomes, navigation lights, windshields, canopies, propellors, etc.). It is stressed that improper grounding and bonding may result in severe lightning damage.

E. Popp, "Incidence of Overvoltages Due to the Effects of Lightning on Communications Cables and Open-Wire Lines," Telecon Report, vol. 1, no. 4, February 1979, pp. 269-274.

This paper provides tabulations of measured overvoltages induced on cables and open-wire lines by lightning. Plots of the minimum induced voltage, for various cable parameters, as a function of the average number of overvoltage per thunderstorm day and cable length are given. Results measured for cables situated in different locations.

M. M. Rahman, J. E. Sitch and F. A. Benson, "Transfer Impedances of Braided Coaxial Cables Under Applied Longitudinal Torsion," Electronics Letters, (GB), vol. 15, no. 15, July 19, 1979, pp. 455-456.

The effect on the transfer impedance of a shielded cable of applying a rotational torque to the cable is examined. The cable was rotated from 0 to 360 degrees. It was found that at 360 degrees the transfer impedance had increased by as much as 800 per cent. The frequency range was from 100 kHz to 150 MHz.

P. H. Reynolds and D. S. Ironside, "A New Instrument for Measuring Ground Impedances," IEEE Power Engineering Society Winter Meeting, New York, N.Y., February 4-9, 1979, (Published for the IEEE Power Engineering Society by the IEEE, New York, N.Y.), Paper A 79 080-3.

A description of a new and portable instrument for the measurement of the impedance of ground systems is given. This instrument has the capability of measuring very low impedances even in the presence of high interference. A discussion of the effect of the mutual impedance in the connections on the measured impedance is included.

C. Richter, "Berechnungsuerfahren zur Ermittlung der Blitzimpulsbeanspruchung von Generatoren in Blockschaltung (Calculation Methods to Determination of the Lightning-Pulse Load of Generators in Block Circuits)," Elektrie, vol. 33, no. 5, 1979, pp. 253-256.

This paper is in German with only an English translation of the title and abstract.

The possible damage to generators caused by overvoltages caused by lightning transmitted over block transformers is analyzed. A new transmission model of a block transformer is developed.

M. Roney, W. Masi, Jr. and T. DeRieux, "Integration of Electromagnetic Environmental Considerations Into Navy Programs," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The task confronting the Navy in integrating the electromagnetic compatibility requirements with those dealing with radiation hazard, lightning, etc. is discussed. A tabulation of the different military standards dealing with electromagnetic compatibility is given. Included are those dealing with proper grounding bonding and shielding practices.

R. M. Rudakona, M. B. Guzairov and M. F. Ovchinnikov, "Determining the Parameters of Lightning Shield Wires for Ice Melting Schemes," Elektricheskie Stantsii, (USSR), no. 4, April 1979, p. 56-58.

This paper is in Russian with an English translation of the title and abstract.

The paper examines some techniques for removing ice from lightning shield wires for the protection of power transmission lines. Since shield wires are not normally current carrying, the impedance of these wires are not normally specified and must be measured if passing current through the shield wires is used to remove ice.

H. Schlicke, Electromagnetic Compossibility, Interference Control Company, Milwauke, Wisconsin, 1979.

This book deals with the electromagnetic interference problem. The term compossibility is used rather than compatibility since the term electromagnetic compatibility is used in a military context where the source of the electromagnetic interference is intentional. This book, however, addresses the problem of electromagnetic interference in the civilian context where the interference is inadvertent.

Sources of electromagnetic interference are defined and analyzed. The shielding properties of metallic shells, chicken wire and laminations are considered and the transfer impedances plotted.

The grounding of shielded cables and electronic equipment is discussed as well as recommended grounding procedures for low voltage power distribution systems.

E. H. Schulte, "The McDonnell Aircraft Company Lightning Simulation Laboratory," Journal of Environmental Sciences, (USA), vol. 22, no. 3, May-June 1979, pp. 22-27.

Some of the generators used to produce high voltage and current waveforms to simulate lightning are discussed. The equipment available at a lightning test facility is listed.

E. H. Schulte, "Multiple-Component Lightning High-Current Testing," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

The need for a combined waveform representation for simulated lightning is discussed. Lightning is most accurately modeled as a high-peak current, an intermediate current, a continuing current and a high-current restrike. Diagrams of circuits for the generation of these waveforms are given.

R. M. Simons, "Shielding from EMI with Plastics," Product Engineering, vol. 50, no. 12, December 1979, pp. 43-46.

Methods of providing plastic materials with electromagnetic shielding are discussed. An experimentally setup to measure shielding effectiveness is shown. A plot of the shielding effectiveness of plastic embedded with 30 per cent aluminum flake polyester is given.

M. D. Stefano and C. Mazzetti, "Protezione delle Strutture dalle Fulminazioni Atmosferiche di Dehole Intensita (Protection of Structures from Low-Intensity Lightning Strokes)," Elettrotecnica, vol. 66, no. 4, April 1979, pp. 281-290.

This paper is in Italian with an English translation of the title and abstract.

This paper deals with the protection of structures from low intensity lightning strokes. The lightning strokes may occur in an irregular way which involves the lateral surfaces of the structures with protective devices placed on top of them. The inadequacy of the protective devices for protection against low-intensity lightning strokes is illustrated using the exposure concept developed by the authors in their January 1978 paper in this journal. The exposure criteria are expanded and the most favorable location for lateral protection devices is determined. The resulting increase in the lightning protection of the structure is calculated.

S. Tominaga, H. Mukae, S. Matsuda, N. Okutsu and Y. Takahashi, "Dynamic Behavior of Metal Enclosures for Gas Insulated Substations During Ground Faults and Their Immediate Location by Mechanical Means," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 4, July/August 1979, pp. 1283-1290.

Mechanical devices for determining the location of ground faults at gas insulated substations are discussed. These devices make use of the linear reltionships between the ground fault current and the resulting vibration acceleration of the tank walls. These sensors are impervious to disturbances such as thrown rocks and respond only to a minimum of 20 G of tank wall acceleration.

S. Tominaga, K. Azumi, Y. Shibuya, M. Imataki, Y. Fujiwara and S. Nishida, "Protective Performance of Metal Oxide Surge Arrestor Based on the Dynamic V-I Characteristics," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 6, November/December 1979, pp. 1860-1871.

The lightning protective properties of metal oxide surge arrestors is the subject of this paper. These surge arrestors consist of series connections of zinc oxide elements having a highly nonlinear resistance. A simple electrical equivalent circuit is used to model the voltage-current characteristics of the zinc oxide elements. A computer simulation was performed that determined that the effectiveness of these metal oxide surge arrestors for the protection of gas insulated substations was superior to that of conventional arrestors.

A discussion of this paper by S. A. Miske, W. Neugebauer, S. L. Smith, V. Srinivasan and K. Kasturi follows which questions the validity of the authors models and lack of statistical data on which the conclusions are based.

R. Verna and D. Mukhedar, "Ground Fault Current Distribution in Sub-Station, Towers and Ground Wires," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 3, May/June 1979, pp. 724-730.

An analytic technique for the evaluation of the ground fault current distribution in substation, towers and ground wires is given. The effect of a counterpoise and the coupling between the phase and ground wire is included in the analysis. An example of the use of the derived equations is given.

This paper is followed by a discussion by S. A. Sebo, J. M. Nahman and L. Yu which suggests extensions and points out limitations of the author's analysis.

L. C. Walko and T. J. Seymour, "New Techniques for the Measurement of Natural and Simulated Lightning Phenomena," 1979 IEEE Electromagnetic Compatibility Symposium, IEEE, New York, 1979.

Some new techniques for the measurement of lightning phenomena are discussed. A Moebius loop magnetic field sensor, a capacitive type transient voltage sensor and a fiber optics measurement system are described. The use of computers to efficiently process the measure data is also discussed.

K. M. Ward, "Lightning Damped," Electron, (GB), no. 161, January 23, 1979, pp. 29-30, 32.

This paper stresses the need for improved protection of solid state electronic equipment from the effects of lightning. The history of the problem is discussed and a description given of the newest techniques for the suppression of undesirable surges and transients.

R. B. West, "Grounding for Emergency and Standby Power Systems," IEEE Transactions on Industry Applications, vol. IA-15, no. 2, March/April 1979, pp. 124-136.

The recommended (by the National Electrical Code, NFPA No. 70-1978) grounding and bonding procedures for power systems operating at less than 600 volts are discussed. Several grounding schemes are graphically displayed. The author intends to use this paper as a basis for a new IEEE standard to replace IEEE Standard 446-1974.

R. B. West, "Compliance Guide: OSHA and National Electrical Code Requirements for Grounding and Ground-Fault Protection on Construction Sites," IEEE Transactions on Industry Applications, vol. IA-15, no. 3, May/June 1979, pp. 251-266.

The OSHA standards for ground fault protection for personnel on construction sites, which became effective on February 22, 1977, are discussed. The OSHA

standards do not supersede but append the National Electri cal Code requirements. Included in this paper are the grounding and ground-fault protection requirements for receptacle outlets, cords and portable equipment.

E. C. Wooderson and T. J. Ellis, "AC Electrification - Its Effect on Signalling and Communications," National Conference Publication Institution on Engineers of Electrical Energy Conference, Preprint of Paper, Brisbane, Australia, May 17-18, 1979, pp. 36-40.

The use of electromagnetic shielding to minimize the interference with communication circuits caused by electric traction systems is discussed.

O. W. Zartrow, "Choices of Jacketed or Bare Concentric Neutral Cable for Effective Grounding and Corrosion Control," IEEE Transactions on Industry Applications, vol. IA-15, no. 1, January/February 1979, pp. 80-84.

If a bare cable is used as a neutral for grounding a power system, corrosion may occur. Insulating the grounding cable will reduce corrosion but will also reduce the effectiveness of the ground. This paper examines the advantages and disadvantages of jacketed and bare neutral underground distribution cable.

L. G. Zukerman, "Simplified Analysis of Rectangular Grounding Grids," IEEE Transactions on Power Apparatus and Systems, vol. PAS-98, no. 5, September/October 1979, pp. 1777-1785.

A simplified design technique for regular symmetrical, equally spaced, multimesh rectangular grounding grids intended for the safety of operating personnel in substations is presented. The algorithm can be implemented on a pocket calculator. This design technique is obtained by an extension of the principles established in IEEE Standard 80.

Following this paper is a discussion of it by M. B. Awad, H. W. Huestis, A. B. Purdy, J. G. Sverak, G. E. Smith, D. L. Stone, E. G. Via and O. Compton. Zukerman's assumptions are criticized.