# The AIEE Conference in Pittsburgh, January 26-30, 1948

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# THE AIEE CONFERENCE IN PITTSBURG

## JANUARY 26-30, 1948

OTTAWA

JANUARY, 1948

# THE A.I.E.E. CONFERENCE IN PITTSBURGH, 26-30 JANUARY, 1948.

There were approximately 225 scheduled papers and, in addition, about a dozen others which did not appear on the printed program. To get through this large schedule, five sessions were run simultaneously. There were also field trips to various points of interest around the city, and numerous smaller group-meetings on such things as education, safety and professional conduct. Obviously, one man could obtain but a small sampling of this program.

The sessions attended were mostly of the "conference" or discussion type. It is the author's opinion that attendance at this type of session is most valuable, since they meet a need which is not met by published papers. It may be added that, because of the locale of the conference, a preponderance of the papers were concerned with heavy industrial engineering.

The topics covered by the various papers fall broadly into the following classes: materials, control and measurement, industrial equipment, power distribution, and basic sciences.

Developments in new materials came under three headings: magnetic materials, insulation, and semi-conductors.

Magnetic Oxides - (F.G. Brockman, Philips Laboratories, Inc.)

Progress is being made in the development of magentic oxides as core materials. These are competitive with (and must be distinguished from) powdered iron. Their general formula is $M^{++}Fe_2O_4$ where $M^{++}$ is any bivalent metal; nickel, magnesium, manganese, copper and zinc have all been used. They are all characterized by the same crystal structure. The resistance of these oxides is very high, about $10^7$ times that of iron. They are characterized generally by a formula

$$\frac{R}{\mu f L} = AB_m + C + ef$$

where, on the right-hand side, the first term represents a hysteresis loss, the second, residual losses due to unknown causes (perhaps resonance effects), and the last is the eddy current loss. Characteristics of two typical commercial coils using the material are:

4 mH, Q = 600 at 60 kc.
i.f. coil, Q = 200 at 455 kc.

In production material, an initial $\mu$ of 600 and a maximum of about 1200 is obtained. The Curie point occurs at about 120°C.

<u>High Permeability Iron</u> - (G.W. Elmen, Naval Ordnance Laboratory, U.S.A.).

This material is being developed with a view to its use in such devices as saturable reactors and saturating reactors. One aim is to secure a hysteresis loop which is as nearly rectangular as possible, rather than S-shaped. With such rectangular hysteresis loops, the residual flux approaches the saturation value. Cores of high permeability iron are essential to the success of such devices as magnetic amplifiers, magnetic computing devices and mechanical rectifiers.

To date, the most practical method of improving magnetic characteristics, has been by severe cold working (typically, about 99% reduction). Annealing in a magnetic field under strain gives similar results. The improved magnetic characteristics, in all cases, are along one direction in the iron. The Japanese apparently obtained high permeability by preparation of <u>extremely</u> high purity iron but the method is not economically practical. The directional magnetic properties of these improved irons has necessitated the development of the wound transformer core. Apart from transformers, these materials have not yet found extensive application in power equipment.

<u>Insulation</u>

It should be noted that a great deal of effort is being spent on improving the characteristics of the various styrene polymers developed during the war. Such improvement will permit continued utilization of the tremendous plant capacity constructed during the war. New plastics, which would require new plants, thus receive less attention.

The method of synthesizing a plastic may have a large effect on its physical characteristics. In particular, several companies have been successful in developing what are known as "completely filled" plastics. Roughly, with these, there is no solvent to be evaporated, with consequent voids. Rather, all materials in the mix are taken up in the synthesis. The resulting plastic is practically free from voids, dense and firm compared with the same plastic when formed by use of a solvent and subsequent evaporation; also, heat conductivity is higher. Thus specification of the plastic material alone is not sufficient to ensure the desired characteristics.

<u>Silicone Materials</u>

Characteristics of electrical insulators fall into three broad classes: Electrical Characteristics - dielectric strength, resistance, etc., Mechanical Characteristics - tensile strength, coefficient of expansion, etc., Chemical Characteristics - melting point, solubility, etc.

The electrical and mechanical characteristics of the silicones are not outstanding. It is in the last group, Chemical Characteristics, that the striking advantages of this material are evident. Therefore, whenever high chemical stability under extreme conditions (heat, humidity, corrosion, etc.) is required, the silicone materials should be considered.

Sulphur Hexafluoride

This gas, under high pressure, has been used to insulate electrical apparatus to be used at high altitudes, and also to insulate such items as Van de Graaff generators. The features which make the gas desirable for these applications are its extreme chemical inertness and its non-toxic properties. It will not react even with such active elements as boiling fluorine. However, in the presence of an electric spark and a hydrogen acceptor (e.g. oxygen), chemical reaction occurs.

There are only two impurities likely to be encountered in sulphur hexafluoride. One, fluorine, simply causes corrosion and is relatively unimportant. The other impurity, $S_2F_{10}$, is very poisonous and has no noticeable odour. Simple tests are available to detect the ~~pressure~~ presence of this impurity and should always be used. This poisonous gas can be formed from the original sulphur hexafluoride by the action of an electrical spark in the presence of certain impurities.

Under extreme conditions of pressure it may be necessary to warm the gas to prevent its liquifying. Its critical point is at 45°C. with a pressure of 520psi; at 25°C. its vapour pressure is 330psi.

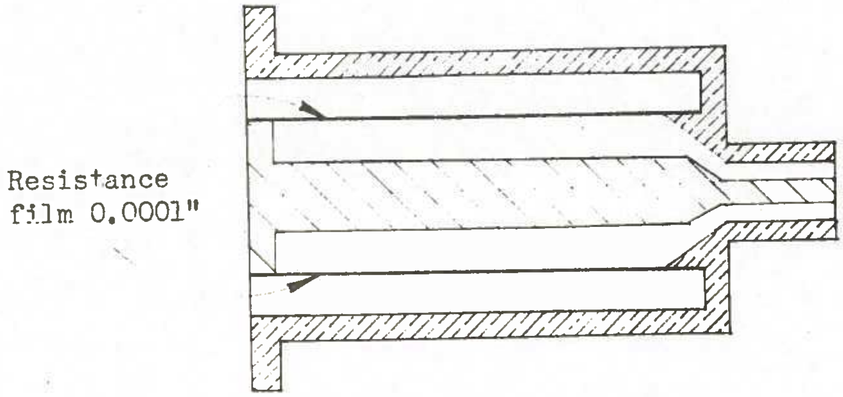
Semi-Conductors - (J.H. Scoff, Bell Telephone Laboratories).

Germanium rectifiers have been developed to supplement the better known silicon type. The germanium type have a maximum inverse voltage rating of the order of 50 volts, which is considerably higher than for silicon, but they are limited to a maximum frequency of about 100 mc. Above this frequency silicon rectifiers must be used. The stability of crystal rectifiers is still much poorer than that of thermionic diodes, but the noise level is better and the maximum usable frequency higher. Silicon rectifiers have been used in radar sets to 40,000 mc.

Pulse Measurements - (N. Rochester and D.L. Stevens, Sylvania Elec. Prod., Inc.).

Large pulse currents are generally measured by utilizing the voltage drop across a resistance placed in series with the current, basing the measurement on Ohm's Law. This inserted resistance must be low relative to the other circuit parameters, so as not to alter appreciably the value of the current being measured. If the high-frequency components of the pulse being measured extend to say 10 mc (as is the case to-day in surge-testing) then the problem is complicated by skin effects. Where pulse currents of thousands of amperesare being measured, heating of the series element during the pulse, will deform the pulse shape, as well as giving a magnitude error.

A coaxial-type resistor designed to overcome these disadvantages is shown in fig. 1. However, there is a frequency-power relation which limits the power as the frequency increases and makes the design unsuitable for many desired applications.

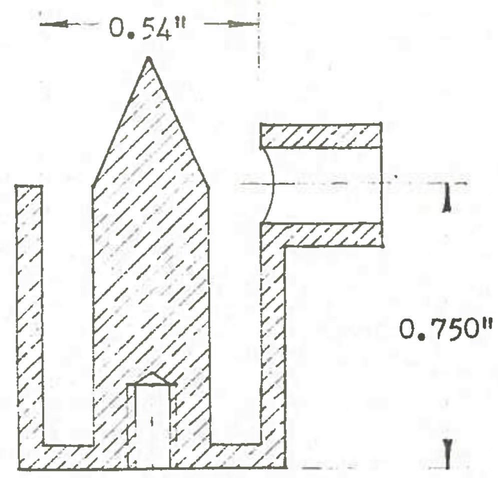



The film thickness must be less than the skin depth at frequency measured.

Fig. 1

Another method consists of inserting a small inductance, rather than a resistance, in series with the pulse current. The resulting output is the derivative of the current and must be integrated to get the actual current. Usually the current derivative waveform is displayed on an oscillograph and photographed, the resulting curve being integrated graphically.

One suitable inductance for this application is constructed as in fig. 2.




Inductance 2.5 x $10^{-9}$ H.

Fig. 2

Multiple-Gun Oscillographs

To obtain two simultaneous traces on the screen of an evacuated-type cathode-ray tube, two methods are available; a single gun can be fitted with a "beam-splitter" or two separate guns can be used. The latter is the method described here. To compensate for unavoidable differences in guns, the accelerating voltages on the guns are separately adjusted so that deflection sensitivities are equal. Small d-c bias voltages on the plates are used to make the undeflected spots coincide. Compensation for differences in the amplifier gain is provided by an adjustment on the screens of the push-pull amplifier tubes. It is claimed that, with the double gun construction, mutual interference is less than in the case of a single gun and beam splitter. It may be noted that tubes with four or five guns are now available.

Oscillograph Time Bases

Oscillographs, employing polar coordinates, rather than rectangular, are sometimes required. Special tubes, employing two concentric annular rings for deflection "plates", have been used but are not too satisfactory because of the non-linearity of the deflection. In such tubes the inner ring must be supported from the face of the tube, which makes the tube mechanically difficult and expensive to construct, or else the supports must cross the gap between the annular rings, thus necessarily leaving one or more gaps in the trace on the screen.

To avoid these difficulties, it is usual to employ the ordinary cathode-ray tube and apply sinusoidal voltage, 90° out of phase, to the deflection plates. This gives the desired radial scale. Since the signal deflecting voltage must also be applied to the deflecting plates, precautions must be taken to avoid interaction between time base and signal deflection voltages. One satisfactory procedure has been to use multiple grid "mixer" tubes such as the 6L7 or 6AS6. The time base and deflection voltages are fed to separate grids and the resultant composite voltage at the mixer plate is applied to the deflection plate of the oscillograph. A push-pull arrangement is used to minimize the non-linear distortion which is common in such mixer tubes, but the non-linearity is still greater than in the usual amplifier arrangement.

Oscillograph Terminology

Some dispute arose over the terms "circular time base" and "circular linear time base". Apparently some people wish "linear time base" to be limited to the usual straight line presentation, with a spot velocity linear in time and space. (The so-called "A-scan" of radar jargon.) Others apparently feel that "linear time base" should include any presentation in which the numerical spot velocity is constant, and would include circular and spiral sweeps, etc.

The Linascope - (J.R. Leslie and K.H. Kidd, The Hydro-Electric Power Commission of Ontario)

This is a parallel development to the paper "Transmission Line Fault Locator" (N.R.C. publication No. PRA-135 and ERB-176) by the present writer. It should be noted that the instrument now has been adapted to use on "live" lines. It is also finding widespread use on open-wire communication lines, both for the location of faults and for the location of small impedance discontinuities which impair performance. On power transmission lines, faults at distances of over 300 miles have been located successfully. The Commission has several "d-c" types (for use on "dead" lines and communication lines), and is constructing additional "wave burst" or carrier types for use on live lines.

Basic Sciences

Papers on this subject show an increasing tendency towards the use of equivalent circuits and machine methods in analysis. The work of Kron of the General Electric Company in developing circuit equivalents of rotating machines is well known. Not so well known are his equivalent circuits for such things as resonant cavities and wave-guide components, which permit study of these items on the a-c network analyser. Westinghouse engineers have even developed a mathematical model of the electric arc.

It is apparent that there is a growing necessity for standardization of terms, definitions, symbols and notation in the field of electrical engineering, particularly electronics. The only paper of this type attended was one on mathematical notation for electrical quantities. It is, I feel, significant that the Chairman had difficulty in curtailing the long, and at times heated, discussion.

W.G. Hoyle