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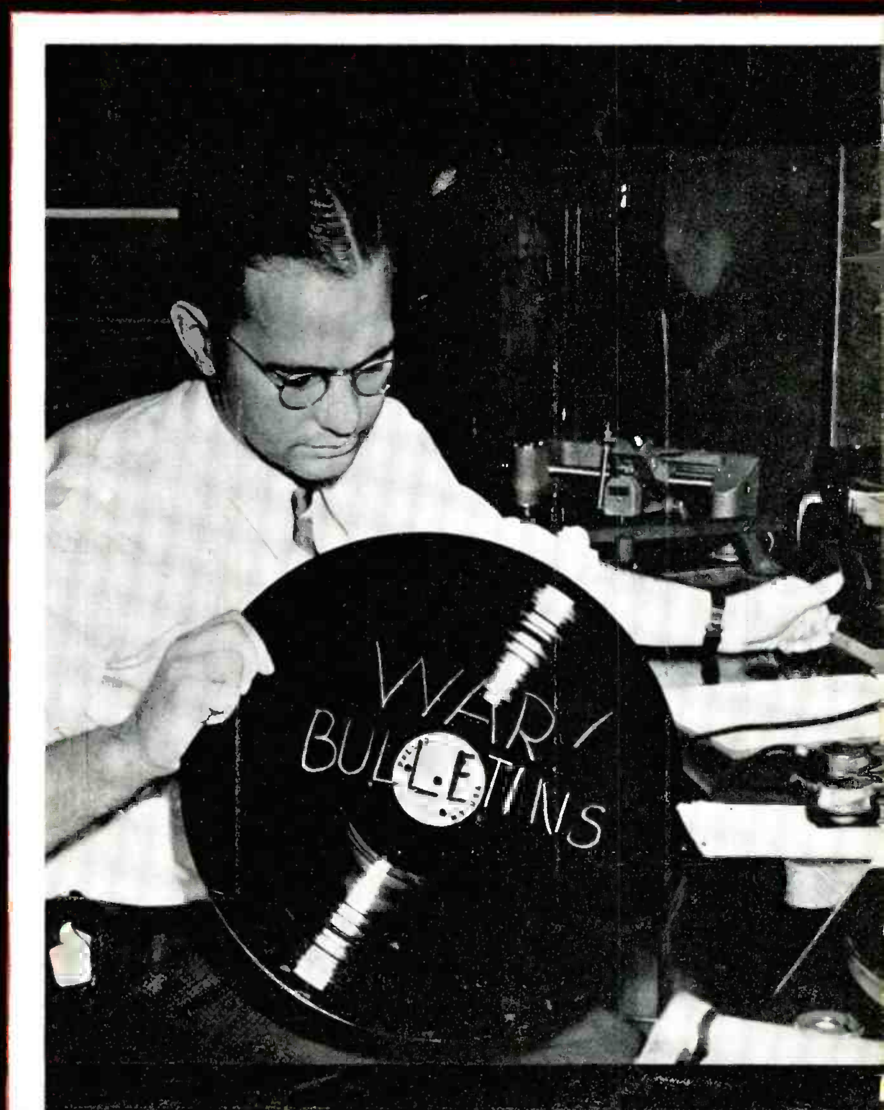

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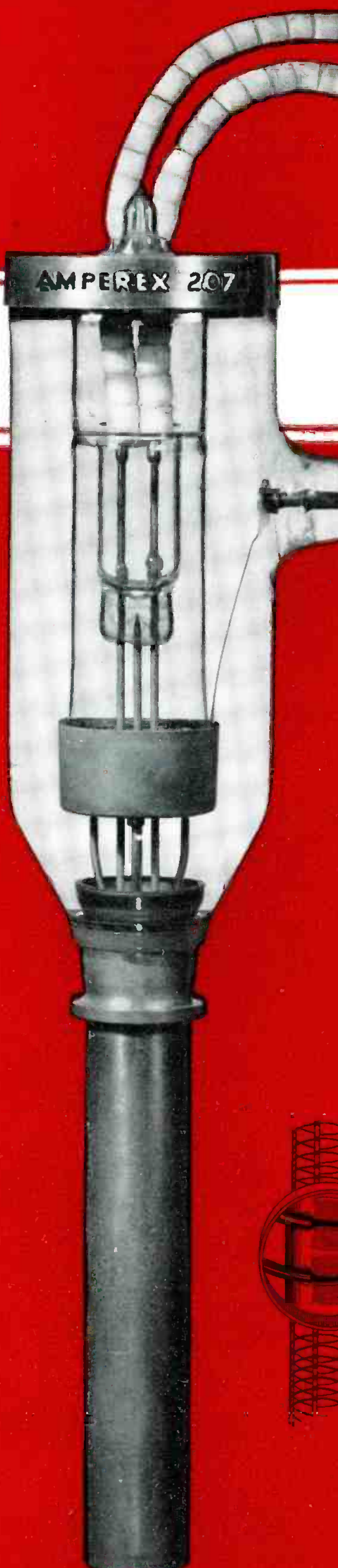
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SEPTEMBER 1939

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VOLUME 19
NUMBER 9

RAY D. RETTENMEYER
Editor

• Editorial Comment •

AGAIN the broadcasters have come through with flying colors—this time by voluntarily adopting rules to apply to war broadcasts.

On September 11, Neville Miller, President of the National Association of Broadcasters, made public an arrangement voluntarily reached by the Columbia Broadcasting System, Mutual Broadcasting System and the National Broadcasting Company for the conduct of their broadcasting during the present war emergency. Lawrence J. Fly, Thad H. Brown and T. A. M. Craven of the FCC were informed of this arrangement at an informal meeting with Neville Miller, NAB, Niles Trammell, NBC; Alfred J. McCosker, MBS, and Edward Klauber, CBS.

In general, every effort consistent with the news itself is to be made to avoid horror, suspense and undue excitement. Particular effort will be made to avoid suspense in cases where the information causing the suspense is of little use to the listener, and the networks will avoid descriptions of hypothetical horrors which have not actually occurred. In addition, in all broadcasts about the plight of refugees, the number of killed and wounded, etc., the broadcasters will use their best news judgment and try to avoid undue shock to the radio audience, without taking upon themselves an unjustifiable responsibility for concealing how bad the war really is.

According to the agreement, the broadcasters will make every effort to be temperate, responsible and mature in selecting the manner in which they make the facts of the war known to the audiences. Also, they will at all times try to distinguish between fact, official statement, news obtained from responsible official or unofficial sources, rumor, and matter taken from or contained in the foreign press or other publications. The radio audience will be clearly informed that the news from many sources is censored and must be appraised in the light of this censorship.

In our opinion the broadcasters deserve a great deal of credit for cooperating in this manner. Radio broadcasts handled in the manner agreed upon will be of *real* public service.

• Contents •

COVER ILLUSTRATION

History 1939 style! Eugene Darlington, manager of General Electric's international short-wave stations WGEA and WGEO, Schenectady, N. Y., shown holding one of the records on which are recorded all of the steps in the outbreak of the European War, including addresses by many of the heads of the nations involved.

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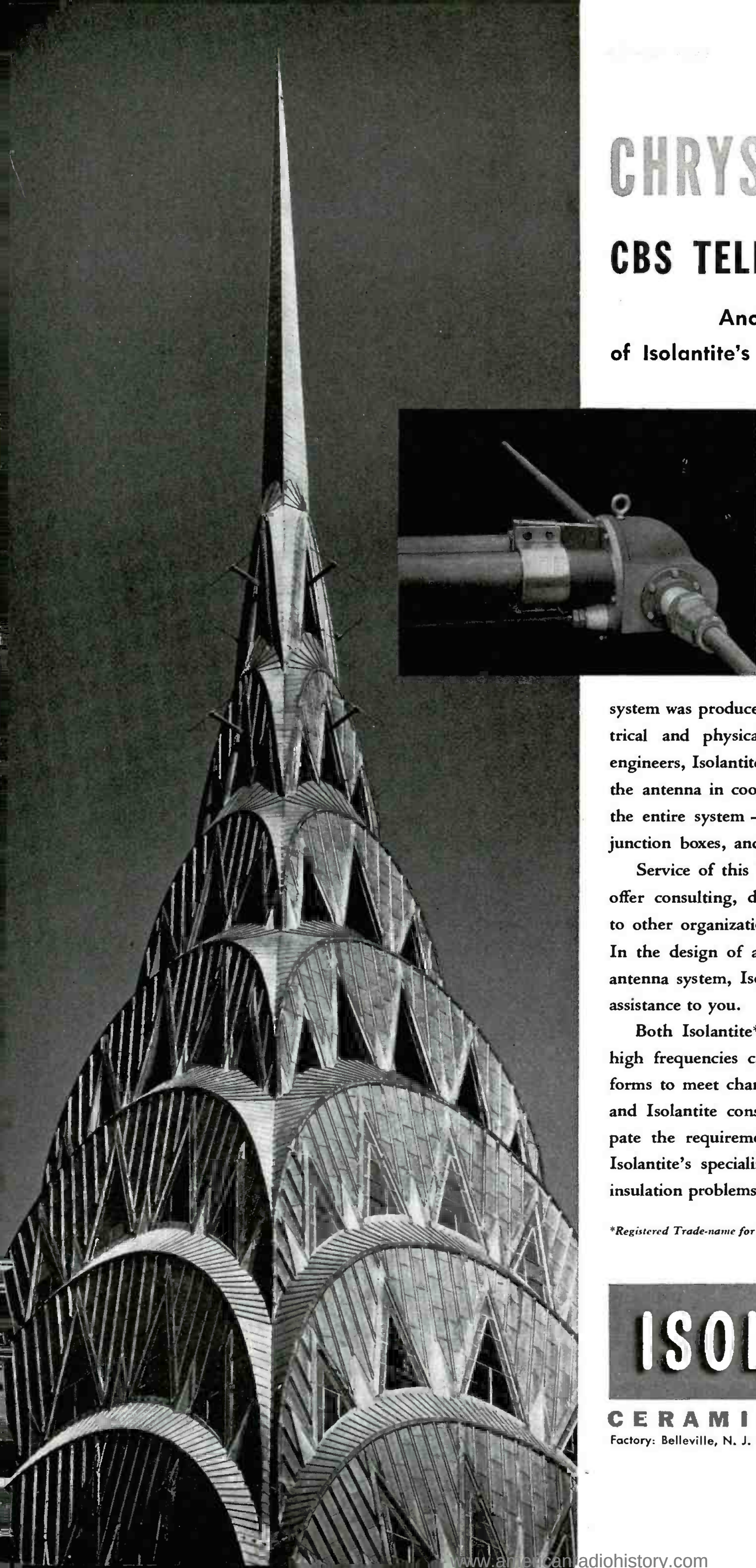

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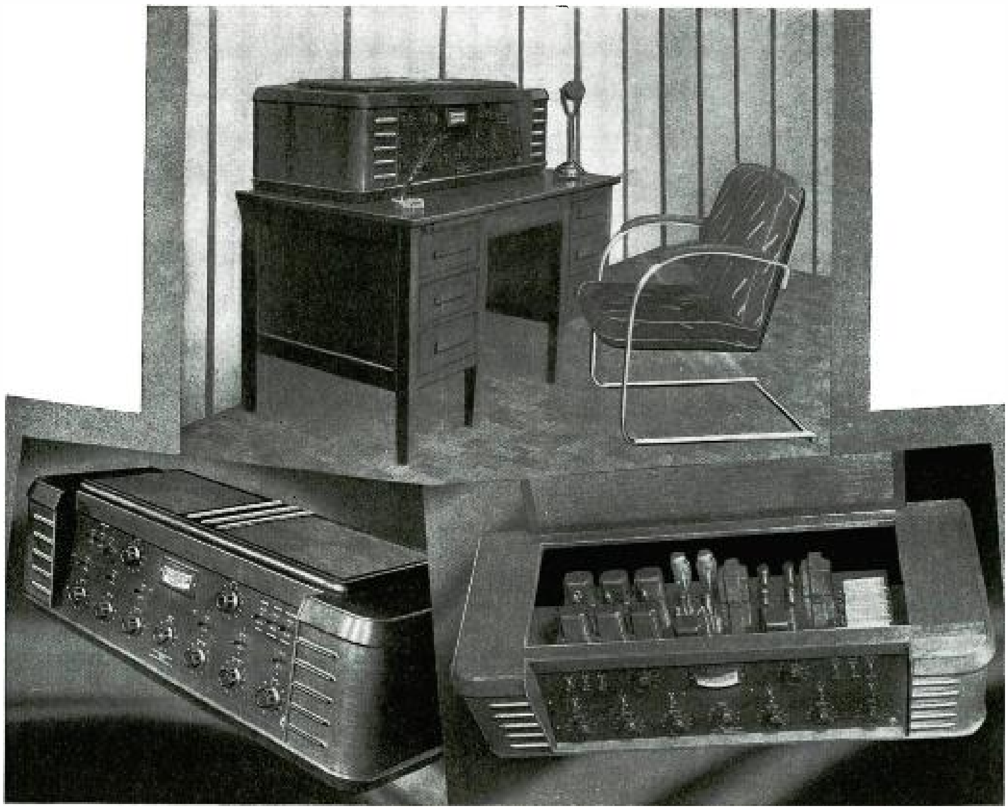

Typical 20 series console installation at CKTB, St. Catherines, Ont., Canada

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CORONA AND IONIZATION DETECTION . . .

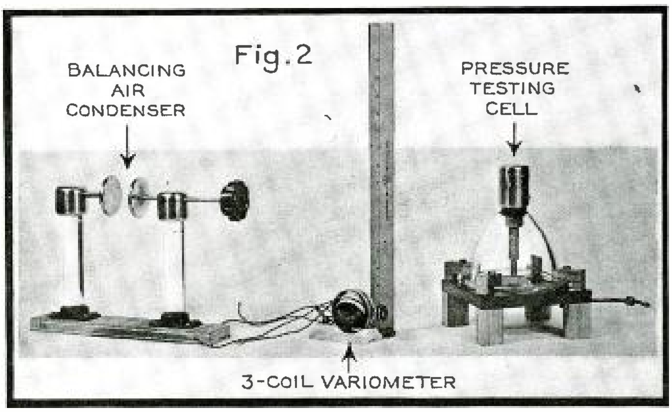
By H. A. Brown and B. H. Weston
Dept. of Electrical Engineering
University of Illinois

The direct detection of r-f surface corona and internal ionization discharge.

1. Introduction

A LOW-INTENSITY corona discharge existing in a comparatively very powerful radio-frequency electromagnetic field is completely masked by the latter, as it may be as small as one thousandth part of the masking field intensity. Therefore it is difficult to directly detect the presence of (a) surface corona on insulation, (b) corona discharge from a point of high curvature on a high-potential tank circuit and or (c) internal ionization discharge in a gaseous void or flaw in insulating material associated with radio-frequency high-potential apparatus.

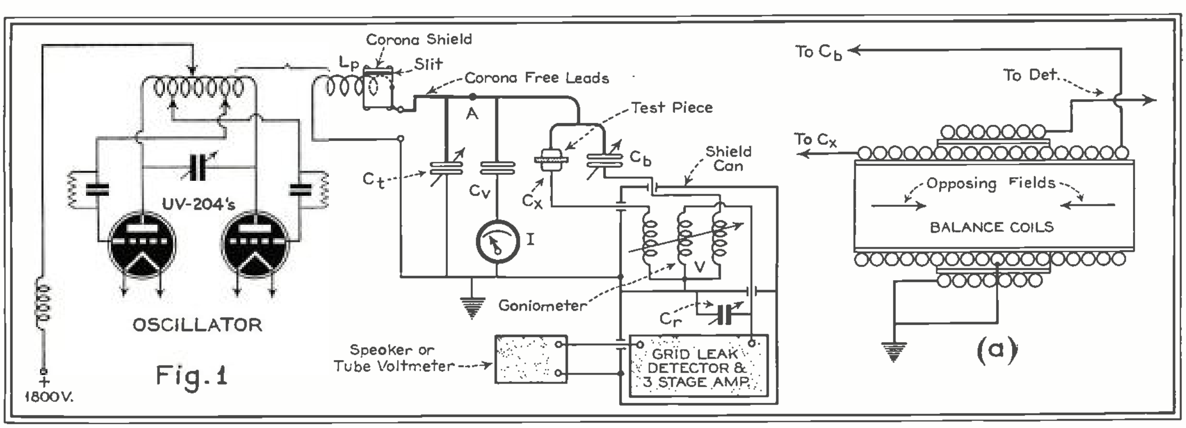
A similar state of affairs exists at the commercial-power frequency of 60 cycles. An ionization discharge in a single void in wire, cable, or machine insulation often produces a disturbance in the 60-cycle charging current which is less than one thousandth part of the charging-current amplitude. More intense ionization discharge can be detected by power-factor measurements, but very often power-factor behavior does not show when ionization in air spaces in laminated insulation begins.[1] Surface corona, at its starting point, also usually does not produce a noticeable disturbance in high potentials existing in 60-cycle circuits and machines. Sensitive and effective means of directly detecting the presence of such phenomena at commercial-power frequencies have been described.[2] Briefly this consists of a specially designed resistance-capacitance bridge associated with amplifiers, and a high-pass filter system to completely suppress the 60-cycle charging current and harmonics thereof. Another method consists of connecting a suitable amplifier filter system in parallel with an air-cored inductance coil, the latter being placed in series with the testing potential and on the grounded side of the test piece. (The design of this equipment is described in the reference given in (1).)



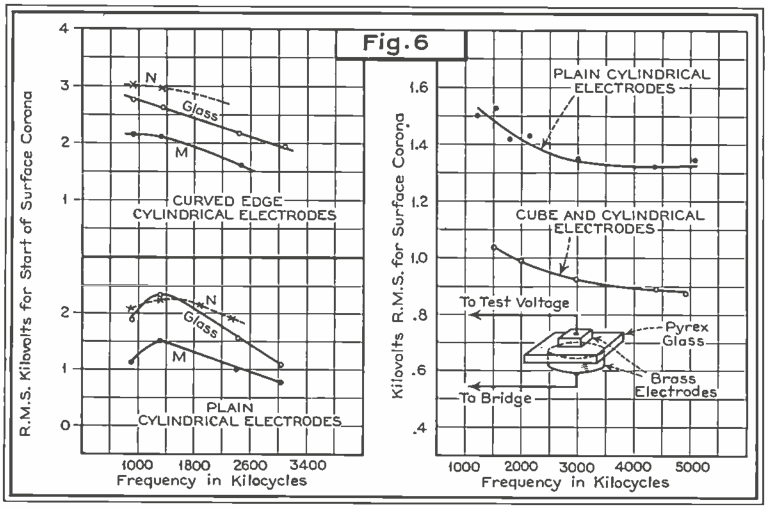
Showing special apparatus.

2. Apparatus and Method for Radio-Frequency Detection

In Fig. 1 is shown a diagram of the testing apparatus designed for radio-frequency discharge detection. The pick-up coil L_p is coupled to the push-pull oscillator tank coil, and the oil-immersed condenser C_t is varied so that resonance is approached as indicated by the increase of current I. C_v is known so that the voltage applied to C_x, the test sample of insulation between metal electrodes may be easily found ($E = I/\omega t$). The charging currents through the capacitance of C_x and through the variable balancing air condenser C_b pass through two coils of a 3-coil variometer, V, shown within the metal shielding box. This device is nothing more than the well known "goniometer" (but much smaller in size), and its tertiary coil is connected to a tuning condenser C_r and to the input of a conventional grid-leak-grid-condenser-type vacuum-tube detector of the usual design. By varying the position of the three variometer coils the inductive effects of the charging currents of C_x and C_b are made to cancel in the tertiary coil and produce no effect on the detector. Balancing is facilitated by providing slight modulation of the oscillator plate-supply voltage. The slight pulsation in this voltage due to inadequate filtering, or to commutation ripple, is sufficient for this purpose. After adjusting to the correct relative position of the three coils no sound can be heard in the receiver, even though C_r is adjusted for resonance with the



R-f discharge detection bridge and associated apparatus.



testing frequency. The balance is sensitive and stable to a gratifying degree.

Now, when the voltage is increased until surface corona, or internal ionization discharge, occurs in C_x a disturbance or modulation of the charging current of C_x occurs, producing a sound in the speaker or receiver. This sound varies; for surface corona discharge, it is usually a dull hiss, often becoming a whistle for a pinpoint discharge, and for internal voids it is a tearing static like sound, approaching a hiss when the voids are very small. If C_r is varied while the discharge occurs a very sharply defined value of C_r is noted for maximum output. When using an oscillator the change of C_t will change the frequency and simultaneous change of position of one coil of V, and variation of C_r must be carried out to maintain optimum balance and sensitivity.

In the design of this apparatus care must be taken to make the variometer or goniometer coils small and of sufficiently low inductance so that the potential drop across these coils is small compared to that across C_x and C_b. The balancing condenser must have no corona discharge, especially between its metal parts and where they touch their insulating supports. In Fig. 2 are shown photographs of this condenser and of the three-coil variometer. Two concentric solonoids which slide over each other may be used instead of the three-coil variometer, but phase balance is not so easily accomplished if there exists a sizable loss component in C_x. The manner of using these solonoids is shown in diagram (a) of Fig. 1.

Fig. 6. Variation of surface corona discharge with frequency.

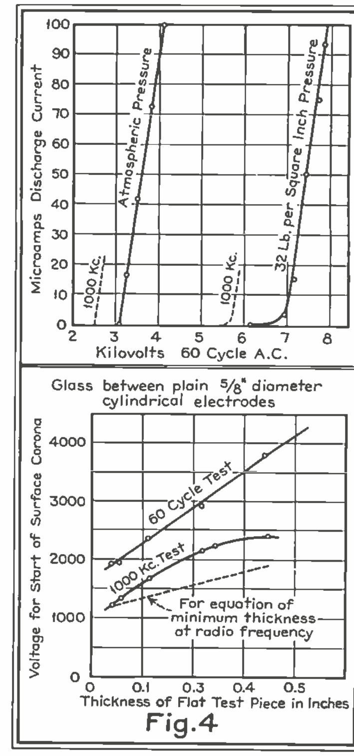
Fig. 4. Variation of corona discharge with voltage and sample thickness.

3. Testing for Corona Discharge on Apparatus or Circuits

In the previous paragraph the method of detecting discharges associated with a test piece of insulating material was described. The electrical detection of a small pinpoint of corona discharge on high-potential apparatus is more difficult than that in a small sample of insulation, or piece of metal, which may be mounted in the testing apparatus of Fig. 1. If a corona discharge occurs on the tank circuit of the oscillator of Fig. 1, point A of the testing circuit may be connected to one end of the tank coil, L_p and C_t are omitted. Another balancing air condenser is substituted for C_x in Fig. 1. Then, if the two goniometer coils are slightly dissimilar, the side-band components of modulation due to the corona disturbance will produce unequal inductive effects in the tertiary coil and a slight hissing sound is noted in the speaker. This effect, however, is much weaker than when the apparatus is used for discharge detection on small test pieces.

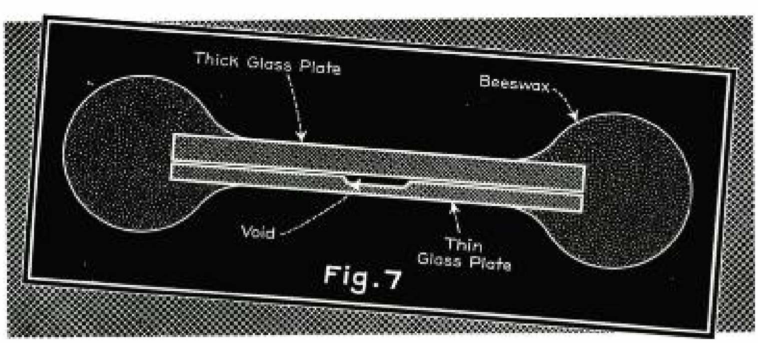
4. Some Characteristics of Surface Corona Discharge

Several Outstanding Testing Electrodes.—Characteristic behaviors of



surface corona discharge have been observed when metallic electrodes of various forms are placed on opposite sides of flat test pieces of insulation, such as glass, ceramic materials of different composition, etc. Fig. 3 shows various test electrodes, constructed of solid brass, machined to shape, and placed in contact with flat test samples of insulating material. The figure should be self-explanatory. The edges of the electrodes *not in contact* with the test piece surface were rounded to prevent corona discharge into space. When the applied voltage is raised to a certain value surface corona discharge starts at points C for the different types of electrodes shown in Fig. 3, (a), (b), and (c).

Description of Surface Corona Discharge.—Where the electrode edges make contact one or more pinpoints of corona discharge start with sufficient applied voltage, and very soon stretch



Special test piece with hermetically sealed artificial void.

out radially from the electrode edges in long glow-like streamers of discharge. Sometimes the pinpoint discharges occur just under the edge and cannot be seen, but are easily detected with aid of the test apparatus. As the voltage is further raised the streamers increase in number and strength, until they merge into disk-like fan of luminous discharge. This generates considerable heat, and if allowed to continue for some time, say 30 seconds, a plate-glass sample will break into many pieces due to local heating on its surface. If ¼-in thick pyrex samples are used several small pits will form at the electrode edges and the discharge will concentrate into these pits, gradually assuming an arc characteristic.

Eventually one or more holes will be bored through the test piece by melting action of the discharge arc, this taking place at the surprising low potential of 3200 volts at 1000 kc. For ceramic samples holes are also burned in the surface, but it requires a much greater time to burn entirely through the same thickness of test piece. Some ceramic materials burn through quicker than others. At 60-cycle voltage this phenomenon does not occur and the corona is a uniform glow which increases in intensity and space covered as voltage is raised, and will not generate great heat. Puncture or surface flash-over will occur before intense local corona discharge can produce high-temperature spots and holes.

TABLE I

TYPE OF ELECTRODES ON ¼" THICK GLASS PLATES	VOLTAGE AT WHICH SURFACE CORONA BEGINS KV. 60 CYCLES: ATMOSPHERIC PRESSURE	60 CYCLES: 30 LB. PER SQUARE INCH	RADIO FREQUENCY 1000 Kc.: ATMOSPHERIC PRESSURE	RADIO FREQUENCY 1000 Kc.: 30 LB. PER SQUARE INCH
CUBE AND FLAT CYLINDER SEE FIG. 3 (a)	3.2	4.5	2.8	—
FLAT CYLINDER CONTACT SEE FIG. 3 (b)	3.5	6.2	2.6	3.8 (15 LB.)
SILVER PLATED WITH CYLINDERS FIG. 3 (b)	4.0	7.1	3.5	—
CURVED EDGE CYLINDER CONTACT FIG. 3 (c)	5.6	9.5	3.8	—
BORED AND SILVER PLATED SEE FIG. 3 (d)	8.6 to 9.0	11.0	5.1	—

Table showing voltage at which surface corona begins

Comparison of Electrodes—Some electrode designs are superior to others in that it requires higher voltages with the better ones to obtain surface corona discharge. In the case of the curved edge cylinders, diagram (c) of Fig. 3, corona first occurs in the crevice formed by the curved electrode edge and the test piece surface, and in the critical air thickness region, as is recognized in ionization theory, but this will occur at a substantially higher voltage than for surface corona with plain edge cylinder electrodes (a) and (b). Table I shows comparative voltages for which surface corona discharge occurs at 60 cycles and at 1000-kc voltages, for atmospheric pressure and 30 lb. per square inch air pressure. The tests under air pressure were made in the glass cell shown in Fig. 2. It will be noticed that the bored electrode, from (d) in Fig. 3, prevents any surface corona until a considerably higher voltage is reached. At 1000 kc the oscillator used would not furnish sufficient voltage to start a discharge for this case, although 5000 volts could be obtained. For the data of Table 1 pyrex glass test samples were used because the material is without any pores or voids in which internal ionization discharge could occur. This latter phenomenon will be discussed later in this paper. In the table the spaces in the 30 lb. pressure column are blank because sufficient surface corona discharge voltage could not be obtained from the oscillator.

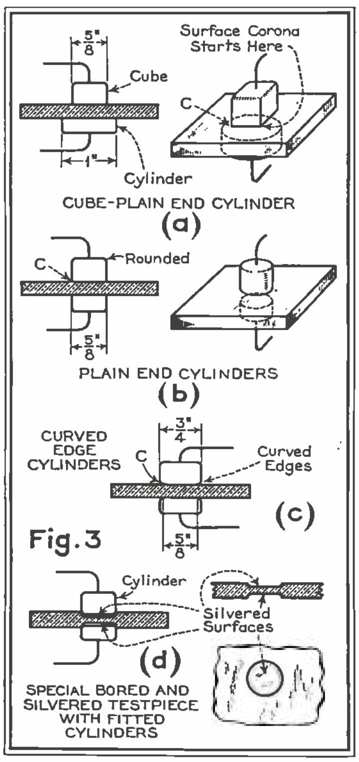
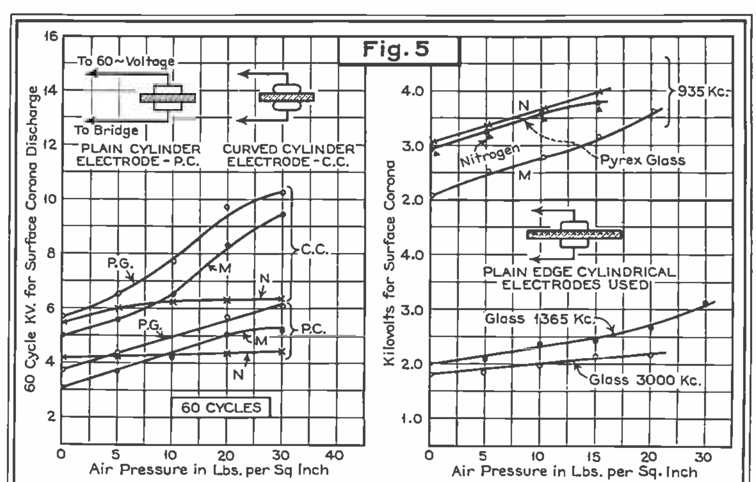


Fig. 3. Types of electrodes used in tests

Fig. 5. Variation of surface corona discharge with air pressure.

Variation with Voltage and with Insulation Thickness.—In Fig. 4 is shown the rapidity with which surface corona discharge increases in intensity as voltage is raised above the initial starting point. At 60-cycle voltages the *surface corona discharge current* was measured in a manner described in the paper referred to in footnote 1. At radio-frequencies only comparative data

(*Continued on page* 30)



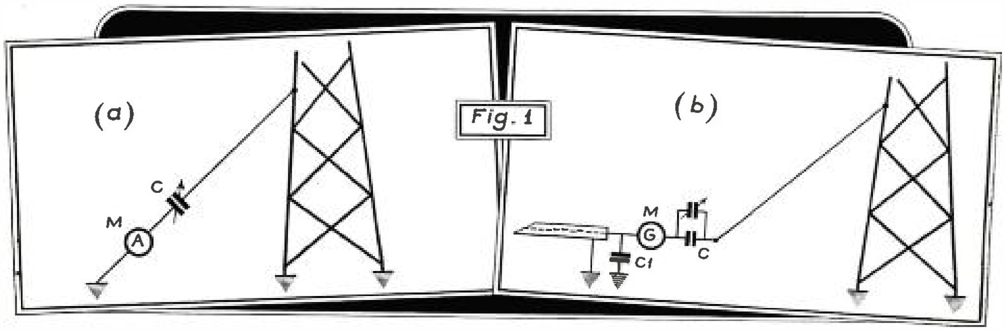


Fig. 1

Simplified Shunt Feeding

By
Fritz Bauer
Chief Engineer,
KGBX-KWTO

WITH summer and its thunderstorms, many stations have again been subjected to program interruptions and equipment failures by lightning. In some sections of the country almost every passing storm leaves its quota of evaporated meters, exploded condensers and collapsed inductors. A very high degree of protection can be had against these hazards by operating the radiator with its base grounded. Other advantages such as the simplification of tower-lighting equipment and the elimination of the remote-reading antenna ammeter, are well known. In a series feed system. currents induced by lightning must pass through the coupling equipment to reach earth. In grounded tower operation the coupling equipment is in parallel with a section of the tower and since the tower provides a path of much lower impedance the currents pass harmlessly to earth.

Although considerable information is available on the theory and adjustment of shunt-fed systems it is usually in a form not readily interpreted by the average station engineer. Further, although the theoretically correct reactance of the series condenser and the position of the slant wire on the tower can be calculated, these calculations are based on assumptions that are seldom, if ever, met in actual practice. This results in the correct values ofter differing widely from those calculated.

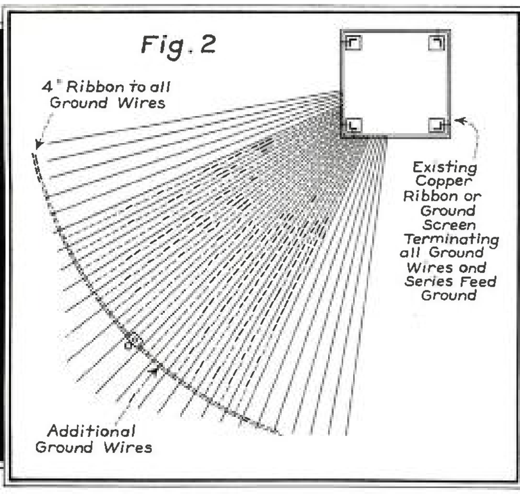
What is needed is a method requiring a minimum of equipment and mathematics that will assure, by simple interpretations of meter readings, and adjustment routine that will result in simultaneously tuning the antenna to resonance and matching the concentric line. The usual method of "tune for maximum antenna current and balanced line currents" will not suffice.

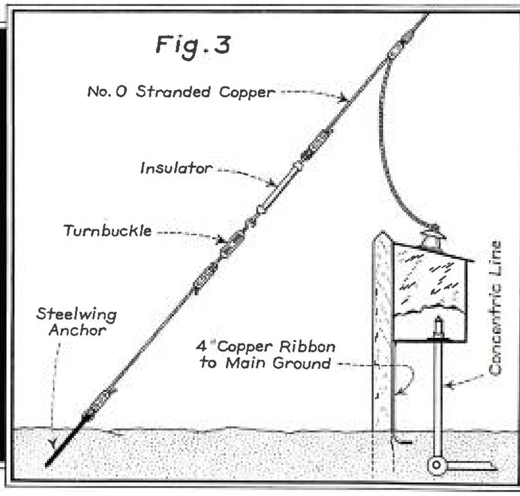
The correct setting for condenser (C) is most difficult to determine for any given position of the wire on the tower because the maximum indication of meter (M) cannot be depended upon to indicate resonance when this instrument is at once the line ammeter and the antenna ammeter. Even with the slant wire incorrectly terminated on the tower, it is still possible to obtain balanced line currents by adjusting C, but the antenna will be out of resonance. . Also, adjustments of C may cause the transmitter loading to vary so much that the maximum antenna-meter readings may be the result of maximum efficiency rather than actual resonance. If it were possible to decouple the transmitter to such an extent that these changes would not affect the loading at all, so that we would have, in effect, a generator of zero impedance, adjustments could be more easily interpreted. If the lower end of the slant wire were grounded (Fig. 1-a) this condition would be met and the maximum deflection of meter (M) would actually indicate resonance. Unfortunately this arrangement lacks coupling facilities since we cannot develop a voltage across zero impedance. If, however, we now insert a high-capacity condenser between the slant wire and ground (Fig. 1-b), we can approach the condition of zero source impedance and still supply a sufficient amount of power to the antenna for tuning purposes. By replacing the line-antenna ammeter with an r-f galvanometer and connecting a .05 to .2-mfd mica condenser as shown at C_1, it will be possible to develop sufficient voltage across the condenser to get an indication on the galvanometer. It will be seen that the capacity of say a .1-mfd condenser is high enough so that when it is connected in series with a capacity in the order of .0005 mfd the resultant detuning can be ignored. The point is to use the highest capacity possible at C_1 that will still give a useful deflection of the galvanometer when C is tuned through resonance.

Showing the inside of a metal tuning box.

It is assumed that interested stations already have a ground system installed similar to that shown in Fig. 2 and that the electrical height of the tower is at least .2 wavelength. The ground modifications necessary for shunt-feed operation are shown in dashed lines. The new tuning house may consist of a small water-proof welded-steel box mounted on a short section of telephone pole and placed on a line passing through the tower diagonal. The distance from this box to the nearest tower leg is not critical but should be about 15% of the tower height for all modes of operation. A greater distance is permissible for .25-wave operation if for any reason this should be desirable but the above figure should be used if the electrical height exceeds .3 wave. The angle the wire assumes is not important. A steelwing ground anchor similar to the type used in guying telephone poles is used to anchor the slant-wire assembly.

To provide a low-impedance path between the base of the slant wire and the tower, a "collar" consisting of a 4-inch, 16-oz copper ribbon is buried in a circle around the tower as shown and soldered to each ground wire. The radius of this ring is equal to the distance from the new tuning box to the center of the tower. A conductor of similar material is then soldered to this ring, run up the post and securely bolted or welded to the metal tuning box at the same point where the companion flange supporting the end of the concentric line is bolted (Fig. 3). Sufficient additional ground wires should also be installed at a shallow depth under the slant wire to bring the total in a 45-degree arc to 30 wires or more. Each tower leg is also grounded to a similar collar around the tower base with more 4-inch ribbon. These risers should be of 40-oz copper or heavier, and run in the most direct manner possible. It is important to ground each leg separately and directly, for otherwise the current distribution in the tower will be such as to cause the ungrounded legs to be "hot."





Upon completing the installation of the extra length of concentric line and ground modifications, complete as far as possible the mechanical assembly within the tuning box. During the tuning operation it is desirable to duplicate as nearly as possible the location of parts, conductors, etc., that will be used in the final assembly.

To facilitate the handling of the slant wire, the wire between the anchor and the insulator should be replaced by a block and tackle. This will permit loosening the wire while a man on the tower raises or lowers the junction. Excess wire can be permitted to hang down inside the tower. Temporary connection can be made by passing the cable once around the tower leg and securing with a Crosby clamp. Use thimbles to protect the cable from any sharp bends. A clamp or small vise on the tower leg under the junction will prevent slipping. Start with the wire secured at about one-fourth the tower height, and drawn tight.

Replace the antenna ammeter with an r-f galvanometer having a full-scale deflection at about 100 ma. Connect a good-grade receiving-type mica condenser of about .05 mfd with short heavy leads directly across the antenna end of the transmission line. Place a capacitor of about .0005 mfd at C shunted by a well-spaced trimmer of 50 to 100 mmfd. Operate transmitter and gradually increase its output coupling or excitation while tuning C until a galvanometer indication is obtained. If none is had select different values for C, in 100-mmfd steps until a maximum indication can be reached with the vernier. Increase value of C_1 as much as is possible and still obtain a useful maximum deflection without overloading transmitter components. This value should be high enough so that any further increase has no appreciable effect on the setting of the trimmer. To check, replace galvanometer with regular instrument, remove C_1 and operate transmitter. If the slant wire has been placed too low on the tower the current at the tower end will be higher than at the transmitter end. Conversely, if the wire is too high the tower current will be low. Move the wire accordingly and repeat the tuning procedure until the currents check equal. *Do not attempt to equalize currents by adjusting C.* This capacity must always be left at resonance. Equal currents at each end of the line usually indicates proper matching if the line is efficiently designed, is of moderate length and terminated in non-reactive elements.

Before tuning it would be well to make sure the line meters read within 2% of each other on that portion of the scale to be used.

If the checks on the tuning are made at or near the operating power it will be necessary to select capacitors of appropriate ratings in position C. The usual selection of spare and experimental capacitors normally found around the station will no doubt yield a suitable combination.

When adjustments are completed the total capacity of the combination can be determined by inspection or measurement. A single condenser of the correct value, with allowances for the trimmer can then be substituted. The peak operating voltage across the condenser can be found from the expression:

$$E_{peak} = \frac{10^3}{6.28\ f\ C} \times I \times 2.8,$$

where f is in kilocycles, C in microfarads and I the normal line or antenna current. Select a unit, or combination of units having a voltage rating at least double the calculated peak and a current rating (at the operating frequency) about 30% greater than the line current. This is also the approximate voltage for which the lower end of the slant wire must be insulated

(*Continued on page* 21)

SPUN-GLASS FLEXIBLE RESISTORS

By GEORGE J. MUCHER

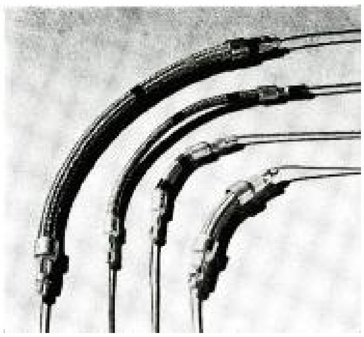
Chief Engineer

CLAROSTAT MFG. CO., INC.

WATTAGE ratings of flexible resistors have recently been stepped up considerably due to the use of spun glass for both core and braided covering. Indeed, it is now believed feasible to operate such units at red heat if necessary, since there is nothing to burn or char or deteriorate. This means more compact resistors for given wattage ratings, or more conservative ratings for units of set sizes, or again greater insurance against breakdown when facing serious overload conditions. Beyond that, there is the possibility that such flexible spun-glass resistors will be used as inexpensive heating elements where compactness, close-fit and low-wattage are prime requisites.

Bending ease to fit available space, together with the handy pig-tail leads for simplified point-to-point wiring of these self-supported units, has made the flexible type resistor popular not only for radio but likewise for other assemblies as well. Consisting of a resistance-wire winding on a flexible core, covered by a braided sleeve and fitted with neat ferrule ends and pigtail leads, these units have heretofore been available in 1-watt and 2-watt ratings per inch of body length. Both core and braided covering have been of cotton or other suitable material to maintain the necessary flexibility and compactness. Wattages have been held down so as not to char or burn the units. There has been, however, a growing demand for higher wattage ratings primarily as power resistors, but also as handy heating elements for small soldering irons, immersion heaters, hair curlers, electric marking pencils, and so on, provided units might be operated at elevated temperatures without breakdown.

In the past we have been faced with the problem of suitable materials capable of handling higher wattages, yet answering the mechanical requirements such as flexibility, uniformity, weaving ease and so on. After trying several different materials, our choice narrowed down to glass. In order to retain the important flexible characteristic, we naturally came to spun glass or Fiberglas, which, in the form of fine threads, is slightly less pliable than fine silk thread. Thus we have in this new material the heat-resistant properties of high-melting-point glass while retaining suitable resiliency for the core and the braided covering that make the flexible type resistor possible.

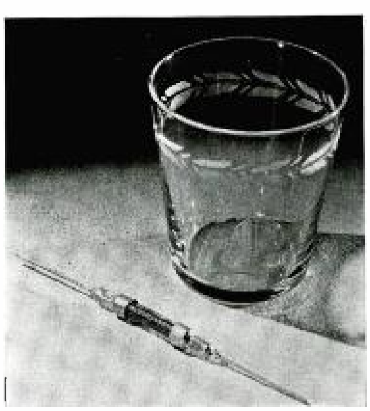


Typical Glasohms of 1/16 and 1/8 inch core diameters.

The spun-glass core and the braiding for Glasohms, begins with glass filaments of the order of 0.0002 inch diameter. These filaments have great tensile strength and can be twisted and wound on spools traveling at more than a mile a minute. This kind of Fiberglas is called "continuous filament."

Actually, 102 of these filaments are drawn together to make a single basic strand of Fiberglas, and at least two of these basic strands are combined to form the finest Fiberglas thread. There are some 90,000 yards to the pound of such basic strand. For use in our braiding machines, we use a thread comprising 20 basic strands, or a total of 2,040 twisted filaments. The filaments are heavily lubricated so as to slip and slide together for subsequent twisting and weaving operations.

This resistor uses spun glass for both core and braided coverings.



The spun-glass braided covering is milky white at first, and shows signs of lubricating oil used for the filaments. However, the operation of the resistor at rating for just a few moments serves to dry out this oil, whereupon the braid takes on a rich silky, tan appearance. We color-code such resistors by colored bands on braiding and on one of the ferrule terminals. The flexibility is almost as great as that of cotton-covered cotton-core flexible resistors.

Due to the nature of spun-glass insulation and covering, Glasohms may be operated at 300% overload, whenever the resultant temperature rise is permissible. In radio work these units are recommended as series rectifier plate resistors. Using these Glasohms in place of usual bare helical windings, we have stepped up the wattage ratings of our plug-in or other voltage-dropping units from 50 watts to 100 watts.

It should be noted that wattage ratings of resistance windings depend on heat dissipation. When the heat attains such elevated temperatures as to impair or even melt the wire, then the unit is hopelessly overloaded. When the wire winding can be imbedded in some suitable material which not only withstands operating temperature but also conducts the heat away from the winding and dissipates it to the surrounding air, then the winding can be operated at a higher wattage because its heat dissipation has been correspondingly increased by the greater mass of the surrounding material. Such is the case with Glasohms.

These spun-glass flexibles are suitable for making up attenuators and other step-by-step resistance devices which, while of compact dimensions and reasonable cost, must handle considerable power.

Aside from the use of these new units as resistors, there is the broad field of low-wattage electric heating to be considered. Glasohms can be operated at red heat without damage. The flexible unit can be wrapped around any part to be heated efficiently by close contact. It can be jammed into tight casings.

(*Continued on page* 28)

Book Reviews

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA, published by D. Van Nostrand Company, Inc., 250 *Fourth Avenue, New York City,* 1938, 1234 *pages, price* $10.00.

The ten thousand terms which are defined in this encyclopedia are taken from the following twelve fields: aeronautics, astronomy, botany, chemistry, engineering, geology, mathematics, medicine, mineralogy, navigation, physics, and zoology. These definitions are supplemented with 1,200 illustrations.

At first glance, ten thousand words appears to be quite a large number, but, when these are apportioned to twelve different subjects, it is seen that there are less than a thousand terms for each subject. Consequently, even a rapid survey of this encyclopedia reveals that absence of many terms, including some which have extensive usage.

Despite this defect, *Scientific Encyclopedia* should prove of value as a work of reference.

RADIO TROUBLE SHOOTER'S HANDBOOK, by A. A. Ghirardi, published by Radio and Technical Publishing Co., 45 *Astor Place, New York City,* 1939, 518 *pages, price* $3.00.

Although primarily intended for the radio service man, this book should prove of considerable interest to the engineer, particularly if he occasionally tinkers with radio receivers.

As the book is divided into fifty-two separate sections, attention will be called only to those which the reviewer feels may be of interest to engineers. Of unusual interest are the two trouble-shooting charts, one for home-radio receivers and the other for auto-radio receivers.

No longer need the engineer unversed in radio wonder regarding the significance of the variously colored wires in his receiver, for section 17 gives the RMA Standard Color Codes. This color coding is given for resistors, condensers, resistor cords for a-c, d-c receivers, dynamic loudspeaker leads, intermediate-frequency transformer leads, and audio-frequency transformer leads.

Attention is also called to the sections on Servicing Portable Sound Recorders and Servicing Intercommunicator Systems. A useful feature of this book is the inclusion of several unusually complete directories which give the names and addresses of manufacturers of radio receivers, parts, accessories, tubes, sound equipment, intercommunicating equipment, sound-recording apparatus, and test equipment. D.B.

THEORY AND APPLICATIONS OF ELECTRON TUBES, by H. J. Reich, published by McGraw-Hill Book Company, Inc., 330 *West* 42 *Street, New York City,* 1939. 670 *pages. Price* $5.00.

There has long been a need for a text which bridged the gap between Chaffee's "Theory of Thermionic Vacuum Tubes" and other books which deal with this subject. Professor Reich's "Theory and Applications of Electron Tubes" admirably closes this hiatus.

Although encyclopedic in scope, covering as it does practically the entire field of electron tubes, each subject is discussed with remarkable detail. An extensive bibliography is given for each topic covered, thereby enabling the reader to further pursue any particular field in which he is interested. When the tremendous amount of information available within the covers of this book is considered in conjunction with the price asked for it, it will be readily conceded that "Theory and Applications of Electron Tubes" is one of the outstanding bargains in technical books.

Although the treatment is, in general, mathematical in character, no mathematical training beyond elementary calculus is required of the reader. Moreover, even the reader totally lacking mathematical training should find this an extremely useful reference book, since the author gives clear and detailed descriptions of the physical theory underlying electron tube operation.

Problems are given at the end of most of the chapters. The author, however. is apparently possessed of that mental aberration which so commonly afflicts college professors, namely, that the supplying of answers to the problems would inevitably lead to the moral degradation of the reader inasmuch as he would be tempted to peek at the solution prior to working the problem. This omission of answers considerably lessens the value of the book for purposes of self-study and is, in the reviewer's opinion, the only major defect in an otherwise remarkable book.

This book is unqualifiedly recommended to any and everyone interested in electron tubes.

POLICE COMMUNICATION SYSTEMS, by V. A. Leonard, published by University of California Press, Berkeley, California, 1938, 589 *pages, price* $5.00.

As a review of available police communication systems this compact, carefully documented volume deserves high praise. Intended for the alert police official, it may well prove useful to the engineer as an index to the types and varieties of equipment and devices employed in modern police communication.

Emphasis is placed upon aspects of operation throughout the work; nevertheless, enough information is supplied to enable the technical reader to deduce with fair accuracy the functional requisites of the devices discussed, and the background supplied is sufficiently full so that presently needed improvements can be visualized and future trends can be forecast. In spite of the emphasis upon operation, it is made apparent that police communication lags behind commercial research and engineering in other fields, and it is particularly obvious that the surface has not been scratched in devising, adapting and integrating signal-alarm systems for police purposes.

Of necessity, much attention is given to telephone and radio systems. Detailed consideration is also given to other methods of communication. Yet the author is at his best in discussing the coordination of appropriate methods of communication into a single, unified system, and the chapter dealing with this problem is by far the best of the book. The account of various European systems, although interesting in that it gives a basis of comparison with installations in this country, has little other value. Such criticisms of existing systems as the author makes are seldom constructive, but always cogent. For the rest, the workmanship throughout is competent, and the material remarkably comprehensive; while there is little that is new or striking to be found in this book, it has the great virtue of being, within its limited field, completely adequate and adequately complete. E. A. M.

RADIO LABORATORY HANDBOOK, by M. G. Scroggie, published by The Wireless World, Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S. E. 1, *England,* 1938, 384 *pages, price* 8/6 *net, by post* 9/—.

"Though the most gifted writer may fail to interest all of the people all of the time, it is the present author's hope that he may succeed in interesting some of the people (i. e., all those who experiment in radio, on however small or large a scale) some of the time." Thus remarks the author in his preface. The present reviewer feels that Mr. Scroggie is much too modest in his statement, and that this book will not merely interest but rather will irresistibly fascinate all of its readers all of the time.

Radio Laboratory Handbook covers the entire field of radio measurements, from audio frequencies to the ultra-high frequencies. Various types of measuring equipment, home-made as well as manufactured, are analyzed as regards their utility, precision, and cost. In reference to this latter point another quotation from the preface is informative.

"The only type of reader in this field who is definitely excluded is the one with the incurably academic mind, for he will be shocked by the frequent references to money. The idea that financial cost is too sordid to find a place in serious scientific investigation is a polite fiction, not only as regards the humble amateur but also the largest commercial group or Government establishment. It may generate a delightful sense of purity and loftiness of soul to pretend that expense is simply not considered, but in planning the present work the author presumed to suspect that some of the high-souled ones might not be above snatching a fearful joy by surreptitiously dipping into pages designed to aid the enthusiast in doing things on the cheap."

The author constantly keeps the question of price in the foreground, for he realizes that the readers of his book must obtain maximum utility for minimum outlay in the measuring equipment which they purchase. It should not be thought, however, that the author advocates only very low-priced equipment. On the contrary, he points out that precision and convenience are directly related to price.

Despite the fact that this book is almost completely non-mathematical in nature, the author clearly explains the techniques involved in measuring radio apparatus, from the lowly resistor to the complete radio receiver. This is undoubtedly the most practical book that has ever been written on radio measurements. Even the engineer engaged in making precision measurements will encounter many valuable suggestions.

Radio Laboratory Handbook is recommended to every engineer who has occasion to make audio or radio-frequency measurements.—R. L.

TELECOMMUNICATIONS, by James Herring and Gerald C. Gross, published by McGraw-Hill Book Company, Inc., 330 West 42 Street, New York City, first edition, 544 pages, price, $5.00.

The central purpose of this volume is stated by the authors to be an evaluation, in the light of sound national policy, of existing regulatory legislation and machinery affecting the telecommunications industries. That purpose has been only partially achieved, but the result is nevertheless an excellent introductory handbook in communications regulation.

Evaluation requires background; by far the larger portion of the book therefore consists, of necessity, of a compendium of information on the past history of the four industries concerned: telegraph, telephone, cable and radio. The authors have succeeded in compressing into some 375 pages first, a concise and completely objective review of the past and present economic aspects of these four tremendous and complex industries, and second, an almost equally concise and objective review of their public service and regulatory aspects prior to the Communications Act of 1934. In both instances much that is interesting, as well as a little that is important, has unavoidably been omitted. Thus, intra-national intercorporate conflicts and treaties are merely adumbrated, without orientation either by way of continuity among themselves or in relation to the national economy. And the vast subject of valuation for rate-making purposes—of major importance in the Communications Commission's million-dollar investigation of A. T. & T.—is passed over in three sketchy pages. In spite of these and similar weaknesses, however, the background chapters represent a very efficient concentration of hitherto scattered factual data.

Unfortunately the final, analytical portion of the book does not come up to the standard of the earlier chapters. The communications Act of 1934 is examined solely from the standpoint of elimination of defects in previous regulatory measures; the reader must discover and determine for himself the many questions raised by the extensions of scope and authority contained in the act. What has already been established as "sound" national policy is merely restated, without too critical examination, and without serious attention to the possibility that extension of Federal power in the communications field may result in the formulation of new national policy.

In short, he who seeks a forward-looking appraisal of the present and future problems of governmental regulation of communications will not find it here. The chief value of the book lies in its excellent presentation of factual material.—E. A. M.

RADIO FACSIMILE, Volume 1, published by RCA Institutes Technical Press, 75 Varick Street, New York City, 1938, 353 pages, paper covers, given free as a complementary book dividend with a subscription to the RCA Review at $1.50 a year.

Although this book is not the only book devoted to facsimile, it is, to the best of this reviewer's knowledge, the only one available in English. Covering as it does the work done by RCA engineers in the field of facsimile, this volume is an important contribution to communication engineering.

This book is comprised of a collection of random papers by various authors, and should not be considered an integrated textbook which starts from fundamental principles and develops the subject step by step.

The volume is broadly divided into four general sections: (1) Historical development of facsimile, (2) Status of radio facsimile in 1938, (3) Radio facsimile communication methods and equipment, (4) Radio facsimile broadcasting. Each of these major four sections is further subdivided and contains several papers devoted to specialized aspects of facsimile. The treatment accorded the subject in these various papers varies greatly, ranging from the purely descriptive and requiring no previous knowledge of the subject to those which require a certain amount of mathematical background.

Particularly recommended to the communication engineer desirous of obtaining more information about facsimile is the paper, "A Narrative Bibliography Of Radio Facsimile," by J. L. Callahan, on pages 112 to 128.

The only error observed appears on page 107 in figure 25. A δ (delta) should be substituted for the S which appears in the figure. R. L.

W6USA

SOMETHING new in transmitter design is on display at station W6USA at Golden Gate International Exposition on Treasure Island, San Francisco Bay. It provides an answer to many problems for operators of aircraft ground stations and practically every other commercial transmitter.

It is a multi-frequency transmitter in which band switching and frequency changes are accomplished automatically. All that is necessary to change frequencies is to switch a single dial which changes the low current plate leads. Each stage is automatically tuned to resonance following each frequency change and "peak" efficiency is maintained at all times.

The method by which band switching and frequency changing is accomplished is comparatively simple. The first idea probably came from the method of tuning modern broadcast receivers. Small b.c.l. motors and simple relays were used in each resonant circuit. As a frequency is changed the variation of the plate current actuates the relay and starts the motor, which in turn rotates the tuning condenser. When resonance is reached the plate current falls to minimum value and the motor is stopped. These little motors are equipped with a clutch which releases the armature at precisely the right instant. The motors provide the foundation of the auto-resonator transmitter.

Simplicity and high efficiency are the keynotes of the design. W6USA was built to operate on 10, 20, 40, and 80 meters—any frequency within these bands. Carrier power, approximately 800 watts, is provided by a pair of Eimac 250TH's operating at 2500 volts and 400 ma.

This transmitter was designed by Eitel-McCullough, Inc., makers of "Eimac" tubes, and built to specifications by Wunderlich Radio, Inc. with the cooperation of the following manufacturers who donated parts and equipment; Thordarson Electric Manufacturing Co., Heintz & Kaufman, Bliley Electric Co., Hammarlund Manufacturing Co., Turner Co., and Barker & Williamson.

Showing some of the radio equipment at W6USA.

TWO-WAY TELEVISION COMMUNICATION

A system of two-way television communication in which a single cathode-ray tube at each station serves both as pickup device to develop picture signals for transmission and as a receiver or viewing device to reproduce images transmitted from the remote station, is covered in U. S. Patent No. 2,157,749 just issued to Allen B. DuMont, Assignor to Allen B. DuMont Labs., Inc., of Passaic, N. J.

The two-way television communication system is based on the use of a dual-function cathode-ray tube which includes both photo-sensitive screen (pickup) and fluorescent screen (viewing) side by side or in an otherwise convenient arrangement, but served by a single or common cathode-ray beam. Thus when the tube is transmitting an image, the cathode-ray beam swings over to the photo-sensitive screen or photoelectric mosaic, which it scans in the conventional manner, while at the other end the cathode-ray beam swings over to the fluorescent screen which it scans in order to reconstruct the images being transmitted from the remote station.

IRE Convention Program

September 20, 21, 22 and 23

Hotel Pennsylvania, New York City

THE Fourteenth Annual Convention of the Institute of Radio Engineers will be held at the Hotel Pennsylvania, New York City, on September 20, 21, 22 and 23, 1939. The 1939 Radio Engineering Show promises to be bigger and better, and from all indications the registration will exceed last year's high of 1,768. In addition to the up-to-the-minute technical gatherings, considerable entertainment is being planned.

The program for the technical sessions follows:

WEDNESDAY, SEPTEMBER 20

9:00 A.M.

Registration.

10:00 A.M.-12:00 Noon

Opening address by R. A. Heising, President of the Institute.

(1) "A Single-Sideband MUSA Receiving System for Commercial Operation on Transatlantic Radiotelephone Circuits," by F. A. Polkinghorn, Bell Telephone Laboratories, New York, N. Y.

(2) "Medium-Power Marine Radiotelephone Equipment," by J. F. McDonald, Radiomarine Corporation of America, New York, N. Y.

2:00 P.M.-4:00 P.M.

(3) "The Corner Reflector," by J. D. Kraus, Ann Arbor, Michigan.

(4) "Gaseous Ionization and Surface-Corona-Discharge Detection at Low and High Frequencies," by H. A. Brown, University of Illinois, Urbana, Ill.

(5) "A New Standard Volume Indicator and Reference Level," by H. A. Chinn, Columbia Broadcasting System, New York, N. Y.; D. K. Gannett, Bell Telephone Laboratories, New York, N. Y.; and R. M. Morris, National Broadcasting Company, New York, N. Y.

(6) "Vestigial-Sideband Filters for Use With a Television Transmitter," by G. H. Brown, RCA Manufacturing Company, Camden, N. J.

(7) "A Cathode-Ray Frequency-Modulation Generator," by R. E. Shelby, National Broadcasting Co., New York.

THURSDAY, SEPTEMBER 21

10:00 A.M.-12:00 Noon

(8) "Solar Cycle and the F_2 Region of the Ionosphere," by W. M. Goodall, Bell Telephone Laboratories, New York, N. Y.

(9) "Attenuation of High Frequencies Over Land at Short Ranges," by John Hessel, Signal Corps Laboratories, Fort Monmouth, N. J.

(10) "Demonstration of Aerological Radio Sounding Equipment," by Harry Diamond, F. W. Dunmore, W. S. Hinman, Jr., and T. S. Lapham, National Bureau of Standards, Washington.

12:30 P.M.-2:00 P.M.

Informal Luncheon: Presentation of the Institute Medal of Honor to Sir George Lee of the British Post Office and the Morris Liebmann Memorial Prize to H. T. Friis of Bell Telephone Laboratories.

R. A. Heising, President of the Institute of Radio Engineers.

2:30 P.M.-5:00 P.M.

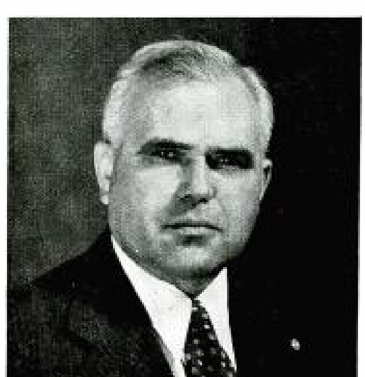
(11) "A Parallel-T Circuit for Measuring Impedance at Radio Frequencies," by D. B. Sinclair, General Radio Company, Cambridge, Mass.

(12) "High-Speed Multiplex System for Loaded Submarine Cable," by H. H. Haglund and A. W. Breyfogel, Western Union Telegraph Company, New York, N. Y.

(13) "Electronic-Wave Theory of Velocity-Modulation Tubes," by Simon Ramo, General Electric Company, Schenectady, N. Y.

(14) "On Diffraction and Radiation of Electromagnetic Waves," by S. A. Schelkunoff, Bell Telephone Laboratories, New York, N. Y.

H. T. Friis, Bell Telephone Labs., who will receive Morris Liebmann Memorial Prize.



FRIDAY, SEPTEMBER 22

10:00 A.M.-12:00 Noon

(15) "Cathode-Ray Tubes in Aircraft Instrumentation," by C. W. Carnahan, Hygrade Sylvania Corporation, Emporium, Penna.

(16) "A True Omnidirectional Radio Beacon," by E. N. Dingley, Jr., United States Navy Department, Washington, D. C.

(17) "Basic Economic Trends in the Radio Industry," by Julius Weinberger, Radio Corporation of America, New York, N. Y.

(18) "Engineering Administration in a Small Manufacturing Company," by C. T. Burke, General Radio Company, Cambridge, Mass.

2:00 P.M.-4:00 P.M.

(19) "Aircraft Radio Compasses—Principles and Testing," by R. J. Framme, Aircraft Radio Laboratory, Wright Field, Ohio.

(20) "Errors in Closed-Loop Direction Finders Caused by Abnormal Polarization," by R. I. Cole, Signal Corps Laboratories, Fort Monmouth, N. J.

SATURDAY, SEPTEMBER 23

10:00 A.M.-12:30 Noon

(21) "Functions of Electron Bombardment in Television," by I. G. Maloff, RCA Manufacturing Company, Camden, N. J.

(22) "Transient Response," by H. E. Kallmann, R. E. Spencer, and S. P. Singer, Middlesex, England.

(23) "A Wide-Band Inductive-Output Amplifier," by A. V. Haeff, and L. S. Nergaard, RCA Manufacturing Company, Harrison, N. J.

2:00 P.M.-4:30 P.M.

(24) "Superheterodyne First-Detector Considerations in Television Receivers," by E. W. Herold, RCA Manufacturing Company, Harrison, N. J.

(25) "Development of a 20-Kilowatt Ultra-High-Frequency Tetrode for Television Service." (In three parts.)
Part I. "Electrical Design," by A. V. Haeff, L. S. Nergaard, RCA Manufacturing Company, Harrison, N. J.; and W. G. Wagener, and P. D. Zottu, formerly of RCA Manufacturing Company, Harrison, N. J.
Part II. "Construction," by R. B. Ayer, RCA Manufacturing Company, Harrison, N. J.; and P. D. Zottu, formerly RCA Manufacturing Company, Harrison, N. J.
Part III. "Test Equipment and Results," by R. B. Ayer and H. E. Gihring, RCA Manufacturing Company, Harrison, N. J.

(26) "Productive Alignment Apparatus for Television Receivers," by L. J. Hartley, General Electric Company, Bridgeport, Conn.

APCO

Gerald S. Morris, President, APCO, Superintendent of Telegraph, Department of Police, New York City.

POLICE communication officers of the United States will hold their Sixth Annual Convention at Kansas City, Mo., October 2, 3, 4 and 5. The jobs of these men call upon them to apply to police communication the latest developments in the field, in order that the law enforcement agencies of the country, and for that matter, of many countries, may stay ahead of the lawless element.

Though the necessity for the enactment of the purposes and the principles of the Associated Police Communication Officers, Incorporated, had existed in America for more than half a century, it was not until the first "radio alarm" from a Headquarters to a moving police car was transmitted scarcely more than a decade ago, that this need began to assume vital proportions. With the entrance of police authorities into the realm of modernization, through the courageous pioneering of Detroit, Massachusetts, and the State of Michigan, with their initial crude stages of the splendid systems of radio communications in operation today, the die was finally cast.

For many years the watchmen, law enforcement and peace officers had, by custom and practice, been literally chained to the sidewalk and those little metal boxes on the corners. Then, suddenly as a cloudburst, there broke in the columns of the daily press the news that a new development had taken place and that in Detroit there were officers riding in cars, actually receiving orders and directions from the loudspeakers of radio sets in their vehicles. Throughout the nation authorities read these notices with varying degrees of emotion. Some scoffed loudly, others condemned as foolish waste of time and energy the experiments of those pioneers. Some, on the other hand, were profoundly impressed with the "extremely valuable contribution of science to the police art."

Within a matter of months from that first rather shaky success in Detroit, there were other cities and other states which were definitely interested and were constructing their own stations.

At that time, the old Federal Radio Commission, a stepchild of the Department of Commerce, was first introduced to problems, the ultimate extent of which even those who live constantly with the field can but speculate about.

With the advent of radio in Police Departments, certain changes were found necessary and one by one such changes were brought about. The era of modernization of law enforcement departments had begun, and with it, problems of most perplexing natures were raised. The Federal Radio Commission, unable to forsee, just as police departments were, the tremendous future which lay ahead, handled the situation in as orderly a fashion as circumstances would permit.

Before very long it was found that certain of these new police radio units might talk to certain others, and thus was created the nucleus for to-day's array of services.

Eugene F. Brown, First Vice-President, Supt. Radio Communications Division, Dept. of Public Safety, Des Moines, Ia.

Lieut. Roy DeShaffon, Convention Chairman, Supervisor of Radio, Police Department, Kansas City, Mo.

The FRC passed into oblivion with the Communications Act of 1934, and, in its stead was created a distinctly new governmental agency with basis in the law and empowered to command and to adjudicate the problems of those earlier days.

In January, 1935, the situation had become so acute in the police radio field that something definite had to be done if these services were to grow and continue service. Already the available supply of frequencies was becoming exhausted. Stations were blooming like mushrooms, and the men who were charged with the responsibility for designing, installing, and operating the units of this new service realized their need for organization in the interests of modern police communications. Accordingly, in St. Louis, Missouri, on a January day in 1935, a group of thirty of those leaders met with representatives of the newly formed Federal Communications Commission. At that meeting, several highly important phases were covered, and chief among these points in the agenda was the thought of forming an organization whose purpose would be that of aiding the FCC and police services in every possible manner. The organization was formed, and during the past four years its members have been slowly reaching their present point of view.

Capt. J. M. Wherritt, Editor APCO Bulletin, Officer in Charge of Radio, Missouri State Highway Patrol, Jefferson City, Mo.

In the formative years, these new "brain storms," as the earlier stations were sometimes called, bred some contempt in the circles of the "wire companies," a contempt which in later years turned to "viewing with alarm" and "deep concern" as this growth of stations and "police networks" continued. How utterly false was the basis for those fears may be plainly stated today when there are more than a thousand such "police radio units" and the business of the "wire companies" still shows increases in police departments year after year. Despite the fact, for instance, that in Indiana there are six state police and twenty-eight municipal radio stations operating twenty-four hours daily, there are still nearly seventy percent more long distance telephone and wire line messages handled in and out of police departments than ever before.

CONVENTION

October 2, 3, 4 and 5
Kansas City, Mo.

Where was the answer to these facts? It lay in the fact that of all of the tens of thousands of police radio transmissions handled annually in Indiana, fully eighty-five percent consists of traffic which was never handled by any service prior to the advent of radio and the awakening of law enforcement officers to the tremendous value of wholehearted interchange of facts and information. Here was a weapon, the greatest ally of enforcement and protection since the advent of finger printing, and the men of law had finally taken it to their hearts.

With the formation of APCO at St. Louis in 1935, there began a dramatic chain of events which were destined to remold the very foundations of police practice and procedure. Knowing that the extensive demands of the immediate future with regard to bulk of traffic between departments and states could never be met with success over the radiophone circuits alone, APCO with the assistance of engineers for the Federal Communications Commission evolved a plan for the establishment of a new facility destined to be known as the National Police Radiotelegraph Service.

Robert E. Franklin, Second Vice-President, Supt. Police Radio, Houston, Texas.

In July of 1935 the new organization of APCO was carefully studied by the International Association of Chiefs of Police and received the stamp of official approval by that body. Members of the IACP were assigned to work with members of APCO in problems relating to the development and procedure of the Police Communications field. Concurrent with this action, the plans for the radiotelegraph service were pushed rapidly along, and at the National Convention of APCO held at Indianapolis in October, 1935, the plan was approved by the body and reported back to the IACP, thence to the FCC.

In the field the idea of additional facilities was met with approval on all sides, though many doubted the wisdom of certain proposals in connection therewith. Legislative sessions in many states would not be held until the early months of 1937, and budgets then available (June of 1936) did not include funds for the purchase or construction of such equipment as would be necessary for the program. Accordingly, at a meeting at Columbus, Ohio, in that year, it was proposed that the radiotelegraph service be made officially available immediately to such stations and departments as might possess either equipment or funds, but that it not be made mandatory until a time eighteen months later, or on January 1, 1938. This extension was granted by the FCC, and the police radiotelegraph service was inaugurated in July, 1936. Thus APCO achieved its initial major goal, and firmly imprinted its value upon the police world.

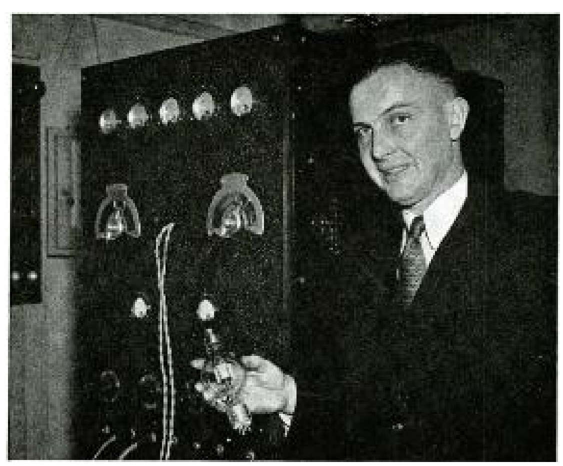
In June, 1936, the Federal Communications Commission invited the representatives of all services to meet in Washington for an informal hearing before the Commission "en banc" for purposes of expressing their ideas as to needs and desires for a proposed "re-examination of frequency allocations." It was, no doubt, quite surprising to the Commissioners, when they received formal notice from the "Police Services" of their intention to appear at the June hearings. It was extremely obvious to all present, however, that the arrival in Washington of a corps of no less than thirty men headed by Captain Donald S. Leonard of the Michigan State Police, Chairman of the Communications Committee of the IACP, was a shock to the entire assembly.

Still greater then the effect, when Captain Leonard, young, vibrant in tone and manner, crisply told the story of the developments, and the things already achieved by this group of purposeful men of the law. Small wonder that there were worried countenances as the Captain warned other services that "the Police Communications Services of this nation shall make themselves heard in this and future hearings as and when the necessity may arise!" As members of the Commission orally expressed both astonishment and congratulations to the Police Services for their most comprehensive and thorough portrayals, the trends of future years were written upon the walls. APCO, walking hand in hand with its superiors, the IACP, was on the march, and a second major objective was attained.

Sgt. Frank W. Morrow, Secretary-Treasurer, Chief Communications Officer, Indiana State Police, Indianapolis, Ind.

Again, when preparing the materials for Havana and the International Conference, the APCO, in collaboration with the FCC engineers, and the amateur bodies, brought about an agreement to shift the frequencies from 1,715 kc to 1,750 kc from the amateurs' band to police and government services, and in return to grant the amateurs those lying between 1,750 kc and 2,050 kc. Of course, in later developments it chanced that in bringing the terms of this agreement into effect, the police CW services lost three frequencies in the 2,000-kc band and received in their stead three widely separated channels in the 7,000-kc portion of the spectrum, which was definitely not

(*Continued on page* 39)



Charles B. McMurphy, Sergeant-at-Arms, Radio Technician, Alameda County Sheriff's Office, Oakland, Calif.

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

UNION CARBIDE ACQUIRES BAKELITE

At a meeting held Tuesday, August 29, 1939, the Board of Directors of Union Carbide and Carbon Corporation approved an agreement for the acquisition by Carbide of all the assets of Bakelite Corporation. Carbide is a producer of chemical raw materials and Bakelite a user of chemicals in its converting activities.

Bakelite Corporation has been active in the manufacture and distribution of thermosetting plastics, principally of phenolic types. Products from this material have become well and favorably known in such forms as telephone receivers, automobile ignition parts, timing gears, radio cabinets, electric insulators, switch plates, bottle caps, lamp bases, pencils, buttons and novelties.

During recent years an increasing number of Carbide's synthetic organic chemicals have been used as raw materials in various plastics, including those made by Bakelite. Carbide also produces vinyl resins, recent developments being "Vinylite" resin for the laminating interlayer in the new high-test safety glass, and "Vinyon" for the production of synthetic yarn.

Under the agreement there will be distributed to Bakelite stockholders 187,500 shares of Carbide common stock exchanged for Bakelite's assets. Bakelite preferred stockholders will be entitled to receive for each preferred share 1¼ shares of Carbide stock, the remainder of the Carbide stock to be divided ratably among the Bakelite common stockholders. The agreement will become effective upon ratification by the holders of each class of Bakelite stock.

TRIUMPH BULLETIN

Triumph Mfg. Co., has recently made available a bulletin describing their Speed-Button 32 Range Meter, a multirange meter for radio and television. Also described is Triumph's Model 130 video signal generator which covers a range from 100 kc to 96 mc. Copies of the Bulletin may be secured by writing to the above organization at 4017 W. Lake Street, Chicago, Illinois.

WIRE BROADCASTING APPOINTMENT

Jarold West, President of Wire Broadcasting Corporation of America, has announced the appointment of L. F. Cramer as General Sales Manager. Mr. Cramer, who will immediately embark upon an active campaign to open up additional outlets for Wire Broadcasting, was formerly with the Allen B. DuMont Laboratories, Inc., as General Sales Manager.

INDUSTRIAL INSTRUMENTS BULLETINS

Industrial Instruments, Inc., Bayonne, N. J., have recently made available two bulletins. Bulletin RC-115 deals with conductivity bridges and dip cells, while Bulletin MB-203 is concerned with an insulation resistance tester. Copies may be secured by writing to the above organization.

BLAW-KNOX APPOINTMENT

Blaw-Knox Company has announced the appointment of Lawrence E. Joseph as executive officer in charge of its Blaw-Knox Division. Mr. Joseph succeeds R. F. McCloskey, Sr., a company vice-president, who was placed in charge of the development of new products for the entire corporation. Mr. Joseph, until the first of this month, was manager of the National Automatic Tool Company, Richmond, Indiana. Prior to that connection he was a vice-president of the Liggett Spring & Axle Company, and previously was engaged as a consulting engineer.

RCA BULLETINS

New bulletins made available by RCA Manufacturing Co., Inc., Camden, N. J., cover the Type MI-7823 ultra-high-frequency antenna, the Type 303-A frequency-limit monitor for monitoring of high-frequency broadcast transmitters, the Model RB-2 pack transmitter for relay broadcast purposes (30 to 41 mc), and the Type 304-A 9-inch general-purpose cathode-ray oscillograph. Copies may be secured from the above organization.

WARD LEONARD APPOINTMENT

Ward Leonard Electric Co., is pleased to announce the appointment of Mr. H. W. Groetzinger, 1500 Cooper Avenue, Pittsburgh, Pa., as their representative for the sale of Ward Leonard radio products. Mr. Groetzinger's territory will be all of the state of Pennsylvania west of and including the city of Harrisburg and all the state of West Virginia.

DUREZ PLASTICS & CHEMICALS

Stockholders of General Plastics, Inc., manufacturers of Durez phenolic molding compound and resins, with executive offices and plant at North Tonawanda, N. Y., on August 30th approved the proposal of the Directors to consolidate the corporation into a new company to be known as Durez Plastics & Chemicals, Inc. The corporation started operation under the new name on September 1st. The new Durez Plastics incorporates in its name the trade name "Durez" under which General Plastics' products have been sold. There will be no change in the management.

U. S. RECORD APPOINTMENTS

The United States Record Corporation, New York City, has announced the appointment of Herbert E. Young as its national Sales Manager. The appointment of Ed Denham, originally with Victor Talking Machine Co. and later representative of RCA Victor, to the post of regional sales manager of the Southern territory was also announced, while Bill Cone of Boston has been made regional sales Manager for New York and New England. Mr. Cone was recently connected with Columbia Phonograph Co.

TERRITORIES OPEN

The *Lansing Manufacturing Company*, 6900 S. McKinley Ave., Los Angeles, Calif., now extending national distribution of their line of sound-reproducing equipment, has a number of distributorships available and will welcome inquiries from qualified concerns.

WILMINGTON FIBRE BULLETIN

Wilmington Fibre Specialty Company, Wilmington, Delaware, have announced a bulletin covering the uses of vulcanized fibre for insulating current-carrying wires. Copies may be secured by writing to the above organization.

NEW COMPANY

John and Joe Erwood have announced the organization of the Erwood Sound Equipment Company, 224 W. Huron St., Chicago. The organization's line will cover the field in sound equipment, including portables of all sizes, fixed installations, institutional and school systems, industrial systems, inter-office communicating systems, mobile systems and custom built installations of all kinds and sizes. Mr. John Erwood, President of the Erwood Sound Equipment Company will have active charge of the sales work. Joe Erwood, Vice-President, is in charge of engineering. Catalog, available shortly, will be mailed on request to the above company.

RECOTON DISTRIBUTOR

Recoton Corporation, 178 Prince Street, New York City, has announced that Canadian Music Sales Co., of Toronto has been appointed sole Canadian distributor. The Recoton organization makes both cutting and playback needles.

LAJOIE HEADS DUMONT SALES

The appointment of Mark B. Lajoie to the post of General Sales Manager is announced by the Allen B. DuMont Labs., Inc., of Passaic, N. J. He succeeds Leonard F. Cramer, resigned. For some time past Lajoie has headed DuMont television sales in the New Jersey territory, following years of Philco merchandising experience.

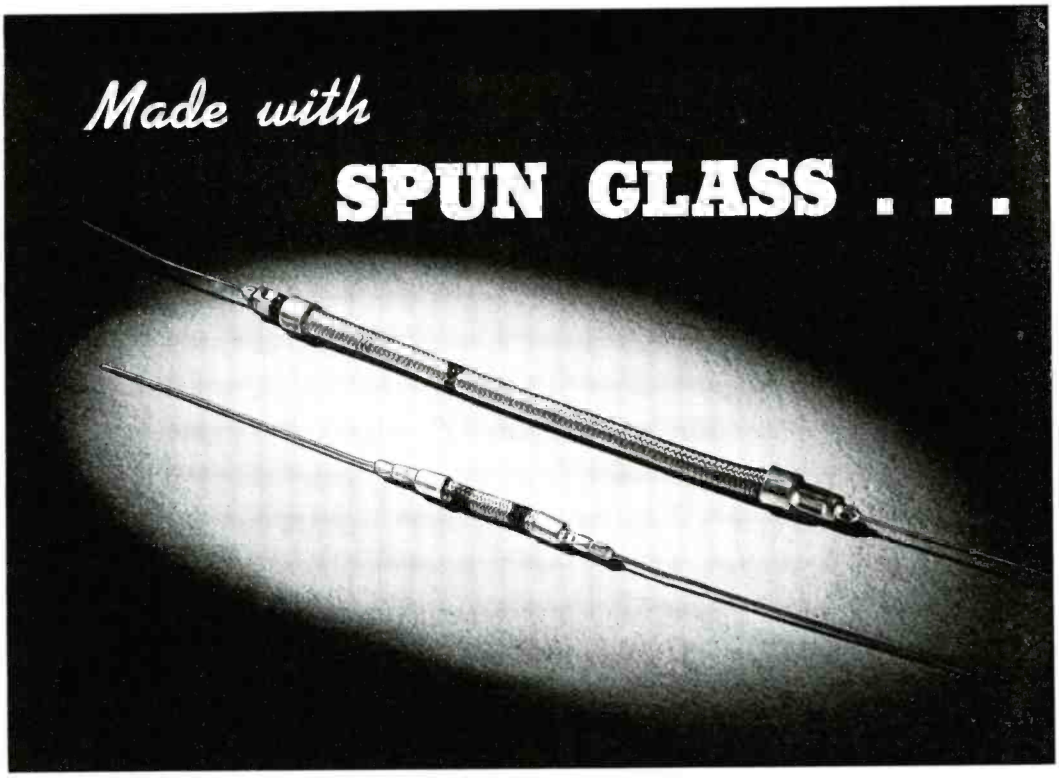
JOHN MECK INDUSTRIES FORMED

It has just been announced that John Meck Industries, 430 W. Erie Street, Chicago, has been formed by John Meck, formerly president of Electronic Design Corp., and sales manager of Clough-Brengle. This organization is manufacturing sound equipment for specialized applications.

WARD LEONARD CIRCULAR

Ward Leonard announces its new, revised Circular No. 507 is now ready for distribution to the radio trade. Copies of this circular will be sent free to anyone interested in radio resistors, rheostats, line voltage reducers and other products of the Ward Leonard radio line.

(Continued on page 18)



featuring . . .

- ★ Spun-glass core and braided covering in place of former cotton or asbestos.
- ★ In two sizes: 1/16" dia. core, 1 watt per body inch; 1/8", 2 watts per body inch.
- ★ May be operated at 300% overload without breakdown. Withstand operating temperatures up to 1000 deg. F., or glowing red.
- ★ Handsome silky tan appearance—maximum eye appeal. Flexible for handy point-to-point wiring.
- ★ Self-supporting. Metal ferrule ends with pigtail or other type terminals. Color coded if desired.
- ★ Resistance values up to 700 ohms (1/16") and 750 ohms (1/8") per body inch. Low resistance values down to 1/4 ohm or less per body inch. Units made up to 500 feet long.
- ★ Ideal for voltage-dropping and voltage-dividing units, attenuators, compact heating elements, and extra-small power resistors.
- ★ Best of all, they are quite inexpensive for the work they do.

CLAROSTAT

TRADE MARK REG. U.S. PAT. OFF.

FLEXIBLE GLASOHMS*

★ Wattage ratings of inexpensive and handy flexible resistors are now stepped up several hundred per cent through the use of spun-glass cores and spun-glass braided coverings. They stand the gaff. Can be operated even at red heat. Nothing to burn, char, deteriorate. This means higher wattage ratings, more conservative ratings, and greater breakdown insurance against overloads. Try a sample GLASOHM* for yourself. Get the engineering data. Just write us on your business letterhead.

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CLAROSTAT *Manufacturing Co. Inc.*
285-287 NORTH SIXTH STREET
BROOKLYN, NEW YORK, U.S.A.
• OFFICES IN PRINCIPAL CITIES •

OVER THE TAPE

(*Continued from page* 16)

WEBSTER CATALOG

The Webster Co., 5622 Bloomingdale Ave., Chicago, have issued a 24-page catalog illustrating and describing their amplifier systems, intercommunicating equipment, sound reproducers and baffles. Copies may be obtained directly from Webster-Chicago.

RCA BULLETINS

Two new bulletins are now available from the RCA Manufacturing Co. Inc., Camden, N. J. One bulletin, issued by the Aviation Radio Section, discusses the location and elimination of engine ignition interference to aircraft radio receivers. The other publication deals with the Types 80-A and 80-B assembled studio control-desk. Bulletin available from the Broadcast Equipment Section.

SYLVANIA PLANT MANAGER RETIRES

Hygrade Sylvania Corporation has announced the retirement of R. W. Roloff, General Manufacturing Manager of the company's tube plants in Emporium, Pa., and Salem, Mass., after more than twenty-one years of service. He joined Nilco Lamp Works, Inc., parent company of the Sylvania Division, in February 1917, and later became factory manager of the Sylvania tube plant in Emporium. In 1933 he was appointed general manufacturing manager in charge of tube production for all Hygrade Sylvania plants, and established headquarters in Salem. Mr. Roloff plans to keep in touch with factory production problems, and his release from active duty is contingent upon his being subject to call if his services are required.

LAFAYETTE CATALOG

Radio Wire Television, Inc. (formerly Wholesale Radio Service Co., Inc.) announces that its 188-page "Master" Catalog for 1940 is now ready for distribution. This catalog features 40 pages devoted to home, portable and auto radios and accessories; 35 pages of public-address equipment; 50 pages of equipment, parts and tools for the service man; and 30 pages for the ham and television experimenter. Write to the above company at 100 Sixth Ave., New York City.

TELELAB FACILITIES

In addition to a complete line of television tubes, National Union maintains a complete television receiver laboratory, which specializes in tube application and circuit design problems. The use of this laboratory is gratis to anyone interested in the manufacture of television receivers or testing equipment. The laboratory has a complete television picture signal generator conforming to the R.M.A. proposed standards. The generator has several fixed patterns and pictures available.

The output of the generator is cabled around the laboratory in concentric cables. The signals are available at (1) video frequency; (2) i-f with carrier set anywhere between 6 and 15 mc; (3) television channel frequencies. In addition to the composite television signals, there are also available separated synchronizing signals, as well as composite synchonizing signals for testing blocking oscillators and synchronizing signal separators independently.

The latest addition to the television laboratory is a tube rack which operates simultaneously up to five Videtrons.

TELEVISION ENGINEERING

Registered U. S. Patent Office

FUNDAMENTALS OF TELEVISION ENGINEERING

Part VI: Synchronization

By F. ALTON EVEREST
Dept. of Elect. Eng.
OREGON STATE COLLEGE

SYNCHRONIZATION is that function of the television system by which the transmitting and receiving ends of the system are held together in proper time relationship. The results would be nothing short of chaos if the light-valve signals representing the different elemental areas of the transmitted image were reassembled at the receiver in any other than their proper relationship. Whether or not visual intelligence is successfully transmitted depends upon absolute synchronism between the transmitter and the receiver. A television receiver might be reproducing every elemental area of the transmitted image upon its screen, but unless they were properly oriented the result would be a meaningless jumble of light and shade.

In the early days of television when the scanning disc or similar mechanical systems were used, only one synchronizing signal was necessary. That signal was used to keep the receiver disc rotating at exactly the same speed as the disc at the transmitter. As holes in both transmitting and receiving discs were drilled according to the same pattern, the lines followed each other at proper intervals. The transmitted pulse applied to a phonic wheel motor at the receiver caused this motor to speed up if it tended to lag and to slow down if it tended to exceed the speed of the transmitting disc. If both discs were turning at exactly the same speed but comparable points on the discs were not in the same relative positions an *isochronous* condition existed. If, in addition to identical speeds, comparable points on the two discs were made to rotate so that they always were in the same relative position with respect to the other they would be *in phase* and *synchronous*. The latter condition is the one that must exist in television systems.

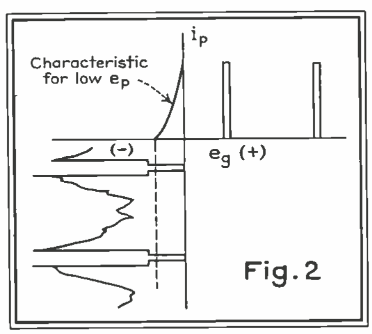
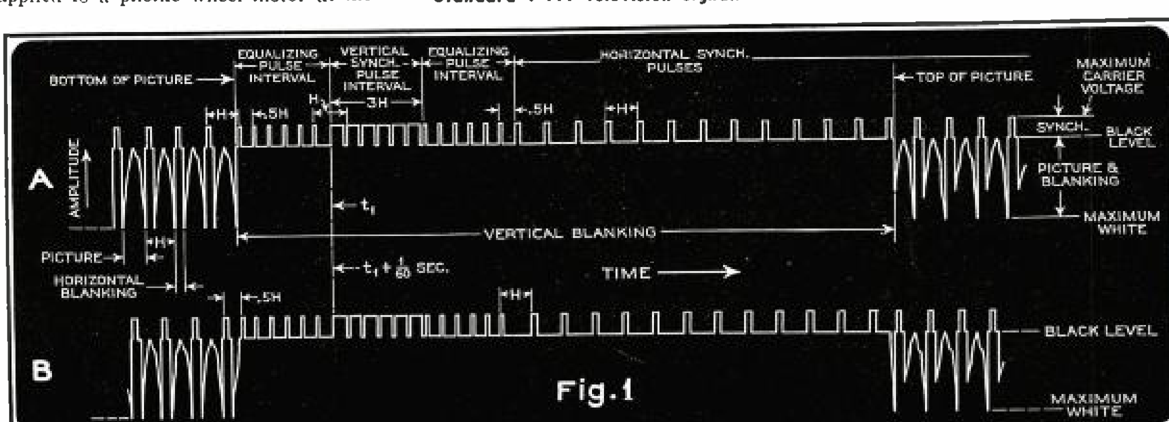


Fig. 2. Operation of 1st synch separator circuit which separates vertical and horizontal synch pulses from picture. Fig. 1. RMA Standard T-111 television signal.

In cathode-ray reproducing systems the image is synthesized by means of constant-speed unidirectional scanning. As discussed in Part V, the scanning potentials or currents are generated locally in the television receiver. For synchronous operation of this type of system, it is necessary that two synchronizing signals be transmitted, one to initiate each line sweep, and one to initiate each field. Interlacing may be accomplished by having an odd relationship between the line and field scanning frequencies.

After the scanning spot has traversed from left to right at a constant speed along a single line, it must return to the left edge of the picture again. The time required for this, called the "fly-back" period, is wasted as far as the image is concerned. The fly-back time is 15% of the total time allotted to one line in the RMA standards. After the scanning



spot has traveled line after line from the top of the picture to the bottom, the standards allow 7% of the vertical scanning period for the spot to return to the top of the picture in preparation for a new field. Here, then, during the flyback period at the end of each line and at the end of each field is time in which horizontal and vertical synchronizing impulses may be transmitted and received. This is the means of synchronization now used, although the details of the systems vary somewhat throughout the world. For instance, in Germany the method used recently was removing the carrier completely for a short interval during the flyback period, the dead space actuating certain circuits and serving as the synchronizing signal. The method used in this country can best be understood by studying the standards proposed by the RMA for uniform television signal make-up for an image of 441 lines, 30 frames per second, 60 fields per second, interlaced.

The RMA Standard Television Signal

It was decided to adopt negative transmission as the norm. That is, a decrease in initial light intensity causes an increase in the radiated power. The value of this lies chiefly in the fact that it permits the use of a simple automatic gain control. The placing of the picture signal on a more linear part of the grid modulation characteristic probably also entered into this choice.

It was further decided that if the peak amplitude of the radio-frequency television signal were taken as 100%, that not less than 20% nor more than 25% of the total amplitude was to be set aside for synchronizing purposes. In other words 0% modulation corresponds to extreme white, 75 to 80% is full black, and the region between 75-80% to 100% is devoted exclusively to synchronizing pulses. This appears to be a rather large proportion of the modulating capability of the television transmitter to devote to synchronization, but experience has proved that it is desirable to maintain good synchronization even down to the point where the picture signal becomes too weak for a satisfactory image.

Fig. 1 shows the standard synchronizing signal advocated in standard T-111 of the RMA report. This figure shows the idealized waveform of blanking and synchronizing signals in the vicinity of two successive vertical blanking pulses. The last few lines at the bottom of the picture are shown at the left, and the first few lines at the top of the picture are shown at the right. The location of the corresponding lines at the bottom or top of the picture of A and B lie adjacent to each other due to the interlacing. It will be noticed that during the flyback time at the end of a frame that "black level" is transmitted which means that the electron beam of the receiving cathode-ray tube is biased to cutoff. This prevents the beam from tracing a spurious path over the screen on its rapid flyback to begin a new field. In a similar manner, blanking pulses are inserted at the end of each line, driving the c-r grid to cutoff, while the beam is being swept back to the left of the picture to begin a new line.

The time elements involved in the horizontal blanking pulses are quite small. The time for a single line for 441-line definition is about 75.5 microseconds. This allows but 15% of this or 11.3 miscroseconds for the horizontal blanking pulse. On the other hand, the vertical blanking signal lasts for 7 to 10% of 1/60 second or from 0.0011 to 0.0016 second, about 125 times as long as the horizontal blanking pulse.

During the horizontal blanking period, the horizontal synchronizing signal is sent by modulating the transmitter into the "blacker than black" region (or from 75-80% to 100% modulation.) This signal is separated in a manner soon to be described and used to trip the horizontal sweep generator in order that the beam sweep be initiated at exactly the proper moment. Now if one of these line synchronizing impulses occurs every 75.5 microsecond, it is obvious that during the vertical blanking period these signals must be continued or control of the line frequency sweep generator would be lost. For this reason, the horizontal synchronizing pulses or their equivalent are transmitted during the vertical blanking period as shown in Fig. 1.

The vertical synchronizing pulses are composed of a pulse driven to the 100% modulation level which is "serrated" or notched as shown in Fig. 1

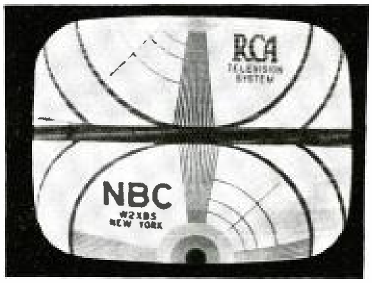


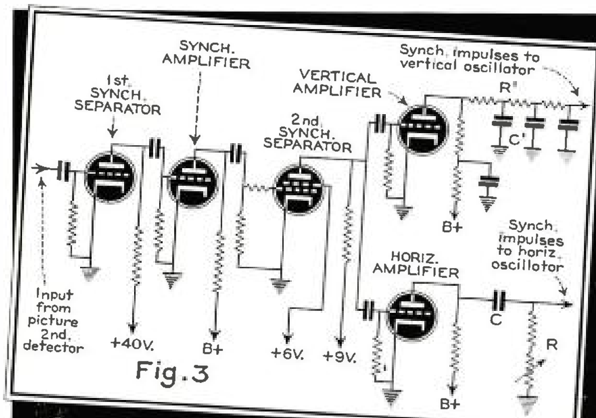
Fig. 7. Showing "loose frame hold," i.e., a lack of synchronization at frame frequency.

in such a way that the horizontal pulses may continue while the vertical pulse is in existence. The greater area under the vertical pulse is a sufficient difference to allow its separation from the others.

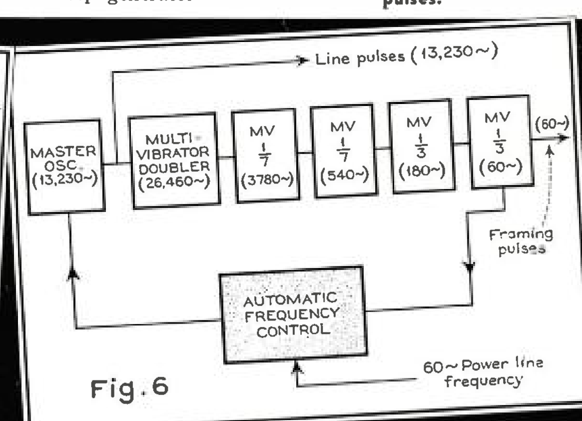
Pulse Separation

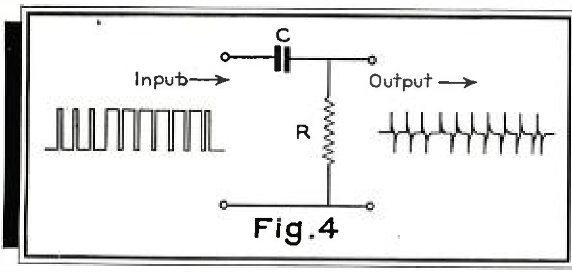
The signal voltage (looking very much like Fig. 1 in shape) which is developed across the second detector diode load resistor of the image channel is applied to the pulse separator circuit as shown in Fig. 2. This circuit is a triode having grid-leak bias and low plate voltage so that the operating

Simplified typical synch separator and amplifier circuits of television receiver.

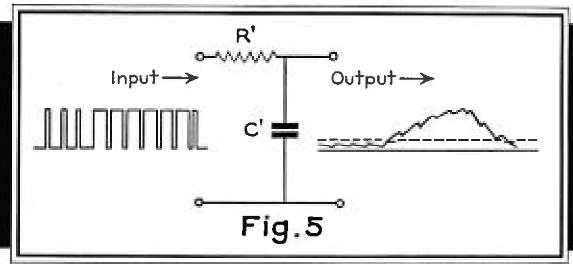


A possible master timing system for horizontal and vertical synch pulses.





Showing the action of the basic horizontal pulse selecting circuit.



Showing action of the basic vertical pulse selecting circuit.

point bears approximately the relationship to the dynamic characteristic as shown in Fig. 2. The image signal and the blanking pulses have no effect in the plate circuit for they are beyond cutoff. The vertical and horizontal pulses, however, are passed, separating them from the picture signal.

Fig. 3 shows this first synch separator tube in conjunction with associated circuits. It also inverts the phase of the signal so that an amplifier stage is needed to rotate the phase another 180 degrees so that the polarity is the same as that on the input of the first tube. This synch amplifier utilizes a normal plate potential and is self-biased so that the grid is not driven to cutoff.

Fig. 8. Showing "loose live hold" or insufficient horizontal synchronization.

The output of the synch amplifier is applied to the second synch separator which serves to clip the top of the pulses and to remove any remaining picture signal that may have been allowed to pass. The series grid resistor cuts the top from any signal which drives the grid into the positive region. This tube is also grid-leak biased. With the voltages indicated in Fig. 3, the tube has a dynatron characteristic which aids in cleaning up the pulses. Any noise which may have become superimposed upon the pulses will also be removed.

The output of the second synch separator passes to two amplifier tubes. The horizontal synchronizing pulses are selected in the plate circuit of one tube and sent to the horizontal sweep oscillator to keep it in step. The vertical synchronizing pulses are selected in the plate circuit of the other tube and are then used for controlling the operation of the vertical sweep oscillator.

Fig. 4 shows the waveforms and the basic pulse selecting circuit used in the plate circuit of the horizontal amplifier of Fig. 3. The function of this circuit is to provide a continuous flow of horizontal synchronizing pulses even while the vertical pulse is acting. The action of this circuit during this particular critical time is shown in Fig. 4. The serrations or notches in the vertical pulse allow a continuation of the pulses in the output of this circuit composed of C and R. The condenser C allows current to pass only while the voltage is changing. The front edges of the pulses produce positive impulses which are used to synchronize the horizontal sweep generator.

Both the vertical and horizontal pulses are applied to the grid of the vertical amplifier and the vertical pulses are separated by a mechanism such as shown in Fig. 5. The condenser C′ is charged through the resistor R′. The area represented by the horizontal pulses is so small that C′ is charged to only a relatively small voltage. However, the serrated vertical pulse charges C′ to a voltage which is sufficient to trip the vertical sweep oscillator and keep it in step. The circuit of Fig. 5 is actually a simplified version of three filter sections in cascade as shown in the plate circuit of the vertical amplifier of Fig. 3.

Pulse Generation

A glance at the complex waveform of Fig. 1 impresses one with the close tolerances which must be observed for satisfactory television operation. It is both interesting and instructive to understand a method of keeping the proper relationship between line and field-pulses. It is also highly desirable that the 60-cycle output of the vertical sweep generator be locked into step with the 60-cycle power frequency. This results from the disturbing effects of a-c hum in the vertical or horizontal deflection circuits or both. The disturbance created is much more disconcerting to the eye if it is in motion as would be the case if a slight difference existed between the field and power frequencies. Wiggling and creeping edges and vertically moving horizontal bands due to uneven line spacing result at the difference frequency. To avoid this, relatively complex systems are used. Fig. 6 shows one such possible system. A master oscillator of some type controllable over a narrow range operates at 13,230 cycles per second which is the line frequency ($441 \times 30 = 13{,}230$). This frequency may be used to control the frequency of the horizontal synchronizing pulses. This is fed into a multivibrator circuit which doubles the frequency and into four successive multivibrator stages which act as frequency dividers of 1/7, 1/7, 1/3, and 1/3, respectively. The output frequency is 60 cycles. To keep this output frequency the same as the power-line frequency, it can be compared to the power frequency by means of a suitable electrical circuit, and the frequency of the master oscillator adjusted to compensate for any difference between the two frequencies.

(*To be continued*)

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(3) Goldsmith, "Television Economics," Part III, Section E-3, "Synchronizing and Video Controls," COMMUNICATIONS, April, 1938, p. 26.

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(5) Zaharis, "Synch Impulse Generator for Television Deflection Circuits," *Electronics*, June, 1939, p. 48.

(6) "Practical Television by RCA," Service Division, RCA Manufacturing Company, Inc.

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SHUNT FEEDING

(*Continued from page* 9)

under all weather conditions.

In time the slant wire assembly will have a tendency to sag, due to slippage at anchor points, stretching of wire, etc. High winds and ice loading will aggravate these conditions. This may result in serious detuning of the system. The tuning method outlined above provides a quick and convenient method of checking and correcting tuning adjustments.

Television Economics

By Dr. ALFRED N. GOLDSMITH

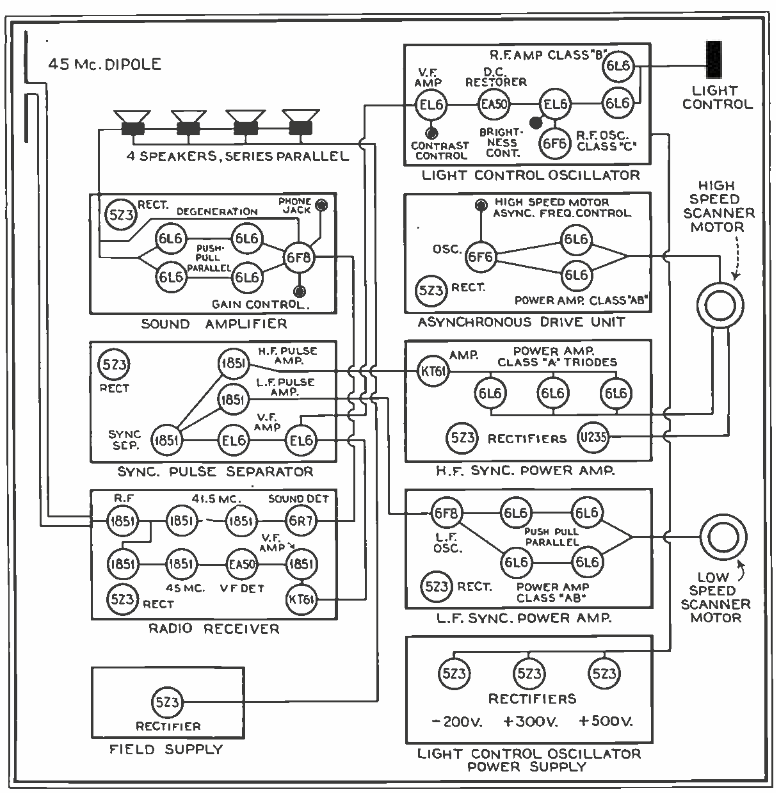
Consulting Industrial Engineer

Part VIII

A NUMBER of earlier American-built television receiver models have been described by their designers. Some may be briefly considered here. In one experimental single-channel picture and sound receiver, there were included 18 tubes, a kinescope, and about 155 component parts (no a-v-c being provided). In another commercially offered receiver producing a 7½ x 10-inch picture, and requiring a power supply of 250 watts, there were 21 tubes and a kinescope. In a laboratory-model receiver, it was found necessary to use 25 tubes and a kinescope, with about 280 components, but an unusual degree of flexibility and an exceptional number and range of adjustments were provided in this outfit. Another receiver was built to produce 441-line "high-fidelity" pictures by utilizing modulation frequencies up to 4.5 mc, at which frequency the response was 70% of the peak response. The corresponding performance was thus in a sense equivalent to 680 elements per line although it was computed that 588 elements per line corresponded to equal vertical and horizontal definition. This receiver included 26 tubes. Still another receiver of semi-commercial design utilized 29 tubes and approximately 230 component parts. A small commercially offered receiver with a 3-inch kinescope contained 13 tubes. Generally speaking, American sets have used from 15 to 35 tubes, depending on picture size, quality, and requisite performance, with most of the sets within the 15-tube to 25-tube range. More recent American receivers average about 23 tubes. A representative group of receivers commercially offered in Europe in 1938 had, on the average, 19 tubes with a maximum of 25 tubes and a minimum of 13 tubes.

The cost of television receivers will depend in large measure on the size of the picture, its median brightness, its contrast and brightness range, and its definition. It will also depend on the fidelity of the sound, although this element will present less of a design problem than in the present broadcast band. In the first place, the audio channels are far more widely separated from the video channels or each other, thus reducing the danger of "monkey chatter." In the second place, atmospheric disturbances are at a lower level in the u-h-f band. And finally, it is planned in the audio portion of television channels to introduce, at the transmitter, a pre-determined amount of over-emphasis of the high frequencies (about 12 db at 10 kc and about 20 db at 15 kc) thus rendering their correct reproduction at the receiver less difficult. The cost of receivers will also depend upon the desired simplicity, reliability, and mutual independence of the controls. Certain "cosmetic factors" such as cabinet appearance will be involved, as will also the inclusion of auxiliary entertainment devices such as phonographs, medium- and short-wave broadcasting, facsimile reception and the like.

While it is likely that quantity manufacture of television receivers will reduce units costs to some extent and therefore permit reductions in the retail sales price, no present justification exists for believing that television receivers are likely to reach the American public in price ranges even approaching those now current for corresponding audio receivers. It should be remembered in this connection that the elaborate video equipment is in effect added to the audio equipment, that a group of essential and complicated voltage waves must be separated from the signal and properly utilized (that is, those forming the audio signal, the video signal, the blanking impulses, the horizontal impulses, the vertical impulses, and the background component), that horizontal and vertical deflection oscillators and deflection-wave-shaping means must be provided, that the kinescope (and its optical system and projection screen, if used) are costly elements, that higher voltages involve more expensive components and the need for protection against shock hazard, that the video circuits in part require better filtering and by-passing than is used at present, that cabinet size must be increased to accommodate the preceding elements, that precision in manufacture must be more general than for ordinary audio reception, and that those developed radio components already available which are used in television receivers have been carefully de-



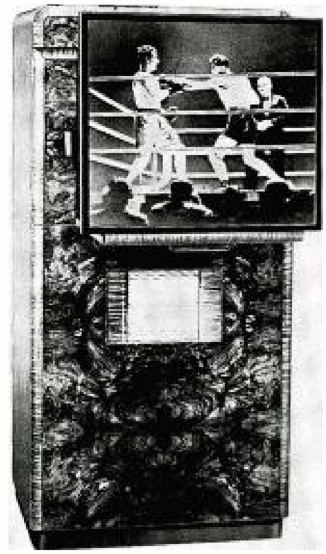
Circuit of a Scophony projection receiver.

veloped and probably cheapened as far as now seems feasible. Accordingly television receiver design and manufacture present an arresting challenge to the engineer in his attempt to maintain or improve quality and yet to reduce manufacturing cost.

I-5 Cabinets

The design of cabinets for television receivers depends on such factors as the following. In the first place, the number of chasses and their dimensions must be taken into consideration. Then, if the picture is to be directly viewed on the end of the kinescope, its position in the central or upper portion of the cabinet largely controls design. If mirror viewing of the image is planned, the support of the mirror controls the design to some extent. If large projected pictures are to be shown, the problem of attractive cabinet design to include or carry the screen, particularly with reasonable dimensions, is a serious one.

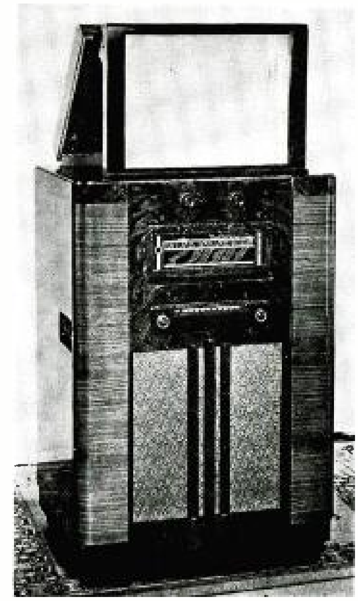
The direct viewing of the kinescope has certain advantages, including particularly slightly greater picture brightness and the absence of need for cleaning the picture-reflecting mirror. A disadvantage of direct viewing in the larger picture sizes is the fact that the kinescope length then controls the depth of the cabinet which may therefore protrude further from the wall or occupy more space on a table than is generally desirable. Mirror viewing of the picture has the advantage that it is relatively easy to locate the reflected picture apparently higher than the top of the cabinet thus enabling it to be seen readily over the heads and shoulders of other persons viewing the program. Further, it is not possible to view the picture very closely in the mirror, a minimum viewing distance being set in effect by the interposition of the mirror in the viewing path. When the mirror is placed on the under side of the lid of the cabinet, it can readily be raised into the inclined viewing position. However, this arrangement prevents the housewife from placing decorative fabrics or ornaments on the top of the cabinet. In some instances this is viewed as a major disadvantage. The table type of television receiver tends to be rather bulky for this class of receivers and is generally preferred in the smaller picture sizes. It is practically invariably of the direct-viewing type. Relatively few projection-type receivers (where an enlarged image is optically projected) have been placed on the market. In one group of these, the screen is in effect suspended by its upper edge from the front edge of the hinged top of the receiver, on the lower side of which hinged top a mirror is placed. The kinescope and the optical system (pro-



A Scophony mechanico-optical projection receiver.

jection lens) are aligned so that the center line of the kinescope and the optical axis of the lens are vertical and pass through the center of the mirror, after which the optical axis is turned through 90 degrees to the horizontal toward the center of the vertical viewing screen. Translucent projection is used. In another group of projection receivers, a separate translucent screen is attached to the front of the receiver and somewhat forward from the front face of the receiver. This permits a larger image size but tends toward an excessively mechanical appearance for a piece of furniture in the home. In one form of European projection tube receiver for the home, the optical path was compressed within the cabinet by the use of two mirrors, the image then being projected upon an appropriate screen on the inside of the lifted cabinet lid. Up to the present no projection type of home receiver has been built in which the picture is projected in the viewing direction on an opaque screen faced by the audience, the projection being either from below eye level or above the heads of the audience. The long throw (projection path) generally required for such arrangements seems unnecessary for picture sizes presently used in television.

A number of suggestions have been made relative to the avoidance of electrical hazards or those which might arise from kinescope breakage. Thus, it has been proposed that the kinescope screen be separated from the audience by a sheet of shatter-proof glass, that ventilating openings be so arranged that they do not permit touching internal "live" portions of the receiver, that the



A Phillips cathode-ray tube projection receiver.

interlock switches for turning off the current supply if the back of the cabinet is removed be provided in duplicate (and particularly if a flexible back is used which might be bent or forced), and that at least certain of the smaller tubes in the set be so arranged that they can be serviced only by trained service men rather than the public user.

A group of European television receivers offered commercially late in 1938 were considered as to cabinet dimensions. Those containing an electric phonograph or producing larger pictures than 9½ x 12 inches (corresponding to the largest usual direct-viewing kinescope) were excluded from consideration.

For console models:

	Height	*Width*	*Depth*
Average	40"	25¾"	21¼"
Maximum	48½"	41¼"	25"
Minimum	32"	17½"	13"

For table models:

	Height	*Width*	*Depth*
Average	19¼"	16½"	16"
Maximum	25"	26"	25"
Minimum	17"	13"	12"

A similar but smaller group of American receivers described in the late Spring of 1939 were also classified as to cabinet dimensions, with the following results:

For console models:

	Height	*Width*	*Depth*
Average	42"	29"	18½"
Maximum	46"	36"	24¼"
Minimum	36"	23"	14"

For table models:

	Height	*Width*	*Depth*
Average	17¼"	16½"	19¾"
Maximum	20¾"	20"	24¼"
Minimum	14½"	13¼"	18"

The above averages, maxima, and minima apply only to the corresponding individual type of dimensions (height, width, or depth) considered as a group. That is, the three values given in any horizontal line do not appear together in any particular receiver.

The console models arranged for direct viewing generally have the kinescope screen at the top of the front of the cabinet, the speaker at the bottom of the front, and the controls beween the two or on a sloping panel at the top of the cabinet. The kinescope is sometimes tilted upward slightly. The table sets are arranged with the loudspeaker either at the same level as the kinescope or below it, and with the controls between the two or else concentrated at the sides or bottom of the front.

1-6 Picture Characteristics, Size, and Viewing

The photographic considerations involved in television transmission and reception include the following. Consider for example the transmission of a test object consisting of a brightness scale extending from some lower limit (which in practice is the so-called "subjective black," and is determined in general by the minimum perceptible brightness for an eye adjusted to what may broadly be termed the average brightness of the entire subject) to an upper limit (which again may be a subjective white defined according to a consistent criterion to the preceding). The receiver will then show a brightness scale as well, and it is possible to plot logarithmically the received scale brightnesses as ordinates against the transmitted scale brightnesses as abscissas. The graph may be taken in the main as a straight line for such systems, and its slope is designated (by analogy to the photographic case) as gamma or the contrast. If gamma is unity, the transmitted and received objects appear identical and the reproduction is faithful, but only in a sense. If gamma is considerably less than unity, the received picture is usually called "flat" and if gamma is much greater than unity the picture becomes "contrasty." It has been found in the case of American (though not most European) motion pictures, however, that the preferred monochromatic reproduction of a natural (colored) scene requires that the "overall gamma" of the process shall be more than unity, and may indeed be as great as 2. A value for the contrast of the black-and-white film print of 1.6 is usual here. This results from the customary negative gamma of 0.7-0.8 multiplied by the usual positive gamma of 1.9-2.4, giving an "overall gamma" between 1.3 and 1.9, or on the average about 1.6. (However, one expert source states that the usual range of negative gammas is 0.6 to 0.75; and of positive gammas from 1.8 to 2.2. The resulting overall gamma is about 1.2-1.4. Still another expert states that the overall gamma range is 1.5-2.0. The need for a gamma above unity is ascribed to absence of color contrast as well as to loss of contrast due to stray light in the camera and on the projection screen.) The "overall gamma" of the print, as compared with the original, is an incomplete measure of picture quality but is usable with caution as a working approximation.

In television from actual studio pickup, the iconoscope as usually constructed shows a gamma of about 0.8. Suppose that the amplifying system of the transmitter maintains this gamma. If then the desired black-and-white received picture is to have the quality usually associated with motion picture reproduction and generally acceptable to the public, the receiver gamma should be about 2, so that the overall gamma of the system (which is the product of the transmitter and receiver gammas) will be about 1.6. When available film is transmitted, with its inherently increased gamma, it is necessary if the receiver adjustments and gamma are not to be disturbed at the changeover from studio to film transmission, to use a logarithmic or compressing amplifier at the transmitter which drops the overall transmitter gamma to something below unity, say 0.8 again. This procedure saves the cost of special television prints. In any case, in the United States, an overall transmitter gamma not too far below unity seems desirable with expansion (increased gamma) at the receiver. Fortunately the kinescope tends to have a gamma of its own in practice of about 1.2 or more, and this could be further increased if desired.

The reproduced contrast range (ratio of maximum to minimum reproduced brightness) for separated areas of good size in the field is of the order of 50-to-1 in conventional kinescopes, and this can also be increased by the methods described in connection with kinescopes. The contrast range for smaller and closer areas in the field is substantially smaller, but more susceptible of improvement even than that for separated areas. It should be added that, for an available brightness range in the received picture as determined by the kinescope and its circuits, the reproducible range of brightness of the original subject to be transmitted will depend on the overall gamma of the system, being least for high overall gammas and most for low overall gammas (which is merely another way of stating that the flat picture, with its low gamma, compresses the brightness range of the original subject and thus, in a sense, enables a greater brightness range to be indicated in the reproduction).

Another matter to be considered in television pictures is the correctness of the perspective of the picture. Theoretically correct perspective is obtained when the picture viewed at the receiver subtends the same viewing angle at the eye as the original subject would have subtended at the eye if viewed from the camera location. In practice, there is often deliberate deviation from this criterion. Wider angle lenses are used in the pick-up when it is desired to include large nearby areas in the picture, or to exaggerate the perspective to give the impression of a larger set than is actually used, or to get the greater depth of focus which is obtainable with the shorter-focus wider-angle lenses. Narrower angle lenses are used when it is necessary to keep at quite a distance from a limited area which is to be picked up (as in the television close-ups or photographic telephoto pictures), or when the ratio of the sizes of two persons or objects at somewhat different distances from the camera is to be kept closer to unity than would otherwise be the case.

The smallest size which need seriously be considered commercially for the 441-line television picture of today is about 3 x 4 inches, and this would be intended for use only in chair-side receivers viewed by one looker or a limited number of persons at a short distance. The next larger size of approximately 3¾" by 5" would normally be viewed from 2 to 4 feet from the picture. The 7½" x 10" picture, which is favored by many persons, is viewed preferably at distance from 3 to 7 feet. Projected pictures as large as 18" x 24" should never be viewed closer than 6 feet, and preferably from 10 to 15 feet from the screen. Such projected pictures tend to show any inherent reproduction defects more obviously than the smaller pictures, and may accordingly present a relatively unattractive appearance when closely viewed.

The stray illumination in the room may be of the order of 0.1-1 footcandle (about 1-10 lux), or more. It is of course desirable to prevent direct illumination from floor lamps and the like falling on the kinescope screen. While a minimum picture brightness of 4 foot-lamberts (that is, 1.3 candles per square foot) has been mentioned, higher brightnesses up to 15-30 footlamberts have been claimed for recent direct-viewed kinescope screen images. The corresponding values recommended for projected motion pictures in theatres are 7-14 foot-lamberts (or 2.2-4.5 candles per square foot).

It has been claimed that actual picture size is not particularly significant as compared with viewing angle. Otherwise stated, a picture which subtends a certain solid angle at the eye is alleged to have the same appearance and entertainment value regardless of its size within wide limits. Thus, a small picture viewed at a short distance supposedly produces the same effect as a much larger picture viewed at a considerably greater distance. It is believed that there are several fundamental fallacies in this line of reasoning. In the first place, psychologically a small object, known as such, is rarely as impressive as a large object—a fact clearly brought out when viewing mountain ranges at a distance as compared to sand heaps nearby. It might be argued that such a psychological reaction is unreasonable, but it is simpler (and certainly more profitable) to please the audience than to argue with it. In the second place, the solid angle subtended by a picture at the eye of the observer changes as the observer moves his head toward and away from the picture. The change in this solid angle per unit forward or backward motion of the head is different for a large picture viewed at a distance as compared to a small picture viewed nearby. There is reason for believing that such frequent and irregular changes in the viewing solid angle are unpleasant. In the third place, the eye must be focused on a picture for each position of the head if a person moves slightly and naturally toward and away from the picture. The major range of focusing of the eye has to be carried out for nearby objects. No readjustment of focus is necessary for slight changes in the distance of more remote objects. Accordingly, for natural back and forth motions of the head, the eye-focusing changes and resulting strain are greater for small nearby pictures. It must be remembered that a pure engineering analysis of desirable picture size, while helpful if cautiously used, is definitely inadequate. Man is not a geometric and optically-stationary object, without judgment, preferences or discrimination (as is sometimes assumed in oversimplified analyses).

The apparent trend of television picture sizes seems somewhat as follows. Table models will present pictures of approximately 7½" x 10" or smaller as a rule. Console models will in the main probably present pictures of about 7½" x 10" or larger. The relationship between picture size and receiver cost is one which will limit the rate at which picture sizes in the most favored groups of receivers will increase.

Where mirrors are used to view the picture, the loudspeaker may be placed further from the floor. In addition, some of the controls least frequently used can be placed under the mirror-carrying lid. It is desirable that the surroundings of the picture in either type of receiver be kept relatively dark. Thus, in one European type of receiver of the mirror-viewing class the entire surroundings of the kinescope were covered with dull dark colored leather. There is, however, some question as to whether a picture is most pleasant when viewed against a dead black background, many persons insisting that a "dazzling" effect and eye strain result. Probably a desirable arrangement is to have a small amount of a soft-colored light (for example, amber, flame or orange light) falling on the television cabinet and screen surroundings. Mirrors for viewing may be made of black glass, aluminum coated. Back-silvered clear-glass mirrors are undesirable because of the possibility of a second fainter image being reflected from the front glass surface. In any case, mirrors require a certain amount of maintenance to keep their surfaces clean and bright, as well as free from the finger marks of juveniles and other inquiring investigators.

I-7 Tube Life

The main group of tubes used in television receivers has substantially the same life as in ordinary broadcast receivers. The kinescope life is particularly important because of its relatively high replacement cost. Projection kinescopes are claimed to have an acceptable life but the heavier loading to which they are subjected is probably a limiting factor. As previously indicated, injury to the kinescope through a stationary beam spot should be avoided by introducing protection against non-deflection, particularly for the larger kinescope sizes.

One limitation to kinescope life is the formation of the so-called "black spot." This is a discoloration or darkening in the center of the screen. It may appear in a few minutes or after many hours. It has been found that its color and rate of formation depend largely on the method of manufacturing the tube, the type of fluorescent screen, and the voltage at which the tube is operated. It is attributed to the impact of heavy negatively-charged particles on the screen (including such particles as oxygen, chlorine, or organic molecules like C_2H_2, or CN, that is, cyanogen). Since there is little that the user can do to prevent this effect, it should be handled by the kinescope manufacturer. One proposed method of avoiding the central "ion spot" is to use a beam gun pointed outside the edge of the screen, thus producing that spot in a non-image area. The electron beam itself is brought back to a normal central position, preferably by a permanent magnet suitably placed, and the usual line and field deflections are then conventionally applied to it. The conserving of the life of tubes was promoted in a certain European receiver by providing an audible warning if the set were left switched on after the program stopped. A pilot light could be used for this purpose, but was found to be "distracting."

I-8 Power Supply and Local Interference

As previously stated, the field frequency at the transmitter is accurately synchronized with the power-supply frequency. If the receiver is used on the same power circuits as the transmitter, only stationary patterns, shadings, or distortions will be produced as a result of induction from the power-supply circuits of the receiver into the video and deflection circuits. It is not meant to imply that such induction is desirable or even acceptable in the best quality pictures, but it is avoidable only by fully adequate shielding. The cost of such shielding is considerable, and there is a natural tendency to tolerate a certain amount of power-supply modulation of scanning and picture delineation. As mentioned, in districts where the receiver is on the same power supply as the transmitter, the undesirable resulting effects are minimized. However, if the receiver is used on a power supply of the same nominal frequency but not rigidly tied to the power supply of the transmitter, slight frequency or phase shifts between the two power supplies will lead to slowly shifting and undesirable shadings, lack of interlacing, as well as "shimmy" (lateral shifts varying from top to bottom of the picture in sinusoidal fashion, and variable with time). In direct-current districts, where alternating-current supply is most usually obtained through a motor generator or rotary converter, such effects are exaggerated. It then becomes desirable to have a motor speed control or its equivalent placed at (or at least controlled from) the receiver so as to reduce these effects so far as possible. However, it may prove necessary and economic to produce specially well shielded receivers for non-synchronous a-c or d-c districts. Alternatively, engineering means may be devised for the accurate frequency control of local a-c generating sources.

This problem presents a significant and pressing economic aspect since sections of certain major cities (and, in particular, New York) are supplied largely with d-c power, and these very sections include as residents perhaps the outstanding groups of persons favorably economically situated and most likely to be prepared to purchase the more expensive television receivers. Accordingly attention to the problems of shielding here mentioned is economically well justified.

Among the more obscure sources of television interference or electrical noise is the high-voltage power unit of the receiver itself. Brush discharge in this unit may cause trouble; and such effects are reduced by avoiding moisture in the power unit (for example, by heating), keeping dust off exposed conductors, electrostatically shielding the unit with an excellent ground connection to the shield, and avoiding small-diameter wires with sharp bends in the high-voltage circuit. Further, both the video amplifier leads and the intermediate-frequency amplifier leads may radiate, causing interference in neighboring receivers and reaction effects in the same receiver. Suitable shielding again is an obviously indicated remedy.

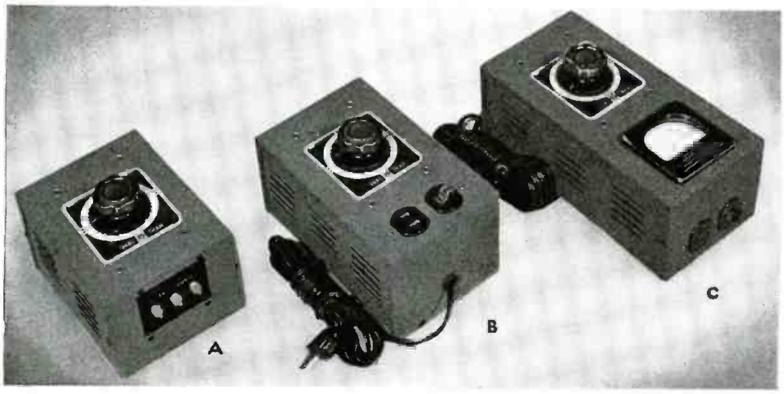
Local interference in television is more important in general than atmospheric disturbances. Noisy household devices or switches may cause some trouble. However, automobile ignition systems, oil-burner ignition circuits, and diathermy radiation or induction are the present worst enemies of satisfactory television reception. Obviously automobile ignition can be handled only by systematic shielding, circuit design, and maintenance, and calls for a concerted, cooperating, and long-term plan on the part of the automobile and radio industries. Interference caused by diathermy equipment similarly calls for cooperation between the medical doctors, radio engineers, radio manufacturers, and diathermy equipment manufacturers. Much diathermy equipment is, in effect, a high-power u-h-f transmitter fed with raw a-c in the plate circuit, and capable of producing badly interfering radio signals, in some instances over hundreds of miles. The nearby television looker in such cases is in an unhappy plight. Diathermy equipment if enclosed in shielded rooms (e.g., a double cage of copper gauze or the like) and with r-f chokes in the power-supply leads may become innocuous from the television viewpoint. Portable diathermy equipment presents a problem since, while it may be shielded, the applied terminals and power lines are available for radiation. The ingenious suggestion has been made that a shielding blanket be thrown over the equipment and patient in such cases. With the approaching advent of large-scale television and with thousands or even millions of lookers, a cooperative program along the above lines is much to be desired in the interests of all concerned.

I-9 Mechanico-optical Receivers

Intensive research has been devoted by numerous investigators to the major problems of the non-electronic type of receiver (that is, receivers whereby the picture is produced through a combination of mechanical and optical means, the light modulation having initially been achieved by the equivalent of a light valve, as for example the Kerr cell). In such receivers of early types, no great difficulty was experienced in producing pictures of moderate dimensions, of relatively low detail (60-120 lines), and with adequate brightness. The difficulty which arose as the television art evolved was the generally highly unfavorable relationship between picture detail and brightness in this type of receiver. Otherwise stated, an increase in the number of lines of the picture of given size brought about an extremely disproportionate and troublesome decrease in the brightness of the picture. It gradually became apparent that a combination of unusually effective and, to some extent novel optical expedients would be required to increase picture brightness, and that even these might well prove

(*Continued on page* 28)

New UTC VARITRAN CONTROLS



- ★ New roller contact . . . practically eliminates contact wear.
- ★ New glass-insulated wire . . . for positive dependability.
- ★ New large, copper, heat radiating disc . . . for cooler operation.
- ★ New copper alloy collector ring . . . eliminates pigtails and loose connections.
- ★ Core type lamination . . . for maximum ruggedness and minimum space.
- ★ New top and bottom mounting . . . for panel, chassis, or bench service.

Type	Input Voltage	Output Voltage	Watts	Maximum Amps.	Approx. Wt. Lbs.	Net Price
V-0	115 volts	0–130	230	2	8	$7.50
V-0-B	230 volts	0–260	230	1	10	9.50
V-1	115 volts	0–130	570	5	11	10.00
V-1-M	115 volts	0–130	570	5	12	15.00
V-2	115 volts	0–130	570	5	11	9.00
V-2-B	230 volts	0–260	570	2.5	14	11.50
V-3	115 volts	0–130	850	7.5	14	14.00
V-3-B	230 volts	0–260	850	3.75	18	18.00
V-4	115 volts	0–130	1250	11	32	20.00
V-4-B	230 volts	0–260	1250	5.5	38	25.00
V-5	115 volts	0–130	1950	17	45	32.00
V-5-B	230 volts	0–260	1950	8.5	56	37.00
V-6	115 volts	0–130	3500	30	90	60.00
V-6-B	230 volts	0–260	3500	15	90	70.00
V-7	115 volts	0–130	5000	44	120	87.00
V-7-B	230 volts	0–260	5000	22	120	95.00

Type	Max. Amps. Output	Approx. Dimensions	Approx. Weight. Lbs.	Net Price
VL-0	1.5	3¾ x 4¼ x 3¼	5	$5.50
VL-1	3.5	4⅝ x 6 x 4⅝	7	6.50
VL-2	6	4⅞ x 6 x 5⅛	10	8.00
VL-3	11	4⅝ x 6 x 6⅛	15	13.00

UNIVERSAL VARITRANS

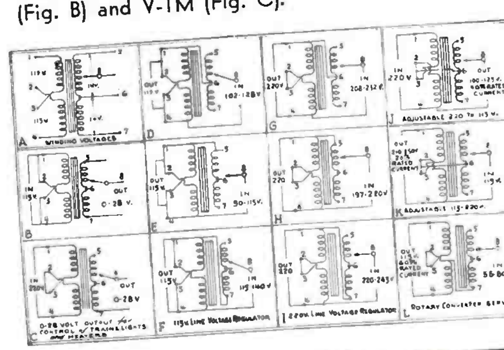
These VARITRANS have a 115/230 V. primary winding and a smoothly variable secondary from O-28 volts. Line voltage control can be effected for 102/140 V. or 197/243 volts to 115 V. or 220 volts, respectively. The 28 volt secondary can also be used for low voltage lights, cauteries, trains, rectifiers, etc. The primary and secondary windings can be arranged to effect variable 220/115 or 115/220 volt arrangements. Appearance as in Fig. A above.

• **FOR CONTROLLING: Line Voltage Rectifier Output, Motors, Lights, Heaters, etc.**

• Variable voltage transformers for smooth voltage control. VARITRAN units employ a special non-fusing *roller* contact to contact the exposed turns of an auto-transformer winding. Rugged construction is employed, with *glass* insulation to assure dependability. Output of 115 Volt unit variable from 0–130 volts (230 Volt unit, 0–260 v.) smoothly without interrupting circuit. Output voltage independent of load.

• Maximum Amp. rating applies from 0 to 20 and 95 to 130 volts. Between 20 and 95 volts current rating tapers off to 50% of rated current at 65 v. point.

• Top and bottom mounting for laboratory bench or panel mounting. All units supplied mounted, with terminal strips as in Fig. A, except V-1 (Fig. B) and V-1M (Fig. C).



UNITED TRANSFORMER CORP.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

FLEXIBLE RESISTORS

(*Continued from page* 10)

There is no need for elaborate ceramic spacers or supports as would be the case with bare resistance windings. In other words, the Glasohm provides its own supports, and forms a complete heating element by itself. True, at elevated temperatures the spun-glass core and braiding will fuse into a solid mass in which the wire winding is firmly and permanently imbedded. The unit now has lost its flexibility, which it no longer needs in its permanent installation. This does not take away but rather enhances the desirability of such an element, since there is now the permanent fitting of the element to its particular job, and a closer contact established between winding and surrounding solid glass sheath, thereby providing maximum conductivity.

Glasohms have already been applied successfully to such heating jobs as small electric soldering irons, hair curlers, immersion heaters and electric marking pencils. In radio, these miniature heaters may find uses in crystal oscillator ovens, where very little heat, but that heat accurately regulated, is required. Glasohms may be used as heating elements at temperatures up to 1000 deg. F.

• • •

PRECISION CATALOG

The 1940 catalog of Precision test equipment illustrates more than 40 models in their new line. Available from *Precision Apparatus Company*, 647 Kent Ave., Brooklyn, N. Y.

• • •

TELEVISION ECONOMICS

(*Continued from page* 26)

insufficient for the purpose unless there were also developed some form of luminous intensifier or light-storage means which would enable mechanico-optically-generated pictures of adequate size and brightness to be produced with high definition. This was the major problem encountered in this type of television; although other factors must be considered such as the cost and requisite accuracy of the optical system, the necessary motor speeds and their operating life, the need for avoiding changes in television transmission methods, (that is, the requirement that the mechanico-optical receiver shall pick up standard transmissions effectively), the nature of the light source and its replacements, and finally the care and cleaning of the optical system.

As typical of advanced effort in this field, a particular European mechanico-optical receiver will be considered. Its distinctive parts include the following:

(a) Split-focus optics. The designers of this receiver have used two separated cylindrical lenses with crossed axes, and therefore capable of focusing mutually perpendicular lines in two different planes. It has been stated that this reduces the scanner to 1/12th of the otherwise required size and permits its operation with larger lens apertures (producing brighter pictures).

(b) Supersonic light control. This essential element of the system is a "light-storing" means. It consists of a transparent-walled cell filled with a suitable liquid. Waves in the liquid are produced by transverse excitation originating in a vibrating quartz crystal which is itself actuated by a video-modulated carrier of the same frequency as the natural frequency of the crystal, the system being made non-resonant by passage of the vibrations through a damping layer on the crystal before entering the liquid and suitable later absorption of the wave energy. A lens is placed on each side of the cell in the light path, and the lateral diffraction spectra from the cell are focused on the viewing screen as an image having a height of about one scanning line and a width which is dependent on the length of the controlled liquid column. It is claimed that this arrangement supplies to the screen the accumulated light from about 200 elementary sources and thus produces an image having approximately 200 times the otherwise obtainable brightness. Excitation energy for the cell is only 5-10 watts. Inasmuch as the velocity of the supersonic waves within the liquid in the cell changes as the temperature of the liquid rises, an adjustment is provided for compensation of this effect, by moving the entire cell closer to the scanner as the temperature of the liquid rises after continued operation.

(c) Capillary high-pressure mercury lamp. This intensely brilliant linear source of light is operated at 80 volts and 3.5 amperes (or 300 watts, including incidental equipment losses).

In the optical system, light from the mercury lamp is focused on the light-control cell; then on the high-speed scanner (which is a polygonal surface of stainless steel); and thence after reflection from the low-speed scanner to the viewing screen. The optical components include the lamp, 6 lenses, the control cell, two scanners, and the screen.

The sound receiver is of the 6-tube r-f type. The 8-tube picture receiver includes 4 tubes for r-f amplification and 2 diodes for rectification and separation of the synchronizing impulses. The modulating circuits for the light control consist of a video amplifier and oscillator, an r-f amplifier, and a d-c insertion tube The r-f amplifier output is modulated by the output of the video amplifier, thus producing two side bands 5-mc wide, and the modulated output is fed to the light control.

The line- or horizontal-scanner motor runs at 30,375 rpm. This is a double motor including an asynchronous section for starting, and a synchronous section which is energized by the line-synchronizing signals. It is stated to be silent in operation; and, with servicing, to have an operating life of several thousand hours. The frame- or vertical-scanner motor is a 1500-rpm synchronous motor geared down to 250 rpm, at which speed the 12-mirror scanner is operated in order to provide the 50 fields per second which are standard in the local transmitter.

The receiver includes as well power supply for the video and audio receivers, for the lamp, for the asynchronous drive unit included in the high-speed scanner motor, for the synchronizing amplifier which supplies the synchronous drive unit of the high speed scanner motor, for the drive unit of the low-speed scanner motor, and for the modulated oscillator feeding the light control. A total of 39 tubes is included in the receiver, which produces a picture 18 x 24 inches in size, of high definition and adequate brightness. The further development and commercialization of such equipment may yield significant data as to the competitive position, under mass production conditions, and for equivalent picture quality, of mechanico-optical versus electronic television receivers, particularly for the larger picture sizes.

Receivers of the type described above, but in larger form and using an arc lamp as the light source, have been applied to theatre television. Other forms of mechanico-optical receivers for large-screen projection have been tried. In one European form the picture is divided into 3 adjacent zones, each of which is separately received and projected abutting the next, that is, from a separate receiver with its own arc-light source and its own Kerr-cell light control. Another form which has been used in several instances consists essentially of a lamp bank, the fixed lamps in which correspond to the dot elements of the picture. These lamps are controlled in their illumination timing (and in some cases in their intensity) by elaborate synchronized commutators, the incoming synchronizing signals controlling the commutator rotation or switching and the incoming video signals controlling the corresponding lamp brightnesses. This last-mentioned method is capable of giving extremely bright pictures but has certain obvious mechanical and electrical problems and limitations, particularly for high-definition pictures.

(*To be continued*)

CORONA DETECTION

(*Continued from page 7*)

could be obtained and this indicated variation similar to the 60-cycle curves. This seems reasonable in the light of other parallel 60-cycle and radio-frequency behaviors shown in Figs. 4, 5, and 6. This indicates the importance of maintaining voltages below the point where even a pinpoint of surface corona discharge starts, because it will increase quickly to values dangerous to the insulation with small further increase in voltage. This would especially apply to the supporting blocks of insulating material used in high-voltage air condensers and coils.

The right-hand graph of Fig. 4 shows that the increase of voltage required to produce surface corona for increasing thickness of the insulating material is quite similar for commercial and radio frequencies. For a particular electrode design and type of insulation an empirical formula for minimum thickness of insulation for non-existent surface corona could be set up. For the 60-cycle case the equation is

$$t = \frac{E - 1600}{1500}, \text{ where } t > .05'',$$

where t is the thickness in inches and E is the voltage above which corona would start.

Taking the 1000-kc curve, and being conservative, the dotted line is drawn in the minimum slope region of the curve. The expression would be

$$t = \frac{E - 800}{325}, \ (t > .05'')$$

The curves for Fig. 4 were obtained for plate glass, but should hold for fairly smooth surface ceramic insulation, provided its dielectric constant were the same as for glass. If the dielectric constant is greater, t should be increased in the same proportion. This is indicated by the comparative data for glass and ceramic samples of Figs. 5 and 6.

Behavior with air pressure.—Variation of surface corona starting voltage with increasing air pressure is shown in Fig. 5. The increase at 60 cycles and at radio frequencies is similar, except in the case of test sample N. The 60-cycle curve leveled off at 10 lbs. pressure for sample N because this was porous ceramic material, and internal ionization discharge began at about 6000 volts. At radio frequencies surface corona discharge occurred below this value even at 30 lbs. pressure. It should be noted that the proportional increase in voltage required for corona discharge is not as great as the increase in pressure. At 60 cycles the voltage increases some 50 percent where the pressure doubles, but at 3000 kc the voltage is only 22 percent

for double pressure. Sample M is of the same thickness as the pyrex glass sample, PG., but its dielectric constant is 25 percent higher, and therefore the surface corona discharge starting voltage is lowered some 25 percent. Sample N had a lower dielectric constant but a rough surface and porous structure. The triangular points just below the 935-kc curve for pyrex glass show results obtained with nitrogen in the test cell. For this gas the corona starting voltage was about 5 percent lower than for air at the same pressure.

Variation with Frequency.—Fig. 6 shows the decrease of surface corona discharge voltage with frequency increase. The samples were of the same material as for Fig. 5. The decrease with the available test frequency increase was always consistent, and the lower radio-frequency values compared with those at 60 cycles are compatible with the results of Fig. 6. No explanation was found for the humps in the plain edge cylinder electrode curves.

5. Detection of Internal Ionization Discharges

Artificial Void.—A gaseous air film or void was prepared in a laboratory test piece by boring a depression about 1/70″ deep in the surface of a glass plate, the depression being about ¼″ diameter. A thicker piece of glass was then placed over this and the edges of the two glass plates were hermetically sealed against air pressure with beeswax. Fig. 7 shows the construction. The test piece was then placed between curved edge cylinder electrodes [see Fig. 3, (c)] and 60-cycle voltage applied in the pressure testing cell at 30 lbs. pressure to prevent surface corona. At a certain voltage an electrically detectable discharge was obtained, then a piece of solid glass of slightly less thickness was substituted, but no discharge was detectable at twice this voltage. This is definite proof that in the case of the laboratory test piece of Fig. 7 there occurred an ionization discharge in the artificial internal void. Next the above test was repeated at 1365 kc with a similar result. The data is as follows:

At 32 lb. pressure using special test piece with gaseous void	3100 volts at 60 cycles 3000 volts at 1365 kc
At 32 lb. pressure using solid glass control	6000 volts required for surface corona at 60 cycles Surface corona discharge voltage at 1365 kc could not be reached—4000 volts was maximum

When testing for ionization discharges in gaseous voids or porous spaces in insulation at either radio frequencies or at 60 cycles it is absolutely

necessary to eliminate all chance of surface corona discharge. This is best attained by using the special *silvered depression* test piece of Fig. 3, (d), and curved edge cylindrical electrodes closely fitted into the depression so as to leave no electrode surface discontinuities at the point where the electrode touches the insulation material. Even then slight surface corona will occur at sufficiently high voltage, due to increased electrostatic flux entering the glass at the edge of the depression, and it is very desirable to carry out the test in a pressure cell, using an air pressure of at least 30 lbs. per square inch. Such a testing cell is shown in Fig. 2. It should be mentioned that the well-known *guard ring* is of no value in the direct detection of internal ionization discharge, because any type of discharge from the guard ring will affect the active test circuit by capacitance connection. This has been adequately proven in previous work.[1] Immersion in oil greatly increases the voltage for surface discharges, but oil cannot be

(*Continued on page* 38)

HICKOK CATALOG

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio, have issued a catalog, No. 12, illustrating and describing their new radio and television test equipment. Copies may be obtained directly from Hickok.

THE MARKET PLACE

SOLDERING IRON BRACKET

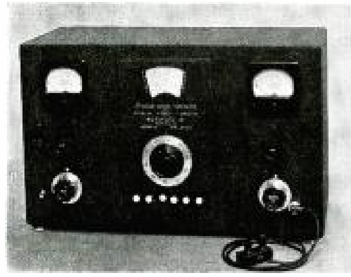
The Model SD3 Kester soldering iron bracket is shown in an accompanying illustration. It is designed to hold any electric soldering iron at the most convenient height and angle. The iron holder can be set anywhere within the 12" height of the bracket—adjusted to any angle within a 360° range. All parts are made of cold rolled steel or malleable iron. Wing screws control all adjustments. *Kester Solder Co.*, 4201 Wrightwood Ave., Chicago, Ill.

PHONO MOTOR

Universal Microphone Co., Inglewood, Cal., has announced a new synchronous motor in its recording division. It is announced as a synchronous condenser start and run 110-volt, 60-cycle motor giving 78 rpm on vertical shaft for steady playback. Condensers are also available for 50 or 25 cycles.

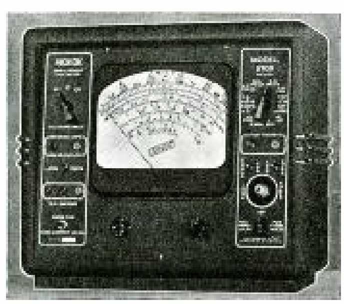
STANDARD SIGNAL GENERATOR

The Model 54 is the first new measuring instrument to be announced by a recently formed-group of Boonton engineers. It has been designed to fill the need for a compact, versatile, and accurate laboratory signal generator embodying the latest design features and techniques. To achieve speed and convenience in radio receiver measurements, all scales and meters are direct reading, controls have been reduced to a minimum, pushbutton coil switching is employed, and a motor drive on the tuning condenser permits rapid traverse of the frequency scale. A master oscillator-power amplifier circuit, in which the tuned amplifier circuit is modulated, permits modulation depths up to 100%, from either an internal 400-cycle or an external variable-frequency source. The carrier frequency range is 100 to 25,000 kilocycles, and the output voltage range 0.1 microvolt to 1.0 volt, across low impedance. *Microvolts, Inc.*, Boonton, N. J.



HICKOK VOLTMETER

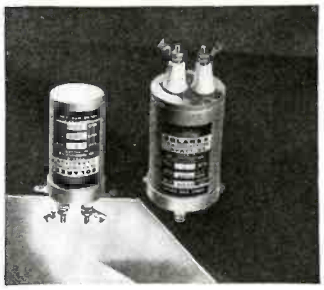
The Hickok Model 210X is a bench tester with the zero-current voltmeter. Additional ranges are added (at 88,888-ohms-per-volt) to 1,000 and 10,000 volts. A 2.5- and 25-amp range; a-c and d-c voltage ranges (at 1,000-ohms-per-volt) to 2,500 volts; d-c ma; ohms to 50 meg; capacity to 200 mfd; db and power consumption tests are additional features of the instrument.



For more information and prices on this and other Hickok instruments write to *Hickok Electrical Instrument Co.*, 10507 Dupont Ave., Cleveland, Ohio.

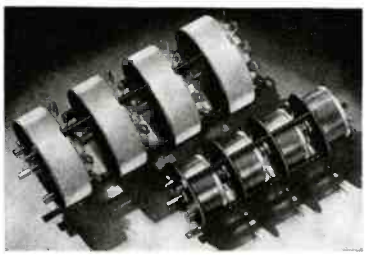
SOLAREX CAPACITOR

Solar Manufacturing Corporation, Bayonne, N. J., presents to radio amateurs a new type of oil-filled capacitor for general transmitting use. This unit, available in all standard values, is called Solarex Type O. Built of paper sections which are oil-impregnated under high vacuum. Carefully insulated assembly rigidly held in round metal cans, oil-filled and hermetically sealed. Terminals are high quality porcelain in stand-off insulators. Mounting accomplished by detachable rings. Units may be used either upright or inverted. Descriptive literature obtainable by writing direct to Solar.



OHMITE TANDEM ASSEMBLIES

Tandem assemblies of 2, 3, 4 or more of the new Ohmite power tap switches are available from *Ohmite Manufacturing Co.*, 4835 Flournoy St., Chicago. These tandem assemblies may be used to switch both sides of a single-phase line or to switch all phases of a 3-phase line; to provide simultaneous control of separate circuits and for other applications.



SIGNAL GENERATOR

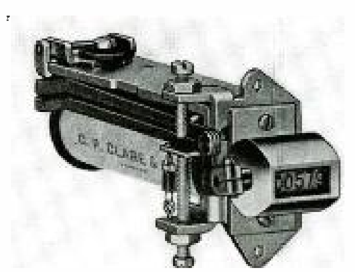
Precision signal generator, Series E-200, features a substitution method for radio receiver alignment. The E-200 supplies its own a-v-c voltage. Six bands from 110 kc to 72 megacycles. Direct reading. Maximum 1% deviation on all bands under widely varying climatic conditions. 400-cycle sine-wave oscillator, independently controlled. Calibrated modulation control provides 0-100% modulation of r-f signal. *Precision Apparatus Company,* 647 Kent Ave., Brooklyn, N. Y.

TRANSFORMERS

Recently announced by Audio Development is a quality and economy series of high-fidelity transformers. Although these transformers were produced for several years as custom built units, comprehensive groups of input, output, impedance, and other transformers are now available as standard units. All of these transformers are said to have flat response characteristics, and a high degree of longitudinal balance. Humbucking contruction, special cases, and alloy shields are used to reduce hum pickup. Also featured are sturdy terminals, easily accessible for wiring. In addition to listed transformers, a wide range of special transformers, such as special impedances, multiple winding, Hybrid, odd-shaped transformers for replacement purposes, etc. can be supplied promptly. *Audio Development Co.,* 123 Bryant Ave., North, Minneapolis, Minn.

ELECTRIC COUNTERS

C. P. Clare and Co., Lawrence & Lamon Avenues, Chicago, Ill., announce their new electric counters: type C for direct current up to 110 volts; type A for alternating current up to 110 volts, 60-cycle. These counters are capable of counting up to 600 counts per minute.



VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President | RCA Building, 30 Rockefeller Plaza, New York, N. Y. | H. H. PARKER, Secretary

TO THE FRIENDS OF DR. LEE DE FOREST:

THE Veteran Wireless Operators Association and the Institute of Radio Engineers, together with several other interested organizations, are sponsoring "De Forest Day," Friday, September 22, 1939, at the New York World's Fair as a fitting testimonial to the outstanding achievements of Dr. Lee de Forest in many humanitarian fields.

You are cordially invited to share this event with us. Dr. de Forest is the accredited inventor of the device—the vacuum tube—which has made modern radio and its associated arts what they are today, and he is the holder of over three hundred patents in this and other fields. His outstanding accomplishments merit this tribute. Dr. de Forest now resides in California and his appearances in the East are few, so this is a rare opportunity for you to pay your respects and be greeted personally by him.

Please do what you can to bring this event to the attention of all interested parties. You can materially advance the work of the committee by selling one, two, or ten tickets to the dinner. Tables of ten may be reserved in advance. Your cooperation will be gratefully appreciated. Tickets must be purchased in advance.

Every time you turn on your home radio, de Forest's "Grid" brings you amusement and information from all the world. Why not, in return, bring a little belated pleasure to him by participating in this recognition by his fellow workers and friends of his pioneer achievements?

We look forward with pleasure to greeting you at the Fair on de Forest Day.

Dinner tickets, including admission to fair and Merrie England village—$5.00.

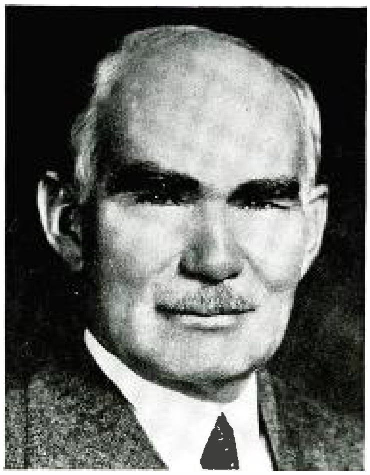
Available from:—Veteran Wireless Operators Association, Radio City, N. Y.; Institute of Radio Engineers, 330 West 42nd St. and at the IRE convention at the Pennsylvania Hotel.

AWARD

On the evening of de Forest Day at the Fair at the Jubilee Dinner an engrossed Scroll of Honor enumerating the accomplishments of Dr. de Forest in many fields and signed by the Presidents of scientific organizations in those fields will be presented to Dr. de Forest in recognition of his outstanding devotion to scientific achievement throughout a long and colorful career. Will you be there to add your tribute to that of many other of his friends and associates?

Further excerpts from the "Story of de Forest" as recorded in the VWOA 1939 Year Book follow:

"'During the early months of 1907,' writes Frank Butler, Doc's first assistant, 'we worked in two little rooms in the loft of the Parker Building in New York,



Dr. Lee de Forest in whose honor the Veteran Wireless Operators Association, Institute of Radio Engineers and several other organizations are sponsoring "de Forest Day," September 22, at New York World's Fair.

trying to perfect the first audions. The tubes were made by McCandless, and the first types had a long bulb with a candelabra base, and red-and-green-covered wires leading from the top.

"'The first tests were very discouraging, as the tubes would last from a few minutes to a few hours. "The secret of making these tubes hold up," said Doc, "is to get an absolute vacuum in them." "Then you will have to study the theory of the glowworm," I said, and Doc laughingly replied, "All right, Frank, start getting wormy right away."

"'In the first tubes, we used a metal plate, and coiled wire grid, the former being called the "metal terminal" and the second the "wire terminal." One day Doc told us to change the names, to call one the "wing" and the other the "grid," for, he said, "it looks just like a grid." "And remember, boys," he added, "the red goes to the plate and the green to the grid." That is how "G for green and G for grid" originated.

"'In that same year of 1907, de Forest and Butler were testing out their first wireless telephone transmitters, which used an arc generator. These were the forerunners of the sets installed in the U. S. Navy ships just prior to their Round-the-World cruise. The New York Navy Yard wireless operator was copying code, when all at once he heard music in his headphones. He called to his chief "there are angels singing in the air." The chief listened in, and later telephoned the *New York Herald*, which ran an article on the mysterious sounds.

"'Doc was coming downtown (in the subway) next day, and read of the matter in his morning paper. At once he called up the paper and acknowledged paternity. As a result of the ensuing publicity, a story on the new method of communication appeared in the *Literary Digest*, in the issue of June 15, 1907.'"

The following is the biographical sketch of *LEE DE FOREST IN WHO'S WHO IN COMMERCE AND INDUSTRY:*

"Dir., Lee De Forest Laboratories; b. Aug. 26, 1873, Council Bluffs, Ia.; s. Henry Swift and Anna Margaret (Robbins) de Forest; ed. Mt. Hermon Boys' School; Yale University (Sheffield Scientific School). Ph.B., Ph.D., D.Sc., ScD.; m. Marie Mosquini, Oct. 3, 1930. Formerly Vice-Pres. and Scientific Director American De Forest Wireless Telegraph Co.; Pres., Radio Telephone and Telegraph Co.; Pres., De Forest Radio Telephone Co.; Pres., de Forest Phonofilm Corp. (New York City); Vice-Pres., American Television Laboratories (Los Angeles, Calif.). Patented in U. S. and foreign countries 300 inventions in Wireless Telegraphy, Radio Telephone, Wire Telephone, Sound-on-film talking pictures, High speed Facsimile and Picture Transmission and Television, also in "Radio-Therapy" for physicians. Inventor of the 3-electrode (radio) Tube, as radio detector, radio and Telephone Amplifier, and as oscillator in "feed-back" or regeneration circuit. Inventor of "noiseless recording" positive prints in talking pictures, "glow-light" recording of sound on films, etc. Was first to broadcast by radio, beginning with the voice of Caruso in 1910, and in 1916 first radio news broadcast, first entertainment radio programs, by phonograph and singer. 1910-20; established first broadcast station, 1916. Called the "Father of Radio." First to publicly show sound-on-film programs in theaters (Rivoli Theater, New York City, Apr. 1923). Awarded Gold Medal, World's Fair, St. Louis, 1904, Panama Pacific Exposition, San Francisco, 1915; Medal of Honor, Institute of Radio Engineers; Elliot Cresson Medal, Franklin Institute; John Scott Medal, City of Philadelphia; Prix La Tour, Institute of France. Cross of Legion of Honor, Fellow, American Institute of Electrical Engineers; Fellow and Founder, Institute of Radio Engineers. Mem. Society of Motion Picture Engineers; Yale Engineering Society; Sigma Xi; Aurelian Honor Society of Yale. Hobby: Mountain climbing. Author of various scientific papers in Journals of Radio and Electrical Engineering, Franklin Institute, Physicians' Journals, etc. Res.: 8190 Hollywood Boulevard. Office: 5106 Wilshire Blvd., Los Angeles, Calif."

CORONA DETECTION

(*Continued from page* 32)

used in cases of tests of ceramic materials, because of impregnating effects. Using these provisions the authors were able to directly detect internal ionization discharge in one sample of quite porous ceramic insulation material. Plans are under way for providing facilities for testing other samples of ceramic insulation for relation between power factor and internal ionization discharge at radio frequencies. At the present time economic conditions do not permit early realization of these plans.

6. Miscellaneous Applications of the Testing Apparatus

The discharge detecting apparatus of Fig. 1 should prove valuable for testing many devices and materials for the existence of ionization discharges. Among the various applications may be mentioned

(a) Standoff insulators
(b) Insulators in which screws, pins, or bolts pass through or protrude into the insulator material.
(c) Bushings through which metal rods pass and which fit into a metal opening
(d) Concentric transmission line insulators (tested in suitable concentric metal tubes as electrodes)

A test of a one-inch standoff insulator having a hole through its center, and resting on a flat metal plate, showed that surface corona discharge existed somewhere in the region of the metal binding post at the top for an applied potential of 1900 volts at 1280 kc. At 2400 volts a flash over and arc occurred along the inner wall of the insulator from binding post to the base plate.

A 3/32″ hole was drilled into a piece of ceramic insulation material to a depth of 3/16″. Potential was applied between a pin fitted into the hole and a metal electrode in contact with the opposite surface of the test piece. At 1240 volts, 1600 kc, discharges were detected by the detection apparatus, and after two minutes of voltage application the voltage was removed, and the insulator broken across the hole. Examination showed three tiny charred spots where the discharge had been concentrated. Such phenomena can be detected before continued use results in holes burned in insulation, weakening it, and eventually causing failure.

Bibliography

(1) Brown, Tykociner and Paine, Bulletin No. 260, University of Illinois. Experiment Station. (1933.)
(2) See reference (1) above: also Tykociner, Brown and Paine, Bulletin No. 259, University of Illinois, Experiment Station. (1933.)

APCO CONVENTION

(*Continued from page* 15)

a progressive step; yet, in thus experiencing a disheartening move, these men on whose shoulders rest responsibility for the peace and safety of our civil nation simply tightened their belts and began planning carefully for the future.

In communications, as in all professions, there are certain ethics and rules of fair play, and in this as in all others there were some who did not play in an ethical manner in some respects. This was true particularly with regard to the use of police radiotelephone stations for long distance point-to-point intercommunication. Strange though it may seem, the worse offenders in this respect were not those stations in sections of the nation in which the services of police networks were most widely and practically used. Nevertheless, due to conditions of interference and chaos resulting from such unethical operations, the FCC decided to enact and to enforce a regulation which banned radiotelephone point-to-point under general conditions beyond one contact and with no voice relay. The yardstick of measurement was that rather questionable article of "within good service range."

There has been more than one full year of operation since that regulation became fully effective. During that period it has become apparent to practical police communication authorities that such regulation imposes a retarding effect upon all services, and that with a proper program of self-policing of facilities such a rule is unnecessary and unjust. In anticipation of the time when the facts might be brought fully to the attention of the FCC, the APCO Convention at Houston in 1938 unanimously approved a resolution providing for the establishment of a practical self-policing plan in the police services.

In 1938, the FCC brought to the attention of the services of the nation notice of impending changes in the rules and regulations relating to the licensing of operators and the terms and requirements of such licenses. Accordingly, the APCO prepared, and there was formally presented at Washington, a complete report with recommendations in this regard. As a result of this report, certain extremely important changes were made by the FCC which were of the utmost importance to Police Operator personnel. Also, in 1937 the APCO Convention at New York City proposed the redrafting of the Operating Procedure Manual for the Police CW Service. This was accomplished during the early part of 1938 and the Houston Convention unanimously approved the redraft. This was then filed officially with the FCC and action is expected soon upon its adoption.

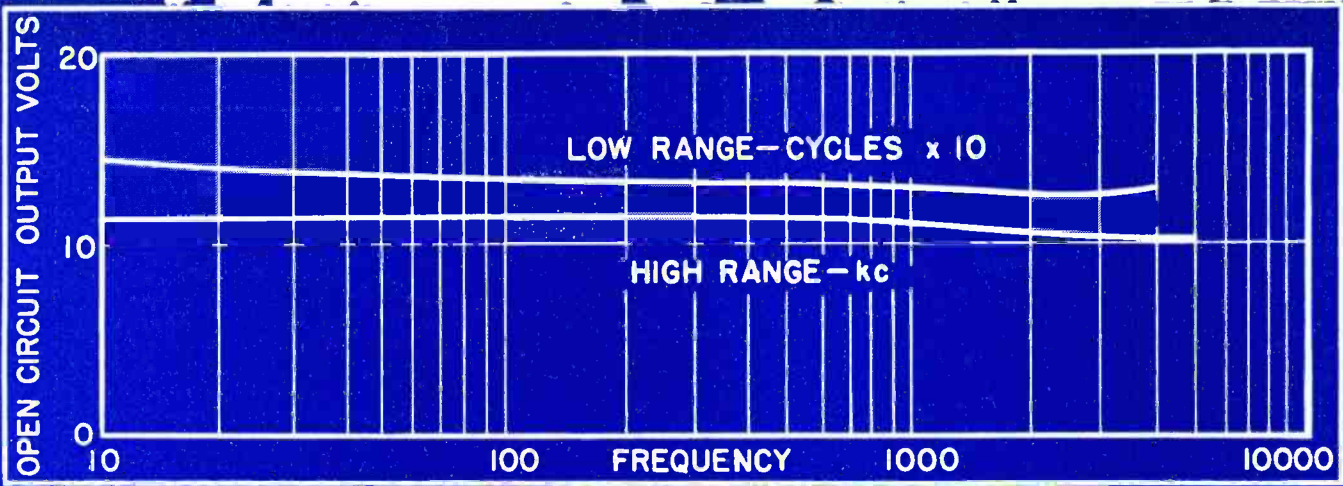
The Houston Convention in October, 1938, had been hailed by many as the occasion for re-birth and re-dedication of the organization of APCO, and the record of this year's achievements may prove or disprove that statement. However, it was Houston which brought about the incorporation of APCO under Indiana Laws. It was Houston which wrote undeniably into the constitution the direct statement that "The Associated Police Communication Officers as an organization shall now and henceforth consider as its responsibilities the observance, growth, development, and proper operation in law enforcement departments and agencies of North America of ALL forms of Police Communication and inter-communication now or hereafter developed for use in, by, or between departments."

Thus APCO welcomes into its membership and cooperation the men of the Gamewell, Telephone, Teletype, Radiophone, Radio telegraph, Facsimile, and Radioteletype fields, to work together in harmony for the greatest good of all the people.

For the future, APCO has great plans—plans which it is hoped shall serve to increase the scope, size, ease of operation, and dependability of entire police service.

In summation: The police communications men of today, knowing their errors of yesterday, are carefully planning and laying concrete foundations for whatever course today's problems and tomorrow's needs may require or dictate. Through APCO the words of Captain Leonard are already on the walls of hearing rooms at our nation's Capitol, and, when the proper hour arrives, these services will be heard in no uncertain terms.

Index to Advertisers



for Television . . . .
new Beat-Frequency Oscillator . . . .
50 Cycles to 5 Megacycles

FOR SOME TIME there has been need for a wide-range oscillator with substantially constant output of moderate power, not only for general laboratory bridge measurements but also for taking selectivity curves over a very wide range of frequencies, for measuring transmission characteristics of filters and for testing wide-band systems such as television amplifiers and coaxial cables.

The new General Radio Type 700-A Beat-Frequency Oscillator was designed for these applications. Through unique circuit and mechanical design and very careful mechanical construction it has been possible to manufacture an oscillator of good stability, output and waveform at comparatively low price.

FEATURES

WIDE RANGE—two ranges: 50 cycles to 40 kc and 10 kc to 5 Mc.

DIRECT READING—scale on main dial approximately logarithmic in frequency. Incremental frequency dial direct reading between — 100 and + 100 cycles on low range and — 10 and + 10 kilocycles on high range.

ACCURATE CALIBRATION—low range: ± 2% ± 5 cycles; high range: ± 2% ± 1000 cycles; incremental dial: ± 5 cycles low range; ± 500 cycles high range.

GOOD FREQUENCY STABILITY—adequate thermal distribution and ventilation assure minimum frequency drift. Oscillator can be reset to zero beat to eliminate errors caused by small drifts.

GROUNDED OUTPUT TERMINAL—output taken from potentiometer; A. avc maintains low effective output impedance.

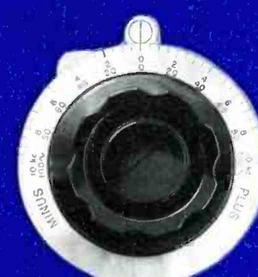
CONSTANT OUTPUT VOLTAGE—open-circuit voltage remains constant between 10 and 15 volts within ± 1.5 db over entire frequency range.

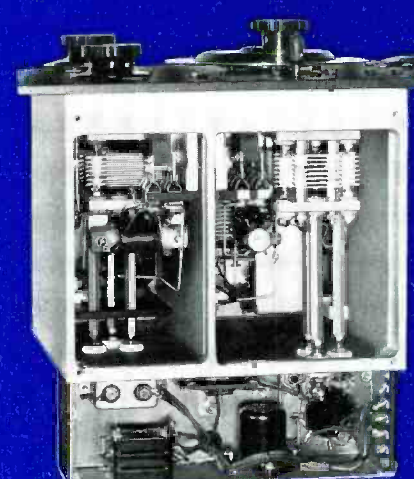
GOOD WAVEFORM—total harmonic content of open-circuit voltage is less than 3% above 250 cycles on low range and above 25 kc on high range.

A-C OPERATED—power-supply ripple less than 2% of output voltage on either range.

Type 700-A Wide-Range Beat Frequency Oscillator $555.00

● *WRITE FOR BULLETIN 486 FOR DATA*





GENERAL RADIO CO. **Cambridge, Mass.** **New York Los Angeles**

Another C-D Development

TYPE U-P

Etched Foil

DRY ELECTROLYTIC CAPACITORS

THE advance engineering design of these new type UP Etched Foil Dry Electrolytics is the result of many years of intensive research in the C-D laboratories.

This research has made possible:—

- ★ Minimum capacity change over wide temperature range.
- ★ Great reduction in physical size—up to 40% for some types.
- ★ Increased life expectancy.
- ★ Reduced direct current leakage.
- ★ Reduced equivalent series resistance.
- ★ Higher breakdown voltage.
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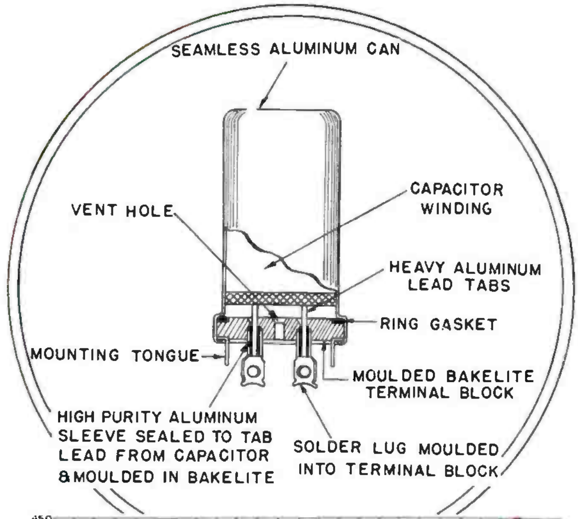
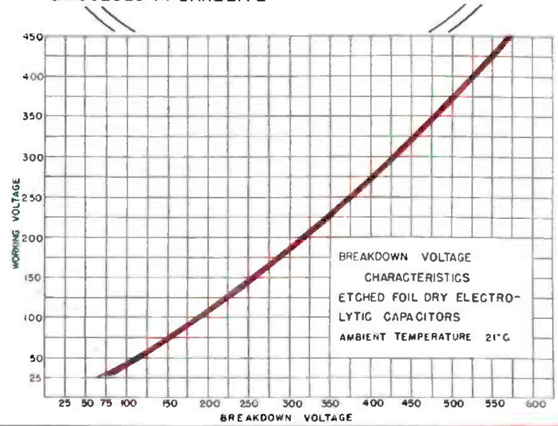
The type UP is the smallest can type capacitor available, and can be supplied in single, dual, triple and quadruple capacity combinations. Complete physical and dimensional data will be supplied on request.

PRODUCT OF THE WORLD'S OLDEST AND LARGEST MANUFACTURER OF CAPACITORS





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