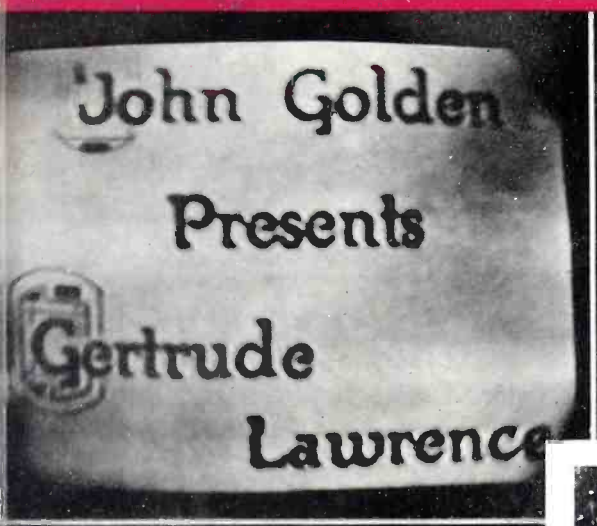
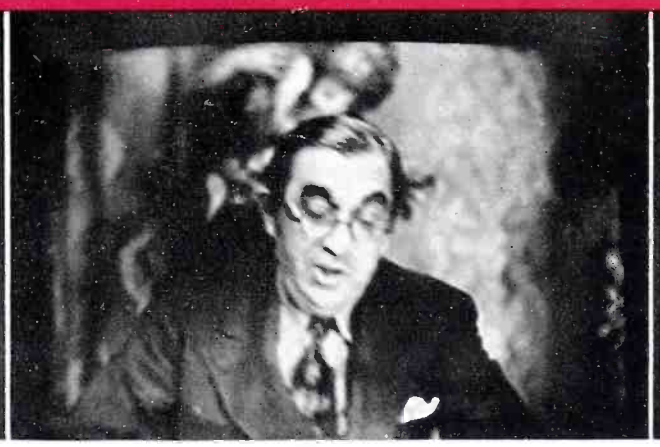
electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture





Scenes from Broadway "Susan and God"

NBC Television Broadcast, June 7

Photographed directly from Receiver

In Electronics' Laboratory (see p. 16)

McGRAW-HILL
PUBLISHING COMPANY, INC.

JULY
1938

Price 50 Cents

ISOLANTITE* insulators keep right on smiling when it rains; they never feel soaked through. High temperature vitrifying keeps the moisture out, and their smooth, glazed surface aids in shedding dust and dirt.

Keeping dry in any weather is very important; for insulators that absorb moisture steal power from high frequency circuits. Modern radio equipment cannot afford to consort with power thieves.

In any kind of weather, Isolantite's low loss feature reduces absorption of power by the dielectric, and keeps every radio circuit at top efficiency. Because of its mechanical strength, small sections of insulation can be used in the high frequency field without risk of breakage.

There are standard Isolantite insulators for many high frequency applications; but flexible manufacturing processes permit the economical production of insulators in a wide range of sizes and shapes to meet special requirements. Isolantite engineers will gladly cooperate on insulator designs.

Registered Trade-name for the products of Isolantite Inc.

ISOLANTITE INC.

CERAMIC INSULATORS

Factory: Belleville, N. J. • Sales Office: 233 Broadway, New York, N. Y.

electronics

RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

ELECTRONICS, July, 1938, Vol. 11, No. 7. Published monthly, price 50c a copy. Subscription rates—United States and possessions, Canada, Mexico and Central American countries, $5.00 a year. All other countries, $6.00 a year or 24 shillings. Entered as Second Class matter, August 29, 1936, at Post Office, Albany, N. Y., under the Act of March 3, 1879.

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CONTENTS—JULY, 1938

DEPARTMENTS

To designers of Home Radios

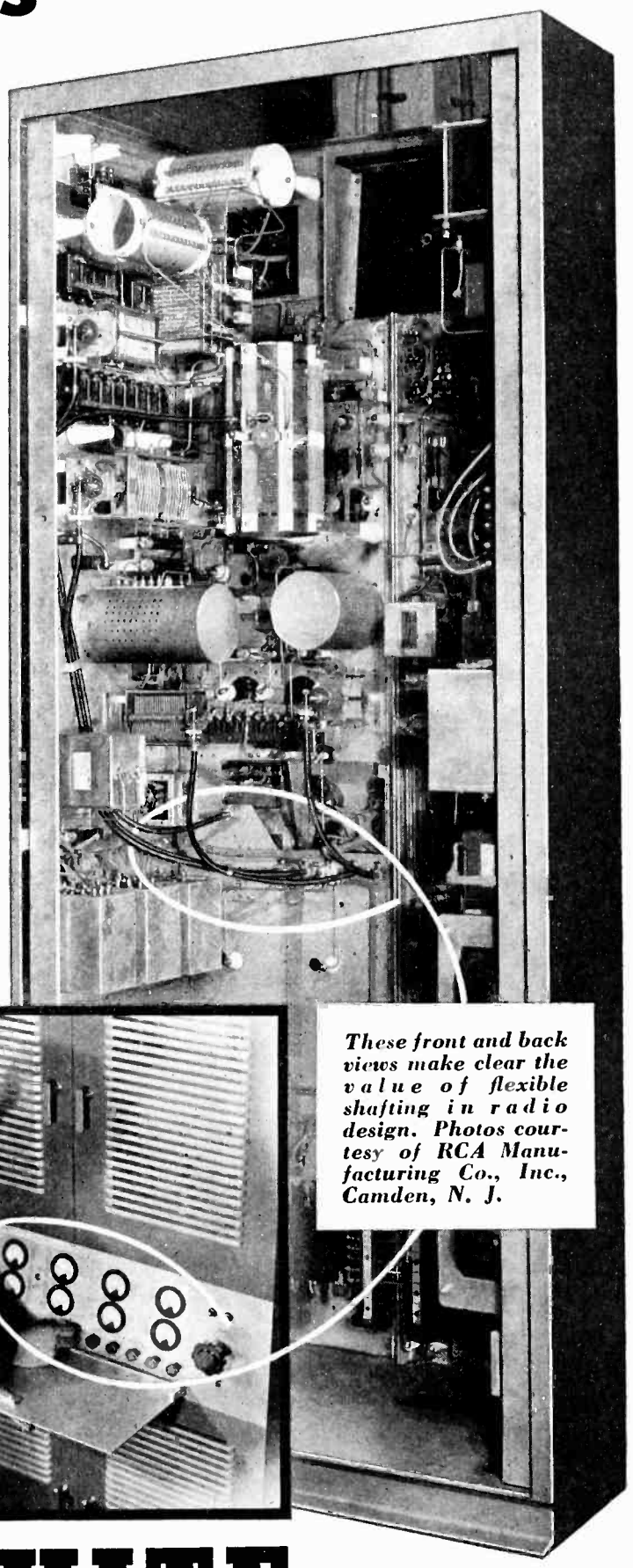
★

. . . An opportunity to capitalize a principle of design that, sooner or later, is sure to be widely used in home radios.

The RCA Broadcast Transmitter illustrated, is an example of the effective application of the principle. See how *the use of flexible shafting makes it possible to place all elements that require tuning in the optimum position with respect to the circuit, and at the same time, to locate control knobs for maximum operating convenience.*

It is quite obvious that this principle can be applied with equal advantage to home radios, and that its use *removes all restrictions to cabinet design.* It permits radio stylists to indulge their ingenuity to the limit, without requiring any sacrifice in circuit efficiency, economical assembly and servicing convenience.

Ask us for a copy of ENGINEERING BULLETIN 38 which tells the whole story about shafting for this purpose.



These front and back views make clear the value of flexible shafting in radio design. Photos courtesy of RCA Manufacturing Co., Inc., Camden, N. J.

S. S. WHITE

The S. S. White Dental Mfg. Co.

INDUSTRIAL DIVISION

Department E, 10 East 40th St., New York, N. Y.

NEW ★ ★ ★ AND 'WAY AHEAD

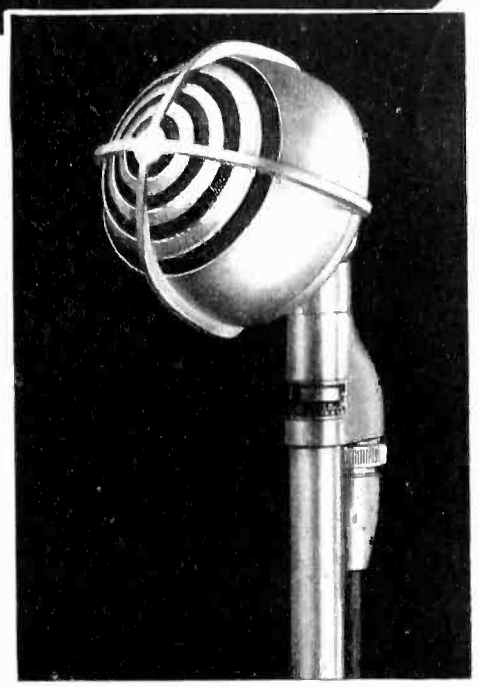
IMPORTANT NEW DEVELOPMENTS
By Shure Engineers

Utilizing new principles and new concepts—Shure Engineers bring you a series of new developments in Crystal Microphones that are of far-reaching importance to every sound system and every microphone user. ★ In the new UNIPLEX, shown at the right, they give you not just "so-called" but *true uni-directional* operation for the first time at low cost! And in the semi-directional, non-directional, and tri-directional models shown below, they bring you new "highs" in performance, in appearance, in value! ★ All these new models, of course, match all amplifiers with standard crystal inputs. And they're all equipped with the new Shure built-in Cable Connector at no extra cost—all in the new rich Satin Chrome finish overall. ★ New Shure "Stabilized" Friction-Lock Floor Stands are available, too, in new ultra-modern designs and finishes—at new low prices. ★ Be ahead this year with Shure! Try these new models—test them yourself. Send for New Catalog and complete information now!

★

The UNIPLEX* is Sensitive at the Front—Dead at the Rear! Really Solves Feedback, Room and Background Noise, Reverberation Problems.

**Shure Patents Pending*



700D

701D

702D

NEW SHURE "UNIPLEX" TRUE UNI-DIRECTIONAL MICROPHONE

Provides high quality wide-range pickup from the front, yet is practically unaffected by sound approaching from the rear. This means freedom from feedback, the practical elimination of crowd and background noise, and remarkable reduction in reverberation "room effects". Tilting head, with new built-in Cable Connector. New Satin Chrome finish. *Model 730A* UNIPLEX Crystal Microphone, complete with 25 ft. special new "Super-Shielded" cable with plug attached. List Price **$29.50**

NEW "ULTRA" WIDE-RANGE CRYSTAL MICROPHONES

With a record of outstanding service in more than 55 countries in all climates throughout the world—Shure ULTRA today gives you the highest performance available in general-purpose crystal microphones. You get "Ultra" Wide-Range response from 30 to 10,000 cycles, high output level, and other extra-dependability features! *Models 700D* "Swivel", *701D* "Grille-Type" and *702D* "Spherical", in new Satin Chrome finish, complete with new built-in Cable Connector and 7 ft. cable with plug attached. List Price..... **$25**

SHURE

NEW "ROCKET" CONVERTIBLE

Has all the features of Shure "Ultra" Wide-Range design, plus new streamlined beauty and versatility. Easy convertibility from conventional to semi-directional (add A91A Baffle) and non-directional pickup. New Satin Chrome finish. *Model 705A* ROCKET Crystal Microphone, complete with Cable Connector and 7 ft. cable with plug attached. List Price..... **$25**

SHURE TRI-POLAR TRI-DIRECTIONAL

The first microphone to give you three-way directional control—Uni-Directional, Bi-Directional, Non-Directional—in the one unit. Solves practically any sound pickup problem. Smooth, high-quality wide-range response. *Model 720B* TRI-POLAR Crystal Microphone, complete with Cable Connector and 25 ft. "Super-Shielded" cable with plug attached. List Price..... **$45**

NEW SHURE 70H "SUPER LEVEL"

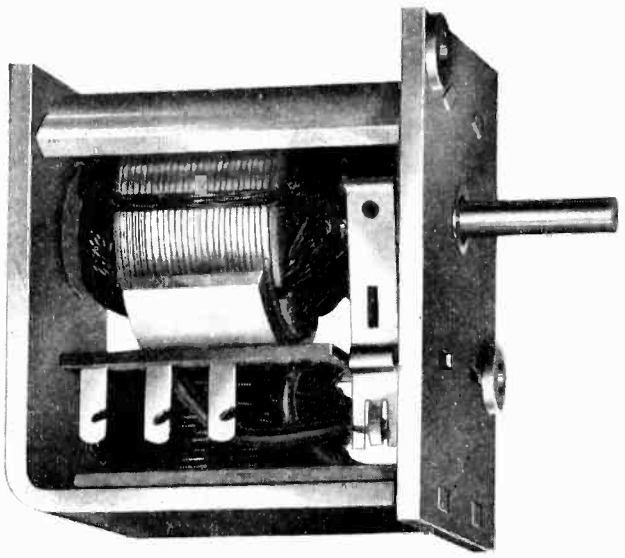
This popular model now provides the highest output level ever available in a crystal microphone. Rated at 46 db below 1 volt per bar (26 db below 1 volt for 10 bar signal). Requires less amplifier gain. Has new built-in Cable Connector. Satin Chrome finish overall. *Model 70H* SUPER LEVEL Crystal Microphone, complete with 7 ft. cable. List Price..... **$22.50**

Shure Patents Pending. Licensed under patents of the Brush Development Company.

SHURE BROTHERS ★ *Microphone Headquarters*

225 West Huron Street ★ Chicago, U. S. A. ★ Cable: Shuremicro

A NEW TUNING MOTOR by DELCO APPLIANCE



Product of General Motors

Here is a new motor every radio manufacturer should see because it is bound to have an important bearing on the industry's tuning problems.

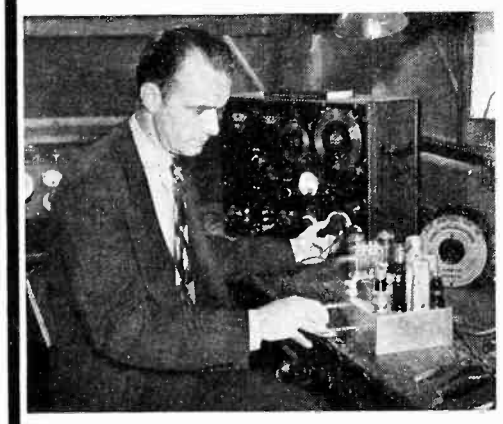
You will find that this new Delco Appliance Reversible Motor is more compact and economical and that its new rigid heavy steel riveted frame, liberal self-aligning bearings and improved commutation make its operation smoother, quieter and lastingly care-free.

Among other things you will see when you have one on your desk are the variety of mounting requirements provided for in the bracket design—terminals that are accessibly mounted on a husky terminal block for quick connecting and secure anchorage.

It will certainly pay you to see this motor and, needless to say, our engineers will be glad to study your needs and to make recommendations.

LENZ Leads Again!

CHIEF ENGINEER W. J. SCHNELL of Sentinel RADIO TELLS WHY HE PICKED *LENZ*



"I found in Lenz Hook-up Wire the dependability and uniform quality we, at Sentinel, insist upon."

Sentinel radios are known for their quality and performance. Mr. Schnell's choice of Lenz Hook-up Wire is in keeping with the precision standards of Sentinel.

LENZ

R. F. CIRCUIT HOOK-UP WIRE

—endorsed by leading manufacturers for its outstanding Dielectric Characteristics.

Radio engineers who have made their own impartial tests know the high quality of Lenz wire never varies. A period of over thirty-four years building, designing and creating wire products exclusively has made the radio industry dependent upon Lenz wire. Low Power Factor—Low Capacity and High Insulation Resistance — place Lenz wire first with radio manufacturers.

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Shielded wires and cables
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Battery and speaker extension cable
Flexible rubber covered lead-in wire
Ground wire
Shielded low capacity cable
Crystal microphone cable
Transmission lines
Push-back wire
Indoor aerial

Write for new illustrated catalog containing complete list of products.

LENZ ELECTRIC MANUFACTURING CO.

1751 North Western Avenue • Chicago, Illinois

ESTABLISHED 1904

"FP" means Fabricated Plate

A Mallory Type FP Capacitor indicates a fabricated plate capacitor...as distinguished from capacitors with foil type plates.

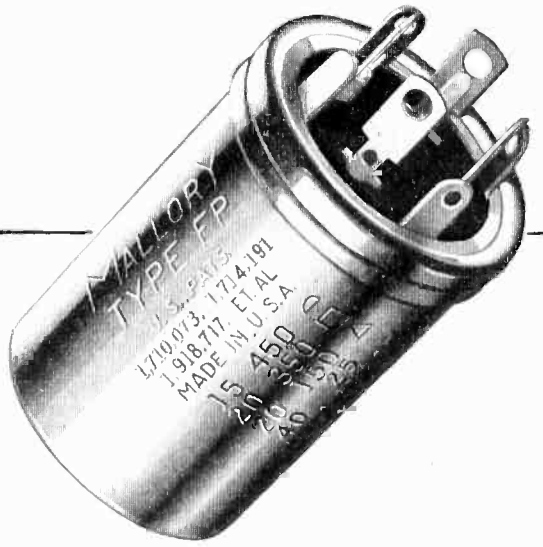
In eliminating the customary anode foil and acid etching processes, Mallory fabricated plate has already won recognition as a development of major importance.

Mallory FP anode plate is fabricated in the Mallory plant by a special Mallory process which deposits high purity molten aluminum on a suitable carrier. This unique method provides a 10 to 1 capacity ratio permitting extremely small size without crowding, and gives even better electrical characteristics than earlier types of anode plate.

Of unusual interest is the outstanding ability of Mallory FP Capacitors to withstand the high temperatures encountered in modern receivers without change in characteristics.

The usual capacity drop due to cathode formation, noted in other types of capacitors having high-ratio anodes, is negligible in Mallory FP Capacitors.

These are typical of the many other advantages which may be secured by specifying Mallory Type FP Capacitors.



Cut shows actual size of a Mallory Quadruple FP Capacitor containing the following ratings with room to spare.

15 MFD	450 Volts DC
20 MFD	350 Volts DC
20 MFD	150 Volts DC
40 MFD	25 Volts DC

(all without harmful coupling effects!)

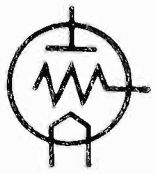
P. R. MALLORY & CO., Inc.
INDIANAPOLIS INDIANA

CABLE ADDRESS—PELMALLO

P.R. MALLORY & CO. Inc.
MALLORY

ELECTRONICS

JULY
1938



KEITH HENNEY
Editor

Crosstalk

▶**FAKE** . . . At the IRE Convention a full size photograph of *Electronics'* experimental television receiver attracted attention. A transparency made from a negative exposed to the screen during the Gertrude Lawrence *Susan and God* television show was illuminated with green light to simulate the appearance of a television image. Practically every engineer who entered the booth looked behind the photograph to find nothing but an electric lamp, going away muttering "fake." We don't deny it was a fake; we claimed only that it was a photograph. For other *Susan and God* photos by Mr. Dudley, see *Life*, June 20, and the cover of this issue.

▶**PROJECTION** . . . A first at the IRE show was the projection of actual meter readings onto a screen by means of the new Weston projection meter. This was part of a demonstration by Mr. Arguimbau of General Radio in which the indicating instrument was the Weston meter with transparent dial, the needle and scale of which is projected by a lamp and optical system.

▶**PARTS SHOW** . . . At Chicago, week of June 6, 8000 manufacturers, dealers, amateurs, engineers looked at products of 146 exhibitors. A. S. Wells, Wells-Gardner, was elected President of RMA for the coming year.

▶**FREE RIDE** . . . Lowell Thomas once announced that he was giving his news broadcast from a telegraph office (which was true) and that it would be nice if his friends would send him a message at the telegraph company's expense (which was the company's idea.) Before the night was over, 260,000 messages had been filed. In another broadcast the announcer stated that a packet of petunia seeds would be sent to anyone who wanted it—for a dime. Over a million dimes were received.

The tremendous appeal, and tremendous response, associated with radio evidenced by these two incidents are reason enough for the worry of the regulatory bodies that radio might fall into the hands of unscrupulous individuals—and the reason why the people should be just as worried lest broadcasting fall into the hands of unscrupulous politicians.

▶**1888–1938** . . . In 1888 Hertz published the first disclosure of his monumental work on electrical waves, work which preceded by many years the good will, entertainment, education that pours from the free broadcast stations of the world, the torrent of hatred, bias, and blasphemy which pours from the few nations whose people have lost their freedom.

In 1938 Hertz's widow and two daughters live in England, unwanted in the land in which Hertz discoveries were made. Quoting from the New York Times, "Dr. Hertz was a Jew though from Aryan stock. His widow and two daughters are Protestants. They lived for some time at Bonn on a modest pension until Nazi molestation drove them to Britain."

Pope Pius recently gave a money grant to the family in a gesture of recognition of the pioneer research of Heinrich Hertz.

▶**IS BIGNESS BADNESS** . . . Countering the continuous barrage of Washington warfare against bigness in business, the Brookings Institution, a non-political, independent research agency, reports its study made to determine whether big companies are worse than small ones. Report states that competition among large companies is just as keen as among small ones; that competition among large companies is much more likely to produce results of benefit to the people.

Competition forces companies to employ research men and to equip themselves with laboratories, and to employ the fruits of engineering. The report states that only by such concerns may the many useful products and better goods everyone desires be brought within the reach of the people.

▶**BIG EYE** . . . A photoelectric cell used with the 200 inch mirror being erected at Mount Wilson will be able to detect the light of a candle 3000 miles away. The mirror itself does not magnify light, but it collects it and focuses it into a small beam so that the astronomer will be able to see what he would if the pupil of his eye were 200 inches in diameter.

▶**NEW PRODUCTS** . . . New products of the laboratories, new materials, new devices, new instruments, new parts and components, new assemblies of existing materials—all these new things are the life-blood of electronics. News of new products is welcome news to the editors of *Electronics*, and we presume, news to our readers as well. But the number of manufacturers who contribute to new product pages of this magazine number over 100, and it is physically impossible for the editors to keep in close touch with each of these suppliers of industry products as the editors would wish. The manufacturers themselves must help in supplying the trade with news of their new products. There are certain concerns, however, which have no regular system for sending such items to these offices, and who take personal affront if their new items are not regularly mentioned in the New Product pages.

One manufacturer recently kicked because his device had not been listed in a compilation. In our files, however, were carbon copies of 5 letters which had gone to his concern asking for material for this particular compilation. Not one letter had been answered. The case was particularly galling to the editors because the concern was an old friend, and is well known for its products in the particular line about which the compilation was made.

New product items are news to the industry; the editors welcome them. If the products are of interest to the readers of *Electronics* and if space permits, news of these new products will be published.

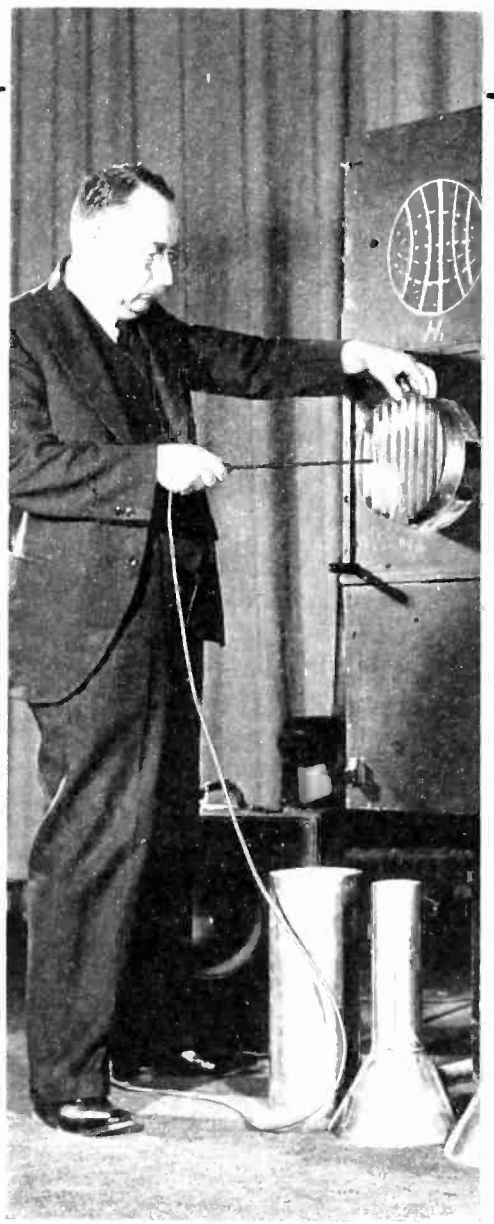
I. R. E. Convention, 1938

PILING up unprecedented attendance, about 1900 engineers of the radio industry attended the thirteenth annual convention of the Institute of Radio Engineers at New York's Hotel Pennsylvania on June 16th to 18th inclusive, overflowed the large ballroom and an adjoining hall in listening to the largest number of papers yet offered, awarded the Morris Liebmann Memorial Prize to Dr. George C. Southworth, the Medal of Honor to Dr. John Howard Dellinger, and the prize for the best paper of the year to Arthur L. Samuel, and found time to review new developments in equipment which were exhibited by manufacturers.

The series of 49 papers presented this year were more diversified than last year, although there was considerable interest shown in television and electronic devices for promoting the transmission of images through space. Discussions of many of the papers (especially those related to television) was spirited, and demonstrations were given as a portion of about a dozen papers. All in all, the convention gave ample evidence of unusual activity in the radio industry despite the recent depression which has dogged its heels for almost a year.

Papers for Broadcast Engineers

Several of the papers were of particular interest to broadcast engineers. Among them was a description of KDKA's new low-angle antenna array, delivered by R. N. Harmon. The tower is 710 ft. high, of triangular cross-section, is in two sections and was pre-fabricated at the factory in 22-ft. sections which were fitted together and welded into place during erection. A ceramic insulator at the center sectionalizes the tower. It is surrounded by 8 suppressors for limiting the radiation to a low angle elevation. At 1 mile the field strength is 1,980 mv/m. The field in the horizontal plane is sensibly circular. In a vertical plane, the maximum lobe occurs at the surface of the earth. A minimum lobe having its maximum at about 1/10 of the amplitude of the main lobe, occurs at a vertical angle of about 70°.



Dr. George C. Southworth, who received the Institute's Morris Liebmann Memorial Prize for 1938 in recognition of his experimental and theoretical investigations on high frequency transmission circuits

Measurements indicate that the suppressors modify the horizontal directivity by decreasing the magnitude of the minor lobe and producing a sharper null point between the lobes.

Single Sideband Transmission

Single sideband reception being one hope of reducing bandwidth in television, Leon F. Nergaard of RCA Radiotron reported on work on this subject. The effect of detuning a transmitter to suppress partially one sideband and increase the width for the other sideband was investigated. The effect of the transmitter on the contrast between narrow dark and light lines in a reproduced television image is determined almost entirely by the decay time of the tank circuit. Detuning has a small effect on the contrast, but this effect is in the nature of distortion because it depends on the width of the line. The rate at which the tank voltage builds up can be increased by detuning; but the rate of decay can only be increased by increasing the decrement, i.e., by increasing the band width. A number of curves showing the response to alternate light and dark vertical lines of various widths and for various degrees of detuning illustrated the above effect.

In another paper involving single sideband transmission, A. A. Oswald, Bell Laboratories, gave a brief description of a system developed for trans-oceanic radio telephone service. The system involves the transmission of a reduced carrier or pilot frequency and is designed to include the testing of twin channel operations wherein a second channel is obtained by utilizing the other sideband.

In this system a single sideband with a reduced carrier is derived, amplified, and transmitted. At the receiver the reduced carrier is separated from the sideband by a filter, after which it is amplified independently and then used directly for demodulation purposes or to control local oscillator frequencies to be used in demodulation. The carrier is also used to control the receiver gain through the use of automatic volume control.

The generation of a single side-

Dr. John Howard Dellinger, whose technical accomplishments and many years of service as head of the Bureau of Standards radio division are recognized in his award of the I. R. E. Medal of Honor

band signal by means of simple modulators and filters requires that the selection of the sidebands be accomplished at frequencies where suitable filters can be obtained. If the radiated frequencies, however, are to be within a range of 4,000 to 22,000 kc, it is necessary to select a sideband, and then translate it by additional steps of modulation to whatever frequency position is desired.

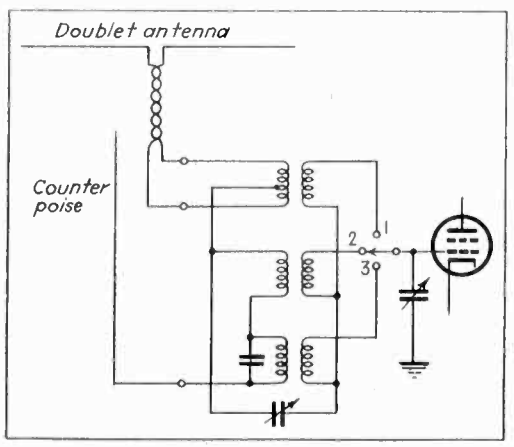
In the case of a receiver for single channel reception, the necessary selectivity can usually be obtained by double demodulation, using an intermediate frequency of the order of 400 kc. For systems requiring more selectivity in order to separate channels lying near each other, such as occurs in the twin single sideband system, triple demodulation is desirable, according to a paper by A. A. Roetken.

The principal advantages of this twin channel system, with wideband amplifiers, are its simplicity and flexibility. The use of a common carrier simplifies the modulation and demodulation problems and reduces the amount of equipment required. Symmetrical filters having bands considerably greater than the bands which are to be transmitted permit variations in the sideband arrangement and may afford a means of reducing interference.

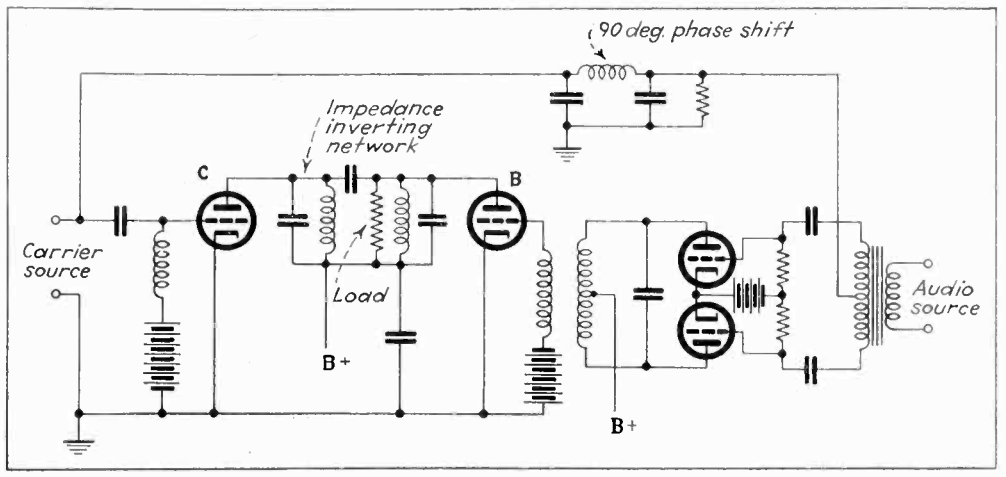
V. D. Landon delivered the paper, "A New Antenna System for Noise Reduction" by himself and J. Reid which dealt with antenna-counterpoise systems for use with broadcast and high frequency receivers for the reduction of noise. It was pointed out that much noise in modern receivers arrives through the power line, since an effective and common ground cannot always be employed in modern receivers. The noise reducing systems described for the most part, took the form of a bridge circuit in which an antenna and a counterpoise (of about one-quarter of the antenna length) fed into the primary winding of suitable high frequency or broadcast coils. The ground point on the chassis, the power line, the antenna, and the counterpoise each form one terminal of the bridge which, when balanced, becomes effective in noise reduction over a wide frequency range. Modifications were shown which were intended to be used with existing receivers without having recourse to modification or alteration of the antenna input circuit. Circuits were shown for one-, two- and three-band operation, in which it was unnecessary to switch the primary coil.

The session held in the Ballroom on Thursday afternoon was devoted to the technical equipment of broadcast stations. O. W. Towner read a paper describing the first U. S. installation of the Doherty high efficiency circuit, that in the new transmitter at WHAS, Louisville. A saving of 6000 dollars per year is expected from the use of the new circuit. The 50 kw transmitter has been designed to drive an additional 500 kw stage, in the event that the pending application for super-power is granted by the FCC. Important advantages have been achieved by the use of negative feed-back, allowing the use of a much smaller power-supply filter than has been customary in the past, and providing a very low distortion percentage throughout the audio system. In the water-cooling system straight porcelain pipes have been used to enclose the water column in place of the rubber hose or porcelain coils previously used.

V. E. Trouant described, in a paper written with J. B. Coleman, several important developments in the transmitters developed in the RCA Laboratories at Camden. Controlled degeneration has been used widely to improve noise and distortion characteristics. New crystal-control circuits give improved performance, especially in transmitters designed for international short-wave broadcasting where frequency changes are necessary in daily operation. In the ultra-high frequency spectrum, the outstanding development is a trans-



Noise reducing antenna system for three wave bands, as described by V. D. Landon



High efficiency modulated amplifier, described by A. W. Vance, which combines the virtues of previous systems, and employs an "r-f bias" to obtain pentode action from a triode

mission-line controlled transmitter having an output of 4 kw at 100 Mc.

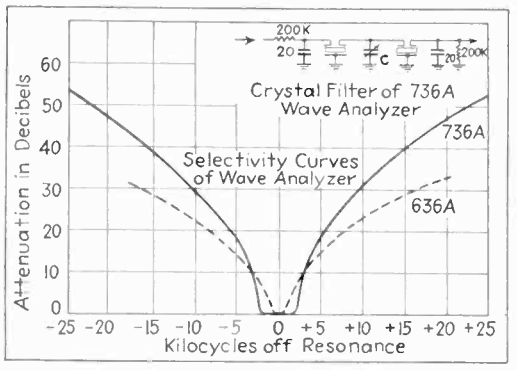
A third version of the high-efficiency modulated amplifier has been developed at RCA in Camden, and was described for the first time by A. W. Vance. The circuit combines the principles of the Doherty amplifier and the Dome amplifier. The basic circuit is shown in the accompanying figure. The tube "B" is the audio tube, receiving power from the audio source and feeding it to the load, which is also connected in the plate circuit of tube "C", the carrier tube. The effective impedance of the load is varied from zero to twice its nominal value by the action of the audio tube, and since constant current is forced through it by the action of the tubes, the voltage into the load is thereby varied from zero to twice its unmodulated value. The constant current characteristic can most readily be obtained from a pentode, but since pentodes are not available in high power ratings, the triode has been given an effective pentode characteristic by applying a "radio frequency bias" to the modulator (audio) tube from the carrier tube, through a 90 degree phase-shift network. One of the outstanding characteristics of the circuit, in addition to its high efficiency of operation, is that fact that on overmodulation peaks in the downward direction, a phase reversal occurs which prohibits the generation of spurious sideband frequencies. As a consequence, the transmitter exhibits no "monkey-chatter" on adjacent frequencies when overmodulated. An experimental form of the transmitter, employing receiving-type tubes and used to test the properties of the circuit, was described.

The audio frequency end of broadcast design was handled by two papers, one by A. G. Goodnow which described the audio facilities of KYW in Philadelphia, and the other by Howard A. Chinn who discussed the design of audio studio facilities.

Mr. Chinn showed that the overall electrical performance requirements of the complete studio audio facilities are determined, to a large extent, by such factors as the characteristics of the best commercially available radio receiver, the ability of the ear to detect loss in fidelity, and economic aspects involved.

At the present time, the response frequency characteristic of the entire program channel should not deviate by more than ½ db from the 1000 cps value for any frequency from 50 to 8,000 cps. In the frequency spectrum from 40 to 10,000 cps the response should be uniform to within 1 db.

The distortion frequency characteristics (combined audio harmonics) should not exceed ½ of 1 per cent rms for the complete program channel for any single frequency test tone from 100 to 4,000 cps at



Crystal filter circuit and its selectivity curve. The dashed line shows the selectivity curve of a former filter

any output up to the normal power level of the channel. The unweighted signal-to-noise ratio, in a spectrum from 30 to 15,000 cps should be greater than 60 db. Weighted signal-to-noise measurements are not advocated for a number of reasons, but if such characteristics are specified a ratio of at least 80 db should be required.

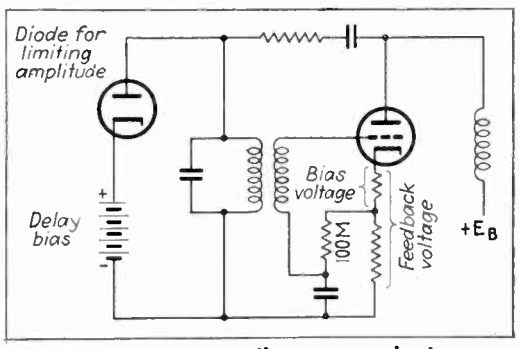
Radio Measurement Technique Discussed

L. B. Arguimbau of the General Radio Company, discussed the application of quartz crystals to a wave analyzer. After giving an analysis of the crystal in a three electrode holder, the equivalent circuit was developed, and was shown to be applicable over a wide variety of terminal conditions. It was shown that the Q of the crystal becomes high as the values of the shunting resistance and the shunting condenser are increased. It was also pointed out that the gain of the crystal circuit, or the ratio of the output to the input voltage, increases with the shunting resistance and decreases as the shunting capacitance is increased. With such a three electrode crystal holder, a resonant and an anti-resonant frequency fairly close together were obtained.

In applying quartz crystals to wave analyzers, a circuit was shown in which two crystals were used to provide the desired selectivity. These crystals were coupled together by means of a small variable condenser, and it was shown that variation of the capacitance of this condenser shifted the peak of one crystal resonance relative to that of the other, thereby widening the acceptance band. Through the use of this circuit, a sharp resonant band with steep sides was obtained. A frequency deviation of about two cycles per second on either side of the resonant frequency of 100 kc was permissible before appreciable attenuation occurred in the filter circuit.

Dr. W. N. Tuttle in a paper, entitled "Bridged-T and Parallel-T Null Circuit for Measurements at Radio Frequencies" pointed out that it is often inconvenient or awkward to make bridge measurements because it is frequently impossible to have a common ground terminal for both the generator and the detector circuits. This condition frequently enables a voltage to be built up between the generator and detector circuit in the usual bridge arrangements. This difficulty is obviated in the case of bridge T and parallel T circuits, although such circuits have the disadvantage of not providing any multiplying factors as is obtained in the case of the usual bridge arrangement. A mathematical analysis was presented of a wide variety of useful T circuits applicable to radio frequency measurements.

A paper by G. R. Mezger outlined the factors which are required in the design of a complete cathode ray oscillograph in relation to the application to which it is put. Considerable attention was devoted to the design of, the overall gain, and response of the amplifier for applying voltage to the deflecting plates, to the linear



Laboratory oscillator employing negative feedback and diode for limiting amplitude of oscillations, described by Prof. Terman

sweep circuit design, and to the high voltage power supply. The advantage of using sweep circuits other than the common sawtooth variety was pointed out. A demonstration was given in which some of the important points of the paper were further emphasized.

Papers on Feedback Circuits

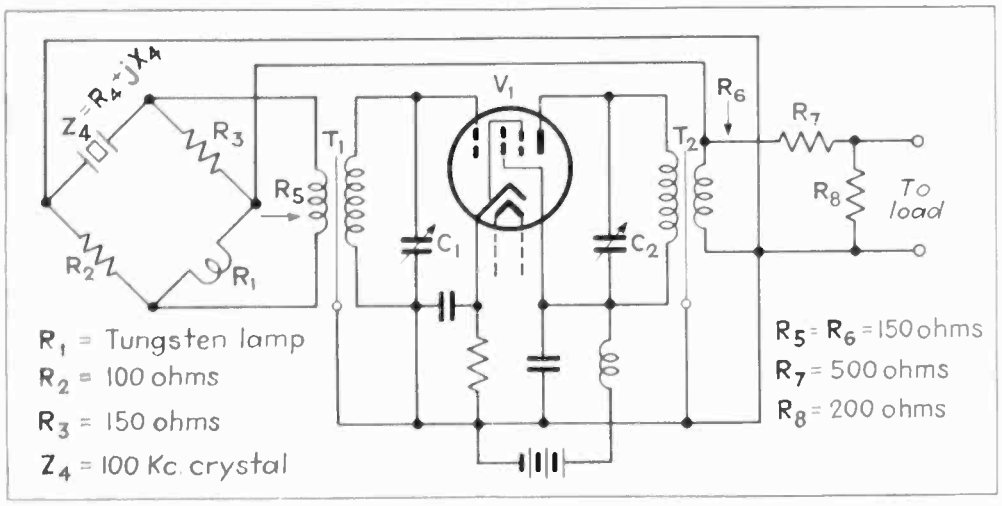
As might be expected several of the papers presented dealt with the applications of feedback circuits. H. F. Mayer discussed the several types of feedback, positive, negative, voltage and current, and showed how they might be applied to audio, radio and intermediate frequency amplifiers.

A joint paper by Professor Terman and his associates, R. R. Buss, W. R. Hewlett and F. C. Cahill, all of Stanford University covered the uses of feedback in laboratory measuring equipment. Amplifiers, voltmeters and similar pieces of equipment having voltage variation of less than 1 per cent from 30 to 20,000 cycles and which did not vary more than 1 per cent for plate supply voltage changes from 140 to 400 volts (normal plate voltage was 250 volts) was obtained. Similarly the gain did not change more than 1/2 of 1 per cent for a heater voltage variation from 5.3 to 7.5 volts.

Through the use of negative feedback, it is possible to provide a circuit in which the response depends only upon the characteristics of the tuned circuit, rather than upon tube characteristics and voltage variations of the tube electrodes as is now commonly the case. Through the use of negative feedback it should be possible to design and calibrate field strength instruments having a gain substantially independent of the tube voltage, and with a calibration which should be maintained over long periods of time.

Other applications of the principle of negative feedback included the possibility of obtaining negative values of inductance, capacitance or resistance, which were stable. Feedback has been used in push-pull circuits to eliminate the unbalance in individual tubes. It was also pointed out that negative feedback could be employed in a laboratory oscillator whose frequency was determined by values of resistance and capacitance. The advantage of such a circuit is that a frequency range of perhaps 10 to 1 can be obtained with commercially available variable condensers and that expensive tuning inductances may be eliminated. By this means, a relatively inexpensive substitute for a beat frequency oscillator, having a high degree of stability, can be obtained.

In another paper on feedback applications, R. L. Freeman, of Hazeltine Service Corporation, covered the use of feedback to compensate for variations of input capacitances of vacuum tubes caused by variations in grid bias. By means of the grid-cathode capacitance and an un-by-passed resistor in the cathode lead, variations in capacity as great as 1.5 μμf, caused by shift in space charge and grid-plate feedback, may be compensated.



Bridge stabilized oscillator described by L. A. Meacham. A telephone switchboard lamp was used for R_1, which aids in keeping amplitude of oscillations constant. An effective demonstration of this circuit was given by the author

L. A. Meacham, Bell laboratories, described an oscillator which approaches the ideal case in which the tube oscillates at a stable amplitude and at a frequency determined completely by the resonator itself, regardless of power supply variation, aging of tube or other circuit elements, or the changing of any other operating conditions.

Essentially, this oscillator consists of a Wheatstone bridge, one arm of which contains frequency determining elements, and a linear amplifier. The amplifier output is impressed across one of the diagonals of the bridge, and the unbalance potential, appearing across the conjugate diagonal, is applied to the amplifier input terminal. One of the four bridge arms, R_1, is a thermally controlled resistance; two others R_2 and R_3, are fixed resistances, and the fourth $Z_4 = R_4 + jX_4$, is the frequency controlling resonance element, which may be a quartz crystal or a coil and condenser in series.

One of the significant differences between the bridge oscillator and other oscillator circuits is the fact that the frequency stability is roughly proportional to the amplifier gain, at least for amounts of gain that can be dealt with conveniently.

The circuit diagram of an experimental bridge stabilized oscillator is shown. The amplifier consists of a single pentode tube, V_1, with tuned input and output transformers, T_1 and T_2, and the usual power supply and biasing arrangement. The crystal, mounted in a cylindrical container has a very low temperature coefficient of frequency at ordinary ambient temperatures. The gain of the amplifier is 52.5 db, representing a voltage ratio of 422 to 1.

Measurements on a bridge oscillator operating at 100 kc. indicate that when the amplifier is adjusted for maximum gain, corresponding approximately to zero phase shift, the frequency change did not exceed more than one part in one hundred million for a plate voltage variation of from 120 to 240 volts. For a given adjustment of the bridge circuit, variations in filament voltage between 7½ and 10½ volts did not produce frequency variations in excess of one part in one hundred million.

In the discussion Dr. K. S. Van Dyke, Wesleyan University, pointed out that since the operation of the

stabilized oscillator depended upon the value of its Q, any increase in Q would result in further increase in frequency stability of the oscillator. He pointed out that crystals operating at 100 kc had been obtained in which the value of Q was as large as 3,000,000. Mr. Meacham estimated that the normal current through the crystal in this circuit was probably in the neighborhood of 5 ma. but the demonstration he gave indicated that even this relatively large current was not sufficient to produce any serious frequency deviation.

In a paper "Evacuated Type Crystal Oscillator Holder", C. F. Baldwin outlined the major difficulties with quartz crystals and described, point by point, the practical methods which have been adapted in eliminating or reducing most of the disadvantages. He showed the construction of a vacuum type, hermetically sealed crystal mounting in which these defects were eliminated or greatly reduced. In this crystal holder, the crystal is mounted vertically in a recessed ceramic block having metal plates pressed firmly to both faces of the crystal. The entire assembly is mounted in a metal envelope similar to that used in the 6L6 tube. After the crystal is properly mounted and clamped in position, the complete unit is placed on an ordinary vacuum tube exhaust machine and the air is pumped out of the envelope. Through the use of the proper tube exhaust schedule, the pressure, humidity and other characteristics of the gas surrounding the crystal may be controlled at will. Hydrogen, helium or other gases can be injected.

Tubes for Television Show Technical Advances

One of the outstanding presentations was that of Harley Iams, who, with G. A. Morton and V. K. Zworykin reported on the "image iconoscope", a new form of television pick-up tube which has a sensitivity about ten times as great as that of the conventional iconoscope. The layout of a typical example of the new tube is shown in the diagram below. The light from the scene to be televised is focussed on a translucent photocathode. An image in electrons is thereby released from the cathode and focussed by an electrostatic or magnetostatic lens on a flat plate of insulating material at the other end of the tube. This plate is treated to have a high secondary emission characteristic, and as the image of electrons hits it, the secondary emission leaves the plate which a charge deficiency whose distribution is the same as that of the lights and shadows focussed on the photocathode. As the bombardment of the image-plate continues, the charge deficiency increases in magnitude, but preserves its geometrical configuration due to the insulating properties of the plate. Consequently, the storage action characteristic of the ordinary iconoscope is obtained.

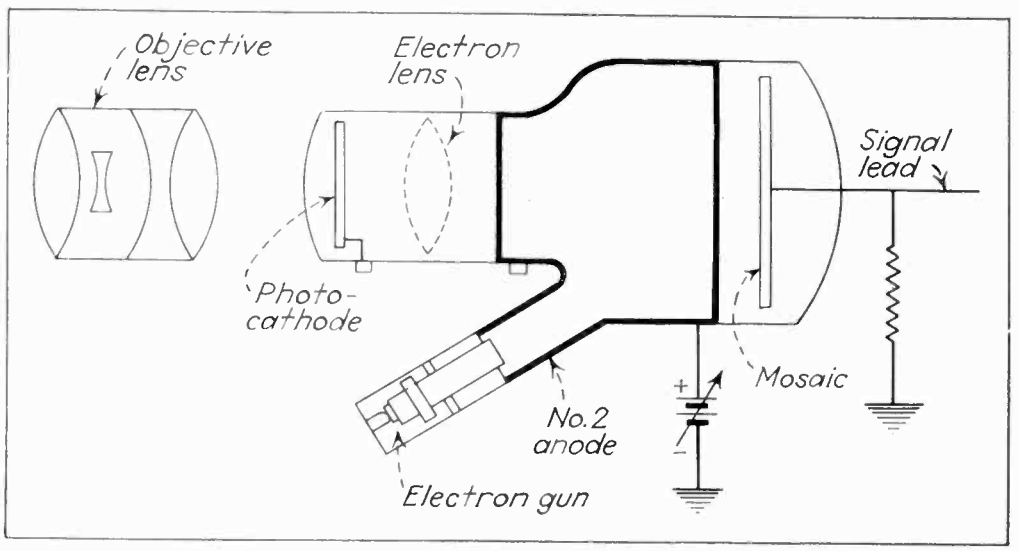
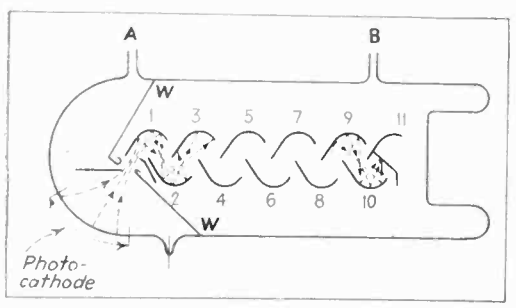


Diagram of the image iconoscope or iconotron. The mosaic, bombarded by an electron image from the illuminated photocathode emits secondary electrons, multiplying and storing the charge image. The mosaic is scanned, as in the usual iconoscope, by means of the beam from the electron gun

The multiplying action of the secondary emission is such, however, that the charge stored is about 10 times as great as the charge actually produced by the photocathode in a given length of time. This results in a tenfold increase in sensitivity. The insulated plate which retains the charge image, is scanned by a cathode ray beam as in the conventional iconoscope, and the replacement of charge on the plate changes the potential according to the lights and shadows in each scanned line. The increased sensitivity may be used to operate the iconoscope with decreased levels of illumination, or with a smaller aperture in the camera, with consequent increase in the depth of focus. The spurious signal or "shading" effect noted in the conventional iconoscope is present in the new tube, but its extent is no greater than and in some cases considerably less than, that of standard tubes. The image focussing system between the photo-cathode and the secondary emission plate is substantially the same as was described by Dr. V. K. Zworykin several years ago (see *Electronics*, January 1936, page 10).

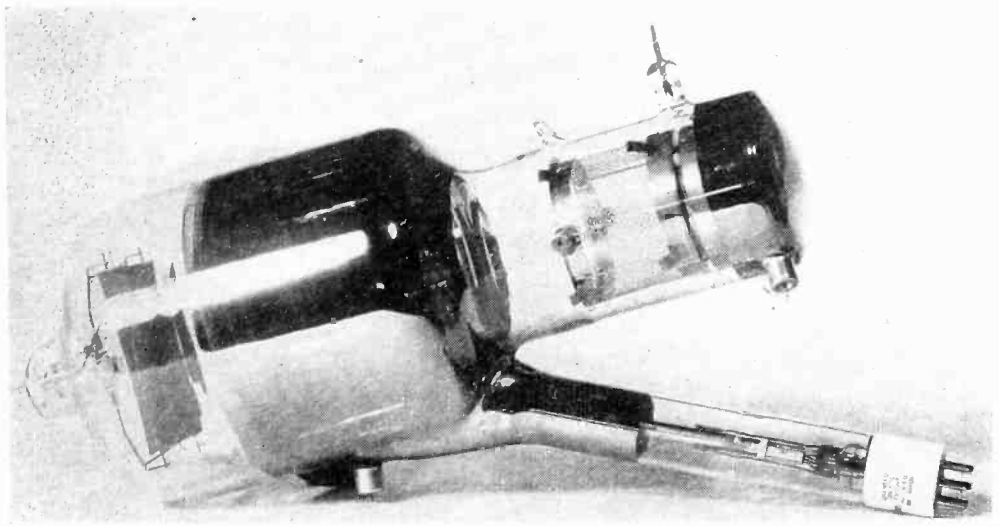
A new type of multistage electron multiplier which employs electrostatic focussing in place of the previously used magnetostatic focussing was described by Dr. Zworykin and J. A. Rajchman. The electrode structure of one of the new tubes is shown. The curvature of the plates serves to direct the electrons from one stage to the next, focussing them successively on the inner surface of each plate, which has a high secondary emission ratio. One such tube, having ten stages and 200 volts per stage, gives a useful amplification of 13,000,000 times. Tubes of a larger number of stages having am-



Cross section diagram of ten stage electron multiplier using electrostatic fields only, described by V. K. Zworykin

plification in the hundreds of millions are feasible. One tube, employing a circular arrangement of elements, allows an amplification of several million within a tube one inch in diameter and one inch high.

The success of the new multiplying structure is due to the use of a very ingenious device for tracing the paths of electrons in different electrode configurations. A flat piece of flexible rubber sheet is pressed over



Photograph of the image iconoscope shown diagrammatically on page 12. The mosaic may be seen at the extreme left. The gauze cylinder, adjacent to the photocathode, aids in focussing the electron image. The electron gun is similar to that used in modern cathode ray tubes. The image iconoscope is ten times as sensitive as the ordinary iconoscope

metal elements which have the shape to be investigated, and the rubber sheet thereby assumes a three dimensional contour which follows the corresponding potential distribution between the elements. By placing steel balls on the rubber and tracing their paths as they roll on the hills and valleys of the contour, it has been possible to predict accurately the focussing effect of different electrode shapes and separations.

Papers on the Kinescope

One television problem is to obtain an image with adequate contrast, for although a relatively low contrast range may suffice for the transmission of intelligence, a much greater contrast range is essential for the reproduction of clear, life-like images.

Factors harmful to contrast are well known and may be studied in a variety of ways. In the belief that the reaction of the observer is the ultimate criterion for judging the perfection of the image, R. R. Law RCA Radiotron, began an investigation of contrast with a series of viewing tests designed to determine the relative psychological effects of the various factors harmful to contrast. On the basis of these tests it was definitely concluded that halation is far more detrimental to image quality than screen curvature or bulb-wall reflections.

Experimental evaluation of the relative importance of the individual factors harmful to contrast lead to the same conclusion. For example, in reproducing a small dark spot on a bright field with a conventional sprayed screen kinescope the limiting value of contrast ratio as determined by each of the individual factors is approximately as follows:

Halation	6
Normal Reflection	60
Curvature of Screen	70
Bulb-Wall Reflection	200

Halation may be reduced several fold by introducing a light absorbing layer on the kinescope screen. According to this analysis a 10 to 20 per cent absorption layer should give a 3- to 6-fold reduction in halation.

Developmental kinescopes made in accordance with these principles give greatly improved contrast. Not only does reduction of halation substantially double or triple the length of the scale available for the reproduction of half-tones, but it has a marked effect upon the sharpness of the image which is analogous to good optical focus in the case of a projected picture.

The sensitivity and picture signal of iconoscopes have been increased recently by a factor of two or three times according to R. D. Janes and W. H. Hickok, RCA, Harrison. The spectral response of the newer tubes more closely resembles that of the eye and may be controlled by processing. "Dark spot" has been diminished by the use of a cylindrical envelope. The increase in sensitivity and picture signal output of the iconoscope arises from the use of an extra sensitizing process called "silver sensitization." This extra sensitization also serves to give a spectral response closer to that of the eye. The resolution is also somewhat improved.

For tubes which are used for viewing actual scenes in the studio, a further sensitization process is used to give the walls of the envelope a high photo-sensitivity. When light from a small lamp is allowed to fall on the sensitized walls without striking the mosaic, another gain in sensitivity and signal output is achieved. The advantageous effect of this "back lighting" method was first discovered by engineers of Electrical and Musical Industries, Ltd., and has been used for some time in the installations for the British Broadcasting Corp. In the studio, the gain from the extra sensitization and the use of the "back lighting" can be employed either to reduce the illumination on the scene or to increase the depth of field of the scene.

In iconoscopes for transmission of movies, photo-sensitive walls are disadvantageous because of signals introduced by the intermittent illumination of the movie film. Iconoscopes for movie transmission are, therefore, designed so that the extra sensitization process does not sensitize the walls of the tube envelopes. In these tubes, the extra sensitization process improves the signal-to-dark-spot ratio. The design of the electron gun has been changed to give a constant current as the beam is focussed, and to prevent secondary electrons from the gun apertures getting into the primary beam. Use of the cylindrical envelope

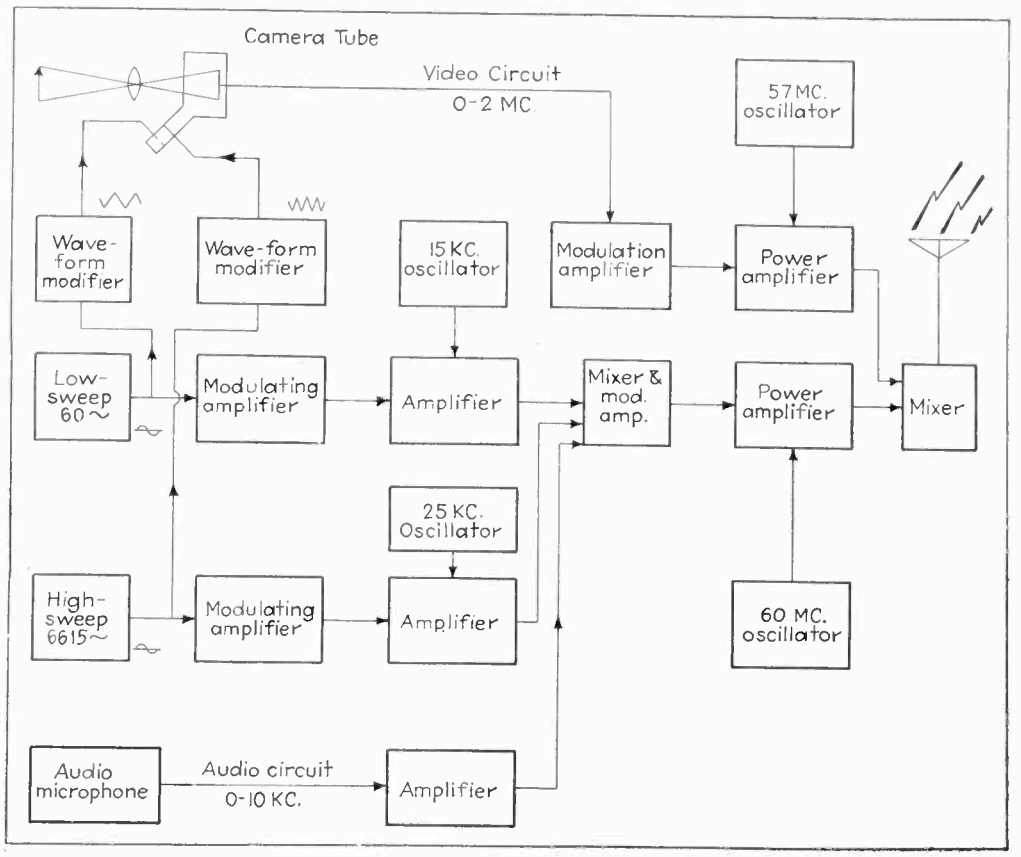
gives a better picture since a good optical window can be employed. Sandblasting of the mosaic improves the picture contrast and quality by removing the specular reflection of the mosaic.

Ship-to-Shore Radio Telephone Equipment

Five papers by members of the staff of the Bell Telephone Laboratories and associated companies were presented Saturday morning on equipment developed for coastal and harbor ship-to-shore radiotelephone service. Transmitting and receiving equipment, both crystal controlled, may be purchased by owners of small pleasure and commercial craft for use in connection with the A. T. and T. harbor circuits. The equipment contains several refinements, such as the codan (carrier operated device, anti-noise) and the vogad (voice operated gain adjustment device), which make such improved performance that the connection cannot be distinguished from a land-line circuit. The shore receivers are mounted in housings attached to telephone poles and connected to the switchboard by land wire. One example of the shore equipment, that recently installed in Norfolk by the Chesapeake and Potomac Telephone Company was described. In the discussion it was revealed that the toll charges are $3.00 for three minutes within 150 miles inland from the shore station, and 50 cents per minute for local dispatching service. Each vessel may be dialed directly from the shore switchboard, and connections between boats may be completed through the shore facilities. These papers were delivered by C. N. Anderson, H. M. Pruden, S. B. Wright, S. Doba, A. C. Dickieson, R. S. Bair, H. B. Fischer, W. M. Swingle, and Austin Bailey.

Television Session Well Attended

The session held Saturday afternoon was devoted to papers on television and as could be expected was attended by a large and attentive audience. The first paper "The DuMont Television System" was presented by T. T. Goldsmith, Jr. The system outlined is that recently described in these pages (*Electronics*, March 1938, page 33) in which the sweep voltages are sent directly from transmitter to receiver, by modulating an auxiliary carrier with the saw-tooth wave form or with sine-waves which are modified to saw-tooths at the receiver. This system concentrates the complicated synchronizing equipment at the transmitter and eliminates sweep voltage generators at each receiver. Furthermore it allows the full modulation amplitude of the television transmitter to be employed for the picture signal, rather than the 70 or 80 per cent now available when synchronizing signals are imposed on the carrier envelope. The block diagram of the transmitter is shown in the illustration. At the receiver the sine wave modulation for each synchronizing direction is modified in a circuit containing a rectifier, a resistance and a capacitance combination. The system allows the use of interlace ratios as high as 4-to-1 or 6-to-1, and these high ratios in turn are sufficient to eliminate flicker even though the picture repetition rate is only 15 per second, instead of the usual 30 per second. A fifty per cent reduction in the band-width required is thereby made possible.



Transmitter of the DuMont system of television. The sweep voltages, generated at the transmitter only, are conveyed to the receiver by modulating a sub-carrier, which in turn modulates the audio carrier at a super-audible frequency

W. S. Barden of the RCA License Laboratories discussed the requirements of detectors for video service. Remarking that the wide band-pass and non-symmetrical character of the modulated carrier make video detection quite different from audio detection, Mr. Barden proceeded to analyze the effects of various load circuits. In the simple circuit, the load is a resistor of not more than 5000 ohms, usually less than 2000 ohms, shunted by the capacity of the wiring and the cathode-to-ground capacity of the diode. Another load circuit of improved performance is that of the low-pass filter shown in the figure. This filter, employing sections which resonate at about 4 Mc, contains two points from which the demodulated signal may be obtained one for the video amplifier and one for the synchronizing-signal separation circuit. The capacity loading of these two circuits is thereby distributed in the filter in such a way that the high frequency response is not impaired.

A description of the two new mobile television units recently put in test service by the NBC was given by H. P. See, John Evans and C. H. Vose. These trucks contain two complete camera chains or picture channels (only one completely installed at present) and a transmitter operating at 177 Mc with a power of about 1.5 kw. A demountable directional antenna having a power gain of about 8 is mounted on the roof of

the transmitter truck. Power for the equipment is obtained from local supply lines at the scene of the pick-up. Inside the video truck are the video monitor kinescopes and oscilloscopes for the two camera chains, so arranged that operators sitting on a bench can observe the quality of the pick-up. The cameras employed are focussed by mirror, rather than by a separate viewing lens, as is used in the studio cameras. A recent test of the equipment at a distance of some 26 miles from the receiver in the Empire State Building gave an acceptable picture, although interferred with by diathermy equipment and other unidentified interference. One out-door pick-up attempted at night was successful in showing up objects under the glare of automobile headlights alone.

What was undoubtedly one of the most stimulating papers was that by Harold Wheeler on wideband amplifiers for television use. Mr. Wheeler showed that interstage coupling systems must veer away from the simpler transformers into the many forms of networks which have been so useful in telephone practice but which have not, as yet, caught the serious attention of many radio engineers. Mr. Wheeler showed fundamental types of circuits in which the input and output capacities of tubes were employed as useful reactances of the coupling networks; and on the basis of these capacities showed that the new high mutual conductance tube, the 1851, was capable of passing a band twice as wide as the 954.

Arthur L. Samuel, awarded the Institute's prize for the best paper published in the *Proceedings* during 1938

J. R. Nelson, of Raytheon, brought up the fact that complex tubes like the converters may exhibit strange actions at unexpected times. The two signal grids make it distinctly possible for the tube to oscillate in one circuit because of the negative resistance of one of the grid circuits. Values of input reactance, oscillating frequencies, etc. were given. The paper was discussed by J. B. Thompson and H. F. Mayer.

A forward-looking paper, although carrying on work begun at the Hazeltine laboratories several years ago, was that delivered by J. F. Farrington. This covered the design of a radio receiver in which the selectivity is controlled automatically in accordance with the strength of incoming signals. The selectivity is controlled in the adjustable band of the i-f amplifier. Each selector contains a pair of resonant circuits tuned to the i.f. These are coupled by vacuum tubes: the i-f amplifier that operates in the direction of travel of the signal and the bandwidth control tube that feeds back energy from the output tuned circuit to the input. The coupling between the circuits effective in determining the bandwidth is proportional to the mean transconductance of the two tubes. By controlling the transconductance, therefore, the bandwidth is controlled.

High Frequency Beam Tube

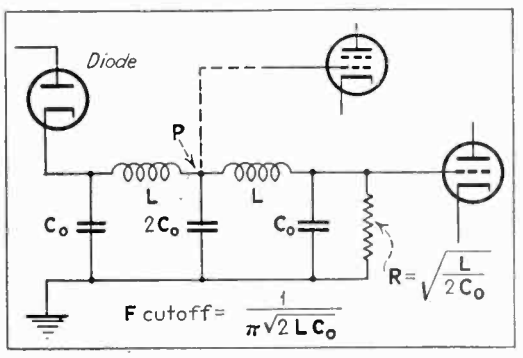
A tube delivering 11 watts at an efficiency of 30 per cent at 240 Mc was demonstrated and described by A. K. Wing of RCA, Harrison. The tube discussed is to be designated as the RCA-832. Two units are contained in a single envelope with the screens and cathodes interconnected. The connection between screens serves as one electrode of a by-pass condenser, the other electrode of which is connected to the cathode. The tube is arranged to allow use of either lumped or transmission line circuits. The demonstration amplifier set-up exhibited used the tube with parallel line circuits. The amplifier was driven by a push-pull oscillator using two 955 acorn tubes.

P. J. Kibler of Washington Institute of Technology described equipment used for "blind-landing". In the transmitter developed by W.I.T. crystal control is established at 4579.2 kc, and thereafter tripled once and doubled three times to a final frequency of 109.9 Mc; the power output at the final amplifier is 400 watts. The entire transmitter is mounted in a trailer which can be moved about the airport according to changes in the wind direction. A description of this trailer was given by G. L. Davies and F. G. Kear and G. H. Wintermute of the same company.

The use of mobile signal-strength measuring equipment of new design was described by W. A. Fitch of NBC. In the new cars, two signal-strength sets are installed, either of which may be used with loop or vertical antenna. A speedometer, which reads to hundredths of a mile, has been connected to an automatic signal strength recorder, so that automatic records of signal strength vs. distance may be made. Examples of such records made on the Jericho Turnpike on Long Island reveal the effect of bridges, and wires running parallel to the road, giving evidence that such obstructions must be carefully avoided if the "free-space" curve of signal strength is to be obtained.

Advances in the technique of disc recording were revealed by H. J. Hasbrouck of RCA in two papers. The system described is intended for immediate playback, and its performance in frequency response and volume range represents great improvements over previous efforts. A convincing demonstration was given to the audience in two records made from broadcast-studio lines. The good high frequency response and freedom from surface noise were readily apparent. The low surface noise characteristic was obtained by recording with a rising frequency characteristic and reproducing with a corresponding falling characteristic.

(*Continued on page* 33)



Load circuit for a video detector, providing two sources of voltage for picture control and synchronization, described by W. S. Barden

A Laboratory Television Receiver

By DONALD G. FINK
Managing Editor, Electronics

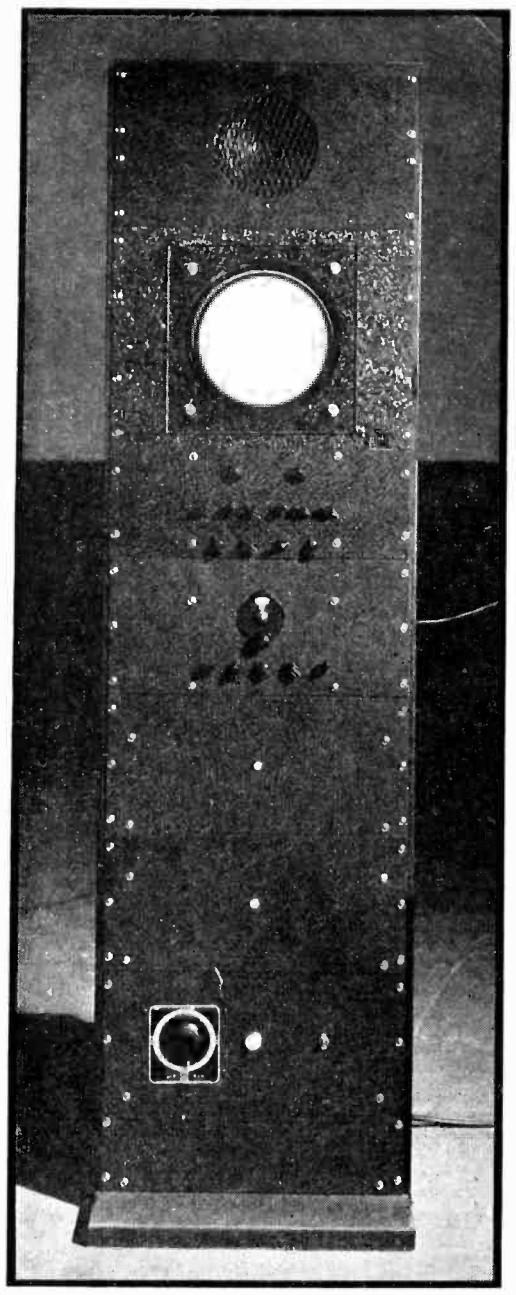


Fig. 1—Front view of receiver in present state of development

IN October, 1937, the editors of *Electronics* began the construction of a television receiver. Two purposes were in mind: first to accumulate information, at first hand, on present television practice, and second to produce a design which would be of interest, and possibly of direct use, to the readers of *Electronics*. The latter purpose could best be served by a design as flexible and as comprehensive as possible, consistent with reasonable cost. Accordingly it was decided to produce a receiver which could serve as a piece of laboratory equipment, designed with the needs of the practicing radio engineer in mind, and intended for such purposes as development work in the laboratories of radio set manufacturing plants. With such a comprehensive design available, it is simple to make the compromises desirable in constructing a receiver for domestic or amateur use.

In undertaking the project, several decisions had to be made at once, particularly in regard to the total expenditure, the types of test equipment needed, the size and type of cathode ray tube, and the general form of construction to be employed. A preliminary investigation showed that the receiver could be built, using a 9-inch cathode ray tube at maximum recommended ratings, at a cost of less than $500. The test equipment used in this development includes, in addition to miscellaneous meters and a standard test analyzer, the following major items: One model 605-B General Radio standard signal generator, having a maximum carrier frequency of 50 megacycles; one model 168 DuMont five-inch cathode ray oscilloscope; one model TMV-52-E RCA beat frequency oscillator having a range from 20 to 17,000 cycles, sine-wave output. The equipment is admittedly the minimum required for the purpose, but it was selected as being representative of equipment available to the average engineer. Rack-and-panel construction was adopted for the receiver as convenient and flexible.

The project has been carried out, and is still under way, in *Electronics'* laboratory on the 35th floor of the McGraw-Hill Building on 42nd St., New York City. The location of the building is particularly fortunate with respect to the RCA-NBC television transmitter in the Empire State Building, and the CBS transmitter now being installed in the Chrysler Building. Preliminary meas-

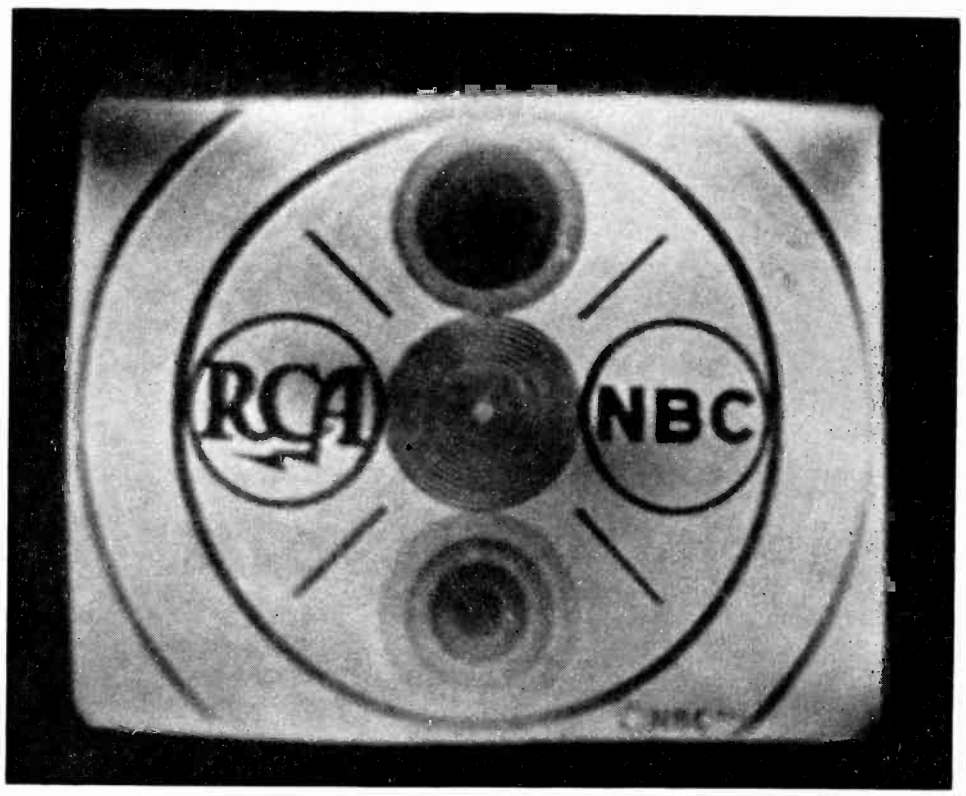


Fig. 2—Close-up of RCA-NBC test pattern, photographed directly from screen of receiver during recent tests. Work on the amplifier circuits is now in progress to improve the detail of the image

The first of a series of articles describing a vision receiver designed and constructed in *Electronics'* laboratory, intended to serve as a flexible and comprehensive piece of laboratory equipment. Details of power supply are treated in this first installment

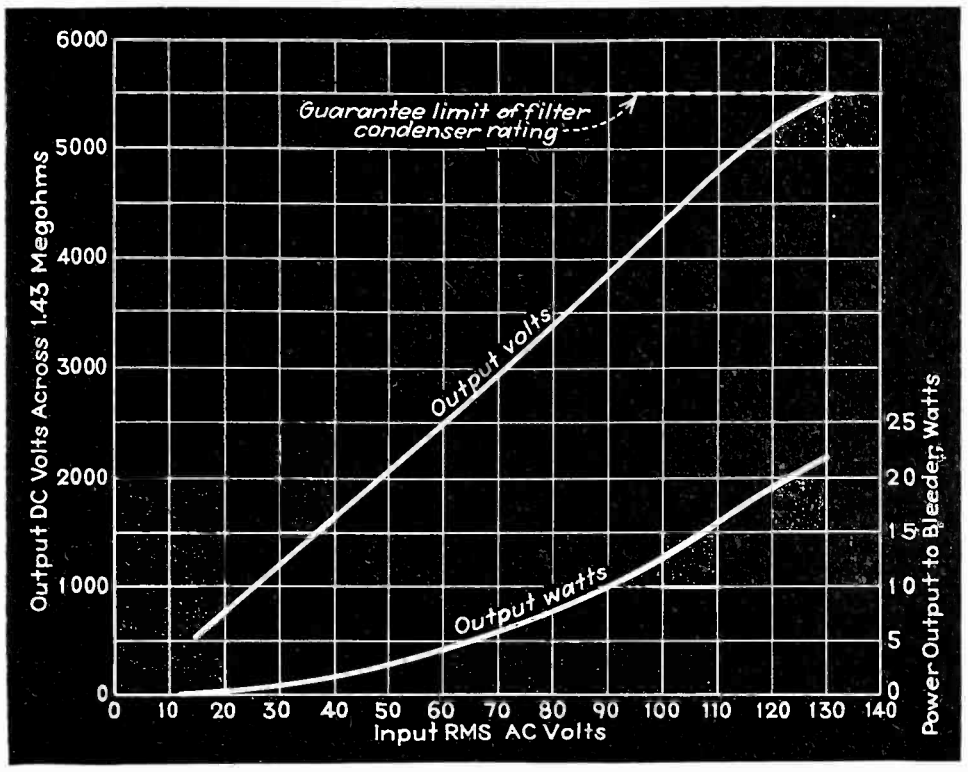


Fig. 3—Voltage and power output curves of high voltage power supply

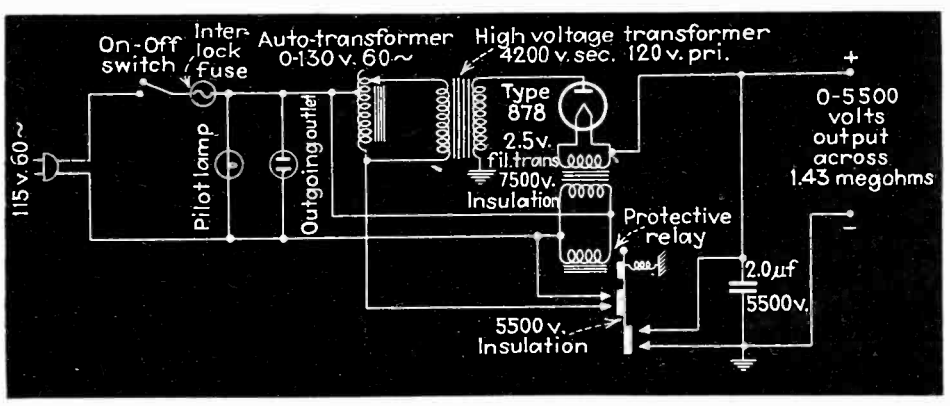


Fig. 4—Connection diagram of high voltage power supply and interlock circuit

urements indicate that an r-f signal of about 0.2 volts is available directly from the lead-in of the antenna, from the Empire State transmissions. This strong signal has proved of great value in the development program, but it has been discounted in all design work, with the thought in mind that the reader may not be so fortunately situated. The design to be described is suitable for operation in any location not limited by adverse signal-to-noise ratio.

Although the project is not yet completed, the results (see front cover of this issue) are sufficiently concrete to warrant publication of the details of those parts of the apparatus now in finished form. Accordingly the following series of articles has been laid out for publication in this and succeeding issues of *Electronics*.

Part I: Introduction. Design and construction of high-voltage and low voltage power supplies. Methods of testing.

Part II: Cathode-ray tube mount. Bleeder circuits; brightness and focus controls. Horizontal scanning current generator. Scanning yoke.

Part III: Vertical scanning current generator. Synchronization-from-video separator circuit. Vertical-from-horizontal sync separator circuit. Sync circuit performance and control. Use of beat oscillator in preliminary testing of sync circuits.

Part IV: R-f and i-f portions of the video and sound receivers.

Part V: Detector, video, and audio portions of the receivers. Contrast control. Automatic circuit functions.

Part VI: Defects in the image, and improper performance of circuits. Use of test equipment in trouble-shooting and routine testing.

A front view of the receiver, in its present form, is shown in Fig. 1. The panels, reading from the bottom up, accommodate the following apparatus: Bottom panel, 0-to-5500 volt power supply, interlock and protective relay. Second panel, 350-volt, 250-ma. power supply for video and sound receivers. Third panel, 300 volt, 50 ma. power supply for vertical scanning generator, and 300-volt, 150 ma. power supply for horizontal scanning generator. Fourth panel, video and sound receivers. The controls are, left to right, horizontal sync amplitude, vertical sync amplitude, contrast, audio volume, audio tone. Above, tuning control. Fifth panel, bleeder and sync generator circuits. The controls in the bottom row are horizontal scanning generator controls, left to right: frequency (fine), frequency (coarse), amplitude, centering. In the middle row the controls are vertical scanning generator controls: frequency (fine), frequency (coarse), amplitude, peaking, distribution, and centering. Top row, brilliance and focus. The sixth panel accommodates the cathode ray screen, protected by shatterproof glass plate, while the seventh houses the loudspeaker.

Every attempt has been made to keep the design flexible. Exclusive of the on-off switch, no fewer than 19 controls have been brought out to the front panel. Separate power

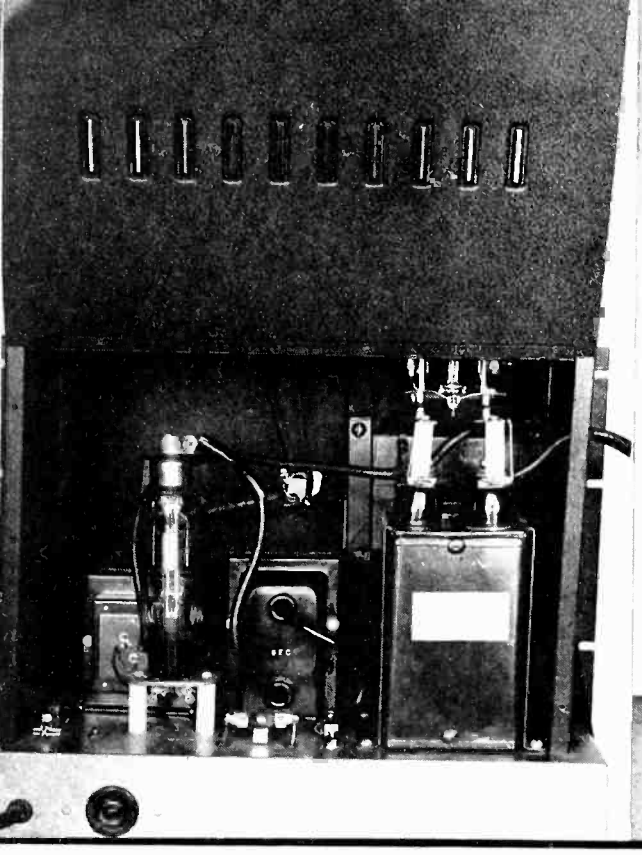


Fig. 5—Interior view of high voltage power supply assembly. Total cost $57.60 at usual trade discounts

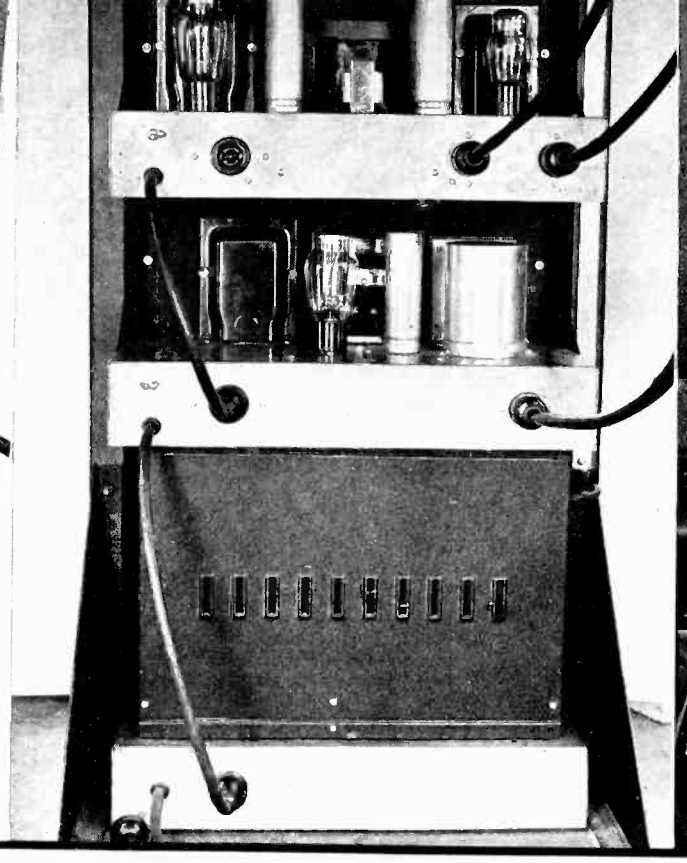


Fig. 6—Rear view of the complete power supply section of receiver, showing method of connecting 110-volt line to each unit

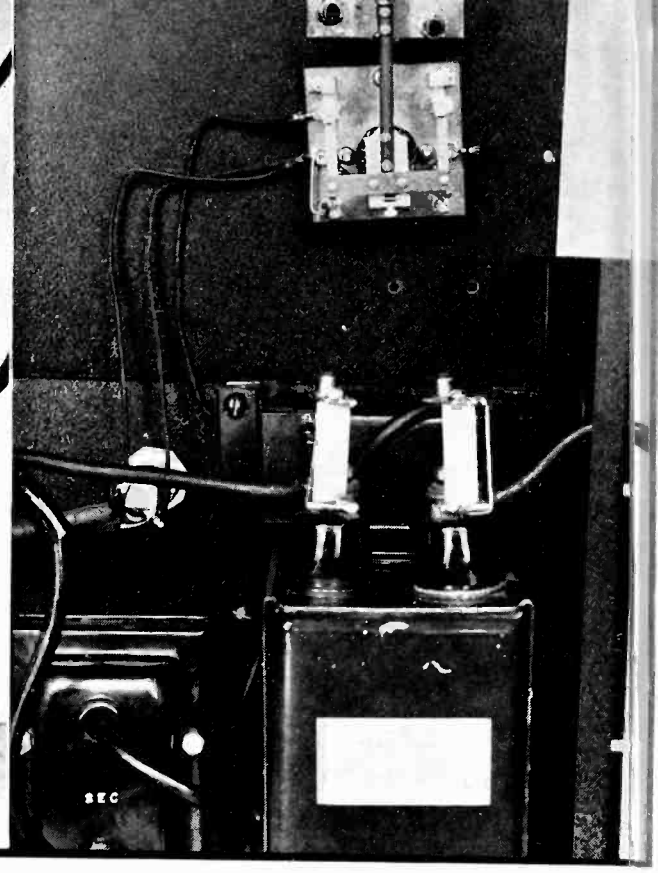


Fig. 7—Detailed view of discharge relay assembly, shown with top of housing thrown back

supplies have been provided for every section of the receiver, to guarantee a minimum of interaction between scanning circuits and receiver. The arrangement in panels is such that the receiver, for example, may be removed and one of new design inserted without disarranging the rest of the equipment. It is clear that many compromises may be made with the layout without adversely affecting performance. These compromises will be stated in the description of each section of the receiver.

Construction Details of the High Voltage Power Supply

The voltage and power limits of the high voltage power supply are shown in Fig. 3. The maximum voltage, 5500 volts, is a compromise between the maximum recommended rating of the cathode-ray tube and that of the filter capacitor employed. The cathode-ray tube, an RCA type 1800 9-inch kinescope, has a maximum recommended second anode voltage rating of 6000 volts. On the other hand, the cost of the filter capacitor increases greatly when its rating is above 5000 volts, nearly doubling in fact between 5000 and 6000 volts. By employing a capacitor of 5000 volts rating (guarantee limit at 5500 volts), a satisfactory compromise was effected.

The interior of the high voltage power supply is shown in Fig. 5. The total cost of the unit, at customary trade discounts, is $57.60. Shown in the figure are the 878 rectifier tube, three transformers, the filter capacitor and the discharge relay. Two of the transformers, the 2.5 volt, 5 amp. filament transformer (left) and the 4200-volt, 10 ma. high voltage transformer (center) are mounted directly on the chassis base. The latter transformer was built to our specifications by the Acme Electric and Manufacturing Company. At the right is the filter capacitor, a 5000-volt, 2 μf, G.E. pyranol-filled unit, with a 5500 volt maximum rating. Behind the condenser is the autotransformer, which is connected as shown in Fig. 4 in the primary circuit of the high voltage transformer. The autotransformer gives a continuous control of the d-c voltage output from less than 100 volts to 5500 volts. While not a strict necessity, this variable output control is a great convenience in experimental work, and fits the power supply for use with other cathode-ray tubes whose recommended maximum ratings are less than 5000 volts.

The high voltage wiring throughout the unit is neon-sign cable insulated for 10,000 volts and costs about 3 cents per foot. The negative terminal of the output is grounded solidly to the chassis. This brings the cathode of the rectifier 5500 volts above ground, consequently the socket is supported on 1½-inch steatite stand-off insulators. The filament transformer secondary is insulated for 7500 volts. The grounded-negative system is employed because it permits the use of a low-voltage coupling capacitor between the video amplifier output and the grid of the cathode-ray tube, which is near ground potential when the negative of the power supply is grounded.

The cost of the unit may be decreased by omitting the autotransformer and by employing an 879 rectifier tube in place of the 878. The 879 costs about one quarter as much, and although its maximum r-m-s voltage rating is 2650 volts, as against the 4200 volts applied, at low current output it may serve without too great loss in life. It is possible also to employ a tuned filter, using two 0.03 μf capacitors and a 1500 henry choke. Such components, suitable for 6000 volt operation are available on the market, but their combined cost just about equals the cost of the 5000-volt, 2 μf capacitor. The tuned filter has the disadvantage that the hum-free output current is limited to about 1.0 ma. whereas the 2 μf condenser will supply 5.0 ma. without objectionable ripple voltage. Only 1.0 ma. is required in the television receiver but the extra current capacity makes the power supply useful for other applications.

In connecting the high voltage

transformer, care should be taken to ground the end of the secondary coil which is wound closest to the core of the transformer. This places the other terminal at high potential, and makes use of the full insulation in the winding. Otherwise, (if the terminal nearest the core is not grounded, i.e. is at high potential), the insulation will fail in short order. This occurred twice in our experience before the trouble was detected. Corona is not ordinarily troublesome at these voltages, but may occur if the above procedure is not followed. Corona in other parts of the circuit is avoided by the conventional procedure of avoiding sharp bends in the high potential leads, and by smoothing off all sharp projections in the terminals.

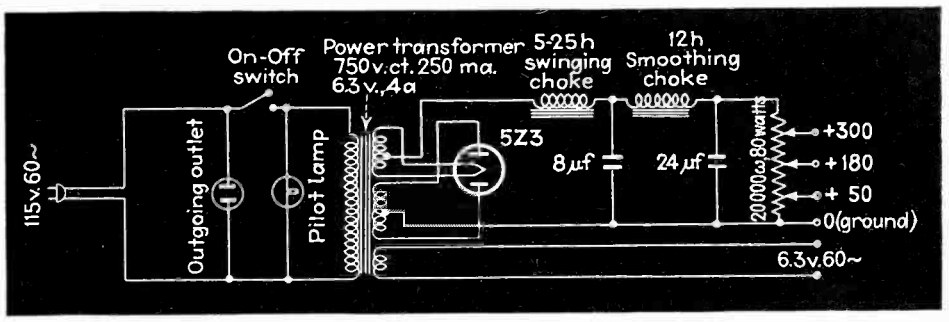


Fig. 8—Connection diagram of low voltage power supply for audio-video receiver, designed with other laboratory uses in mind

In developing the power supply, much work was done with high voltage transformers of the "neon sign" variety. These have the virtue of cheapness, a suitable transformer being available for about $2.65, but their regulation leaves much to be desired. By employing an over-sized unit and running it somewhat under rated capacity, satisfactory performance can be obtained. A unit rated at 6000 r-m-s volts, 18 ma., has been employed with great success, *provided* that the secondary terminal nearest the core is grounded. If such an oversized transformer is employed it is not necessary to remove the magnetic shunt employed as a current limitation device in neon-type transformers.

Protective Devices and Interlock Circuit

It is recommended that no compromises be made in protecting the high voltage supply. If the 5500-volt output of the 2 μf capacitor comes in contact with the body of the operator, the discharge current can reach a lethal value before the capacitor is discharged. The precautions taken in the construction of the supply include (1) completely inclosing the supply in a grounded metal cabinet, (2) placing an interlock on the hinged cover of this cabinet, (3) providing a high voltage discharge relay over the terminals of the condenser, and (4) completely enclosing the positive high voltage lead from the terminal of the filter condenser to the second anode terminal of the cathode-ray tube in insulation adequate both from the electrical and mechanical points of view.

The interlock adopted is simple and direct. As shown in Fig. 5, a tubular fuse is mounted on, but insulated from, the inside of the hinged cover. When the cover is closed, this fuse engages a fuse mount, which is mounted directly on the chassis base. The terminals of the fuse mount are connected directly in the 110-volt, 60-cycle line, in series with the on-off switch. When the cover is opened, therefore, the power is automatically removed from the circuit, including the hold-in coil of the discharge relay described below. When the cover is closed, the spring action of the fuse mount acts to keep the cover closed. In addition holes are drilled and tapped for screws which hold the cover closed. The fuse acts as an overload protection during the operation of the supply, in addition to its interlock function.

The mechanical layout of the discharge relay is shown in detail in Fig. 7, and its connection in the circuit in Fig. 4. The relay is a conventional 110-volt 60-cycle relay having one pair of contacts which make when the armature pulls up. The armature itself was drilled and countersunk to take two small screws. These screws in turn support a hollow fiber rod, about 2 inches long, on the end of which is fastened a spring strip of phosphor bronze. Soldered on the ends of the bronze strip are two large eyelets, into which are fitted ¼-inch carbon plugs taken from the carbon electrode of a flashlight battery. The carbon is held in the eyelets by a pinch fit. The relay is mounted on the top of the metal cabinet and positioned so that the carbon plugs lie directly over the terminals of the high voltage capacitor.

On the capacitor terminals are mounted stand-off insulators, which support brass strips. On the strips are soldered two eyelets which contain carbon plugs similar to those mounted on the relay. These plugs are positioned so that they make direct contact with the plugs on the relay, when the relay coil is not energised. The relay motion is such that when the coil is energised the upper carbon contacts move vertically about ⅜ inch above the plugs on the stand-off insulators. This gives sufficient spacing to avoid arcing when the condenser is operating normally at 5500 volts.

The electrical connections of the relay (Fig. 4) are such that the coil is energised when the off-switch is closed, and when the interlock fuse is engaged in its holder. When so energised, the relay pulls up, opens the carbon contacts which short-circuit the condenser and closes the auxiliary contacts which are in series with the primary of the autotransformer. As a result the high voltage transformer is energised, but it cannot be energised unless the short-circuit is removed from the condenser by the lifting of the relay armature. When the on-off switch is opened, or if the hinged cover is opened, the relay coil is de-energised, the armature falls, power is removed from the high voltage transformer, and the filter capacitor is discharged. The relay armature falls by gravity, hence is positive in action.

The stand-off insulators on the capacitor were originally installed to permit mounting discharge resistors in series with the discharge path. These resistors reduce the arcing, and its attendant noise, but they introduce an additional element of uncertainty (since they may burn out and leave the discharge circuit open) and hence were omitted in the final layout. The discharge on direct short circuit is noisy but it gives audible

evidence of the fact that the condenser has been discharged. It is important to adjust the tension of the phosphor-bronze spring so that the carbon contacts seat definitely and permanently when the relay is de-energised. This prevents any secondary accumulation of charge which might otherwise occur after the initial discharge.

The experience with the discharge relay has been highly satisfactory. The carbon contacts seem to stand up well, after several hundred operations, but in any event are easily replaceable. One way of protecting the contacts is to reduce the auto-transformer control to zero, and to allow the condenser to discharge through the bleeder resistor before turning the receiver off. The relay is always ready to act in case the above procedure is forgotten, or in case one attempts to open the housing before turning off the receiver.

Methods of Measuring the High Voltage Output

Since the measurement of high voltage may be an experience foreign to many of our readers, the following outline is given of the method used in measuring the voltage output. A d-c voltmeter of 1000 volts maximum scale, was connected directly across the output of the supply, with the autotransformer control set at zero. The voltmeter terminals in turn fed a bleeder resistor of 1.43 megohms (made up of 14 100,000 ohm units mounted on a laminated strip and connected in series). In series with the bleeder was a 0-5 ma. meter. The autotransformer control was then advanced slowly until the voltmeter read 1000 volts, and the bleeder current reading was recorded. Thereafter the voltmeter was removed, the autotransformer control advanced in several steps to full output, and the bleeder current recorded. The output voltage at any bleeder current is equal to the bleeder current at that setting, multiplied by the resistance of the bleeder. The latter value, 1.43 megohms in our case, was measured by the corresponding values of current and voltage at 1000 volts. The desirability of measuring the resistance at 1000 volts lies in the fact that the carbon resistors used have a voltage coefficient, which is thereby taken into account in some degree. The maximum voltage output depends, of course, on the value of the bleeder resistance, which was accordingly chosen at the value actually used in the receiver. In making the measurements it is important to remove the voltmeter, except during the resistance measurement, since the current drain of the voltmeter has an appreciable affect on the output voltage. Also in measuring the resistance value the ammeter used should measure bleeder current only, not the sum of bleeder current and voltmeter current.

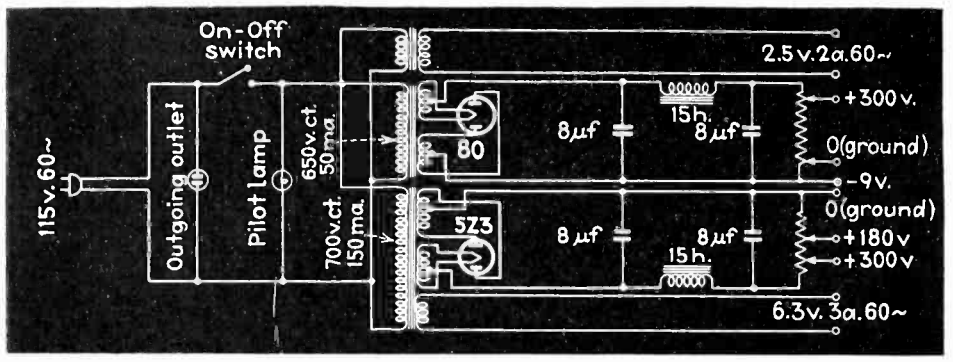


Fig. 9—Connection diagram of power supplies for vertical and horizontal scanning generators. The outputs are entirely independent electrically, making for flexibility and ease of control

Low Voltage Power Supplies

Three separate low voltage power supplies, one for the audio-video receiver and two for the scanning current generators, are provided. They employ conventional components in every respect. The only questions to be answered are the voltage and current requirements, and the type of filtering. For the receiver, employing a total of 16 tubes at an average current drain of about 15 ma. per tube, about 250 ma, at 350 volts is required. The filtering should be adequate to avoid appreciable ripple components. Regulation is not important, since all tube operation throughout is Class A. In our work, the design was made purposely more than adequate for the purpose, with the idea of making the power supply useful for other purposes in the laboratory. Accordingly the filter as shown in Fig. 8, employs a total capacitance of 32 μf and two chokes, for swinging and smoothing action. The transformer employed has good regulation, and the entire supply is suitable for Class B operation. The cost of this unit is $15.88.

The two power supplies for the scanning current generators are mounted in one panel, and are entirely separate electrically. The filter in each case is a single pi-section. The bleeders are 20,000 ohms, that in the heavy current unit being rated at 80 watts. The 2.5-volt, 5 amp. transformer for the cathode ray tube heater is mounted in this supply panel. Figure 9 shows the complete wiring diagram for this unit, including the low voltage taps required for the scanning generator circuits. The total cost of the panel containing these two power supplies and heater transformer is $19.41. The total cost of all the power supply facilities described is just under 93 dollars.

No great harm is done in consolidating the two scanning generator supplies in one unit, of about 200 ma. maximum rating. But the additional cost of providing a separate supply for the vertical scanning generator is less than $5.00 and it allows the frequency of the vertical generator to be varied entirely independently of the frequency of the horizontal generator without elaborate decoupling filters. The use of one power supply for all low voltage purposes (receiver and two scanning generators) is precluded by the heavy current drain, about 450 ma, which cannot be supplied by low-priced transformers now on the market.

Figure 6 shows the rear view of the three power supplies. Each chassis contains an outlet into which is plugged a short connecting cord from the rack above. The on-off switch in the high voltage unit controls all three power supplies, but each of the upper units may be turned off individually by the switches at the rear of the chassis. Output leads from the low-voltage units are connected through wafer sockets and plugs. The 5500-volt lead, made of neon-sign cable, runs up through the inside of the channel of the supporting rack, to the cathode ray tube.

An Electronic Device for Measuring Magnetic Fields

By ALBERT ROSE

Research and Engineering Dept. RCA Manufacturing Co., Inc., Harrison, N. J.

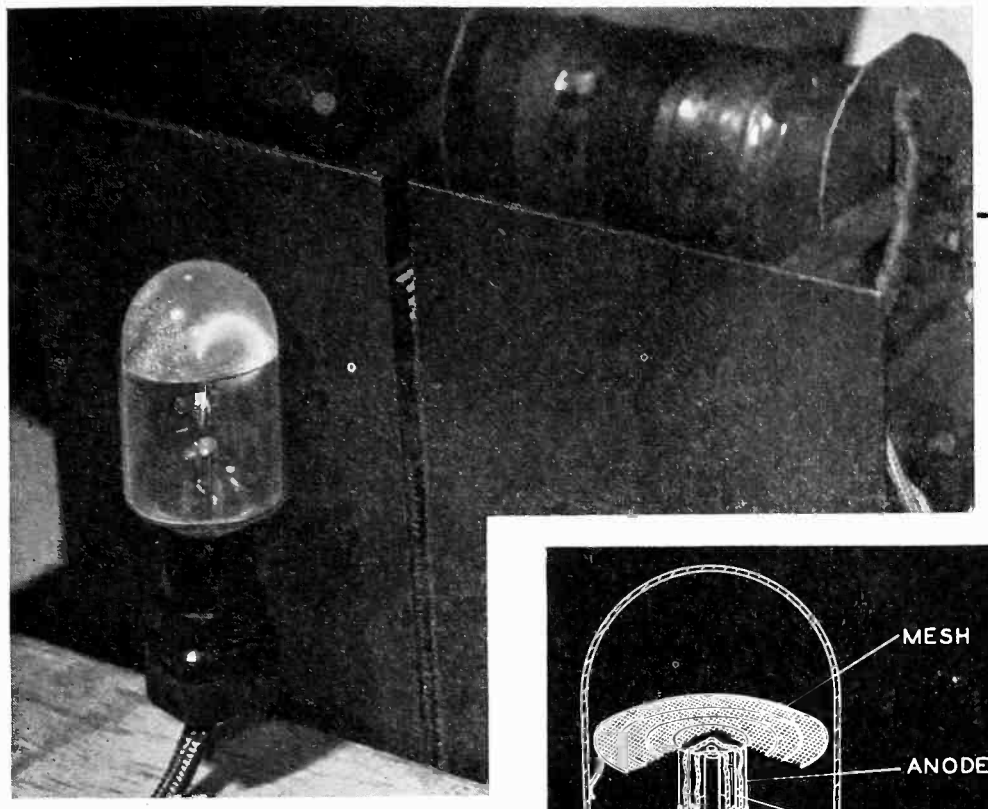


Fig. 1—Magnetic-field measuring tube in operation

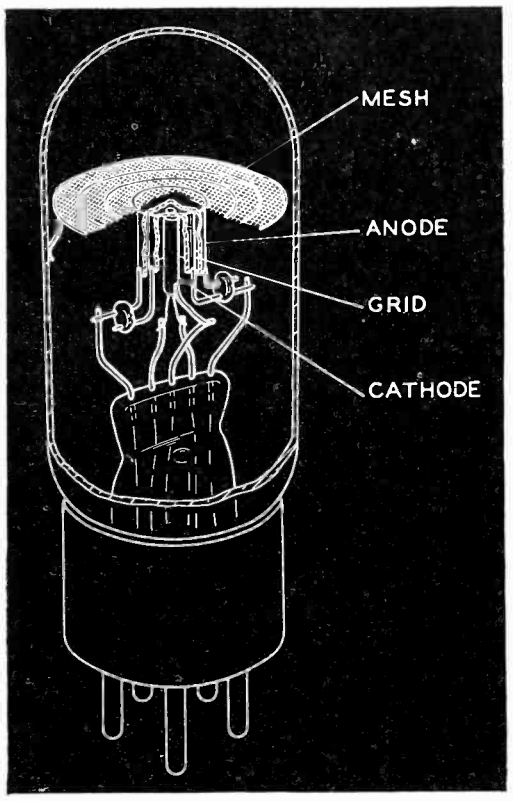


Fig. 2—Diagram showing tube structure

IN the course of work involving magnetic fields not easily calculable, the problem arose of examining the magnitude, direction, and variation of these fields over large spaces. Also, since a number of arrangements of pole faces was to be tried, it was desirable to have a quick, convenient method of exploration. None of the methods of measuring magnetic fields known to the writer seemed to satisfy the requirements of the problem—the exploration of large spaces quickly. A special cathode-ray tube was designed, therefore, which proved to be satisfactory not only for this problem but for other problems where a quick estimate of the distribution of magnetic fields was desired. The following brief description of the tube in its present developmental form may accordingly be of interest to others concerned with the measurement of magnetic fields.

Present methods of measuring magnetic fields suffer from one or more of the following limitations:

1. To get the total field or direction of field at any point a series of discrete observations must be made from which the maximum reading is selected. (Search coil)

2. To get the variation of field throughout a region of space, a large number of separate point-to-point readings must be taken and the results plotted in order to visualize the composite picture. (Search coil)

3. Relatively complex circuits and calibration curves are required. (Hall effect)

4. The method of applying alternating current to the magnet coils and observing the voltage in a small pick-up coil is limited to iron-free circuits.

The device shown in operation in Fig. 1 was designed to avoid the above limitations and particularly to give a direct visual impression of the distribution of magnetic field in a region of space. It makes use of the simple law of motion of electrons in a magnetic field: namely, an electron having a velocity of V volts in a magnetic field of H gausses will describe a circle of d cms. diameter according to the relation:

$$H = 6.74 \frac{V^{\frac{1}{2}}}{d}$$

Half of such a circle is shown in Fig. 1 and was obtained by shooting an electron beam into an electric-field-free space above the mesh anode. The electron gun is mounted just under the center of the mesh. The magnetic field was supplied by the horse-shoe magnet behind the tube. The beam is made visible by the presence of several microns of argon in the tube. The gas serves, in addition, two other functions. First, according to the phenomenon of gas focusing, the beam is kept in constant fine focus throughout its length. Second, the presence of gas ions prevents charges from forming on the glass bulb and, thereby, insures an electric-field-free space above the screen at anode potential. Figure 3 shows an enlarged view of the tube in operation. For photographic purposes the beam cross-section is larger than need be for visual observation. A more detailed sketch of the tube is shown in Fig. 2. The anode and its mesh, together with the focusing grid, are made of

(*Continued on page* 53)

Volume Indicator—Attenuator

Device built by a broadcast engineer for measurements on high-gain amplifiers and transmitters. Useful, also, to a public address engineer. Variable attenuator has a range of 75 db, level indicator measures as low as minus 40 db.

By S. G. CARTER
WSOC, Charlotte, N. C.

HAVING recently had the need for a variable attenuator network with a range of 75 db and a level indicator capable of reading values as low as minus 40 db, a combination attenuator panel and level indicator was constructed that may be of interest to those having the need for such instruments.

The attenuator and level indicator were constructed as one unit. There is no reason, however, why they might not be constructed separately.

The attenuator unit makes use of four H pads to give attenuation in steps of 5 db. The first pad gives a loss of 5, the second 10, the third 20 and the fourth 40 db. These pads are cut in or out of the circuit by means of a four pole two position rotary switch for each pad. There are, in addition, four pads to provide output impedances of 500, 250, 200 and 50 ohms. An additional switch having four poles and four positions is used to select the various pads. The loss of the output pads was made 16 db, the minimum loss for a 500/50 ohm pad. A 500 ohm output without the added 16 db loss might be selected through an additional tap on the output impedance selector switch. The maximum attenuation at all impedances shown would be 91 db, the minimum 16 db.

The level indicator makes use of a 6C5 as a class A audio amplifier, a 6C5 as phase inverter, no-gain stage, to feed the 6H6 connected as a full wave rectifier, a 6F5 as a vacuum tube voltmeter. Calibrated attenuators are provided in the input to the 6C5 first audio stage with an input transformer designed to bridge a 500 ohm line. Calibration of the finished instrument was made from a standard 500 ohm source.

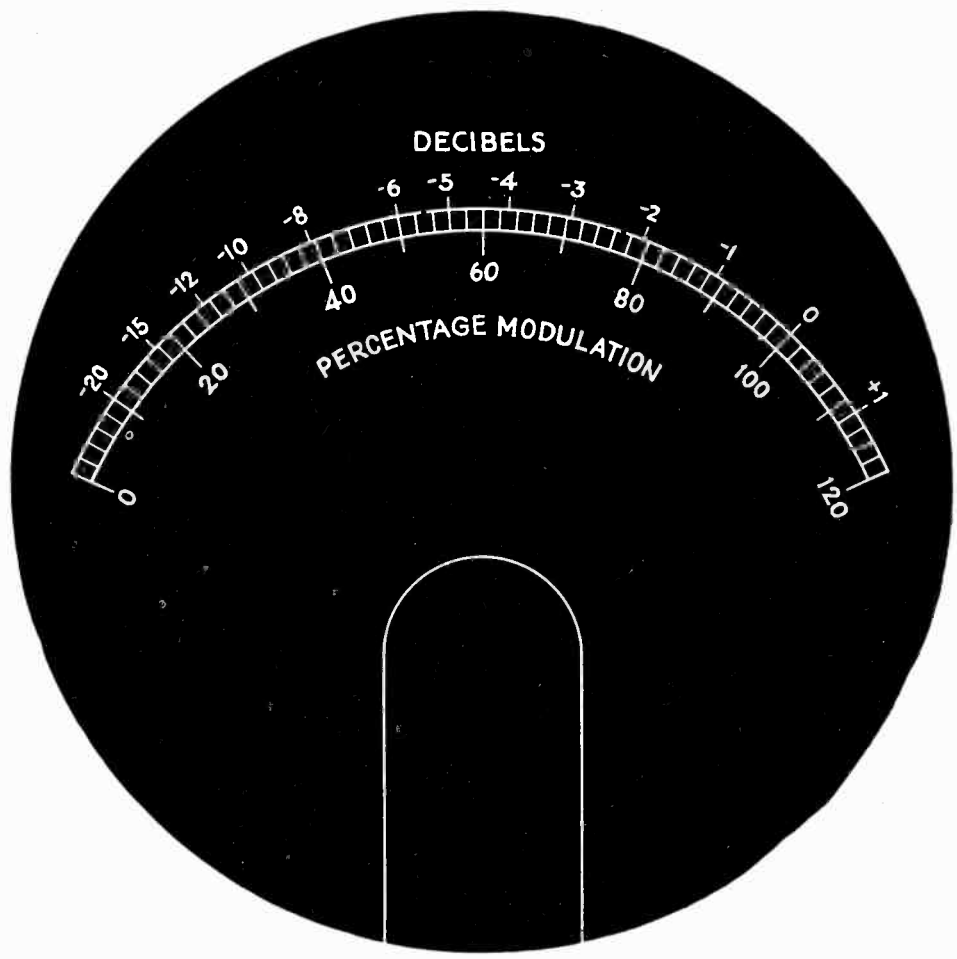


Fig. 1—Scale for volume indicator.

There are two different attenuator networks between the secondary of the input transformer and the grid of the first audio stage. The combination of the two networks gives a variation in range from minus 20 db to plus 30 db. The meter scale is calibrated from minus 20 db to plus one db, giving a total range of plus 31 db to minus 40 db.

The first section of the network is a T type pad having taps to give zero loss, 10 db loss and 30 db total loss. The input and output impedance of this pad is 250,000 ohms. The second network is a potentiometer type volume control having eleven taps. The loss is 2 db per step with no off or ground tap.

The indicating instrument is a 0-1 milliammeter. If the finished instrument is to be used for monitoring service in broadcast or public address work, the instrument chosen should have a high speed movement with a minimum of overthrow. The instrument has a special scale which allows for a comparative reading against percentage modulation when used with broadcast equipment. Special scales similar to the one shown can be obtained from the manufacturers of instruments.

The plate voltage for the entire instrument is supplied by a regulated power supply that will give

constant voltage output over a wide range of line voltage variations. Bias for the 6F5 stage is supplied by three Mallory bias cells having a voltage of approximately 3.1 volts. The potentiometer regulating the output of the power supply is adjusted to give cut-off plate current for the 6F5. This voltage will be approximately 250 volts with the bias shown.

The combination of R_{16} and C_9 in Fig. 2 is such as to give a delay on the return action of the indicator needle of the indicating instrument after a peak has passed. The time constant of this delay action depends on the value of C_9 where R_{16} is one megohm. Roughly, the time constant shown is 0.07 seconds. Faster action may be had by decreasing the size of C_9; for a slower action increase the value of the condenser. A capacity of 0.01 μf will probably be the smallest value desirable while 0.25 μf will be as slow as desirable. The time constant of 0.07 seconds will be found most suitable from a monitoring stand-point.

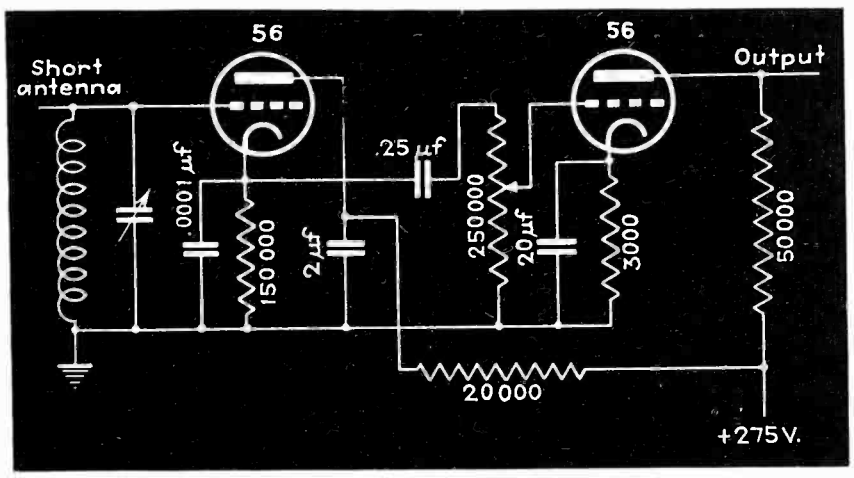


Fig. 3—Detector suitable for measuring hum, noise and harmonic output from transmitter

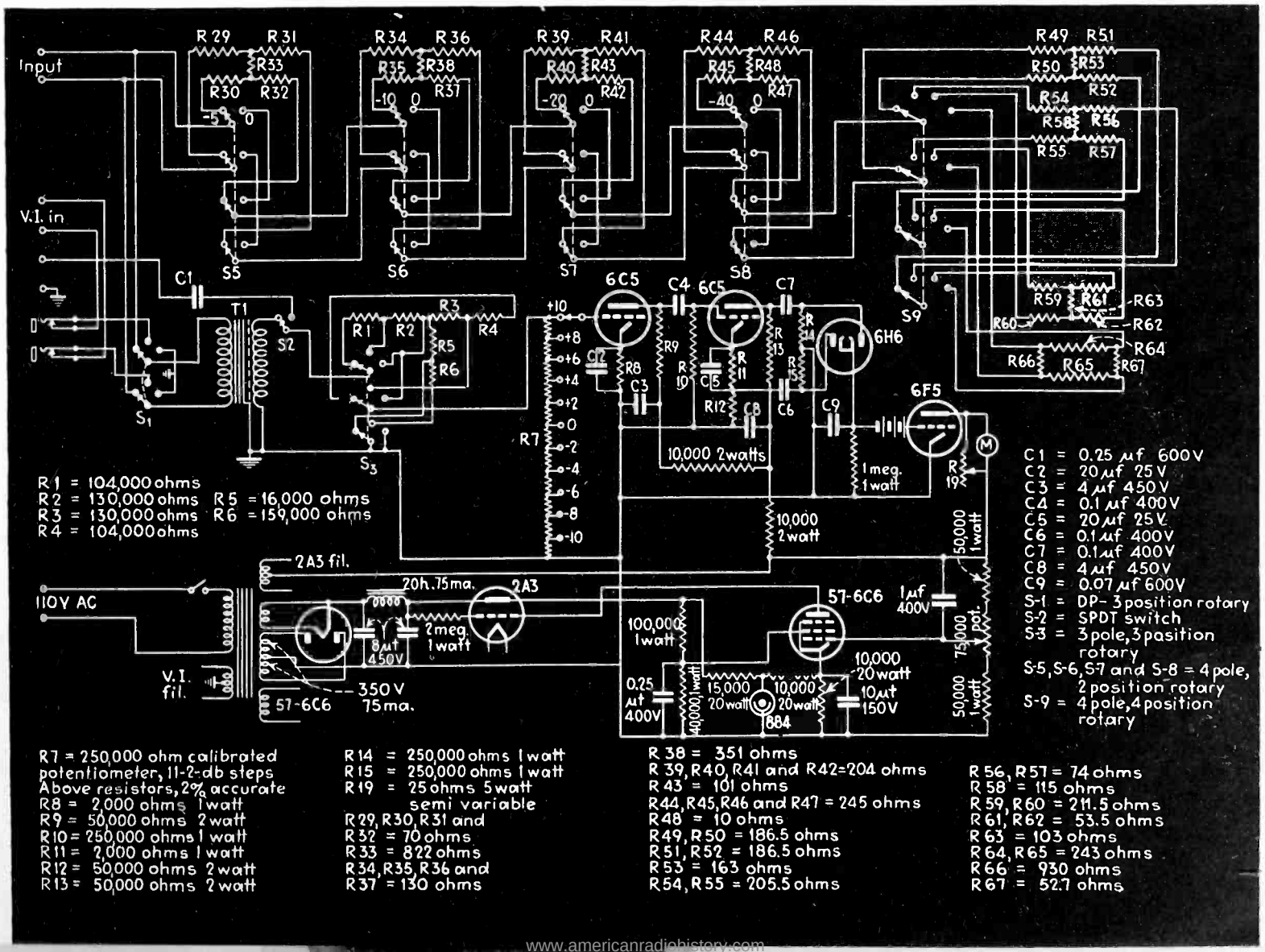
It being desirable, in the writer's case, to have both the attenuator panel and the level indicator together, they were constructed on an $8\frac{3}{8}$ x 19 inch standard rack panel. Where separate construction is desired, the level indicator will fit a panel of $5\frac{1}{4}$ inches. A $3\frac{1}{2}$ inch panel will hold the attenuator section.

Two inputs to the level indicator were provided, the regular input being through the bridging transformer and S_1. The switch provides switching between the jacks or binding post and the input to the attenuator panel.

The second input, provided through the switch S_2, gives input through the condenser C_1 from a high impedance source direct to the attenuator networks in the first 6C5 grid. This type of input is desirable where checks on amplifiers having high impedance output and from diode rectifiers are to be made.

The values of the resistors making up the various pads were figured on a slide rule. They are accurate enough for most broadcast and public address amplifier work. For pads of higher accuracy the reader is referred to a paper by McElroy in the *Proc. I. R. E.*, March, 1935, on five and six place tables of constants to be employed in designing such attenuators. The accuracy of the attenuator steps may be checked back against themselves.

Fig. 2—Complete circuit diagram of the attenuator and volume indicator



Calibration

The method used to calibrate the finished unit was as follows: with the plate current of the 6F5 adjusted to cutoff, the attenuator R_7 is adjusted to its sixth point, which should be labeled "0 db". Switch S_3 is rotated to its center position, which should be labeled "0 db". A high resistance a-c voltmeter of known accuracy or a calibrated volume indicator should be used to measure the input voltage as taken from a 500-ohm line. The shunt resistor, R_{10}, should be adjusted so that the meter indicates "0 db" for an input to T_1 of 0 db or 1.732 volts.

For line impedances other than 500 ohms the corrections to be applied are shown in table 1.

When the 0 db point is determined, the accuracy of the instrument may be checked back against its various points. With 0 db input, rotate R_7 to its eleventh point, which should be labeled plus 10 db, S_3 should be at its third point, which should be labeled minus 10 db, and the meter should again show a reading of 0 db. The switch S_3 may be adjusted to its No. 1 step, which would be labeled plus 20 db and R_7 adjusted to the first tap. The meter reading should indicate minus 10 db. The 2 db steps of R_7 may be checked against the meter scale to check their accuracy.

The accuracy of the steps of R_7 will depend on the unit used. Reasonably priced units of fair accuracy are available and one was used by the writer. Such units are manufactured by General Radio, Daven and Tech-Labs, and no doubt are available from several other manufacturers.

The attenuator may be home-built. The formula for determining the values of the resistors is:

$db = 20 \log (R_2/R_1)$

where $R_2 = R_1 - 250{,}000$ ohms.

Drop 2 db per step; then $2 \text{ db}/20 = \log (250{,}000/R_1)$.

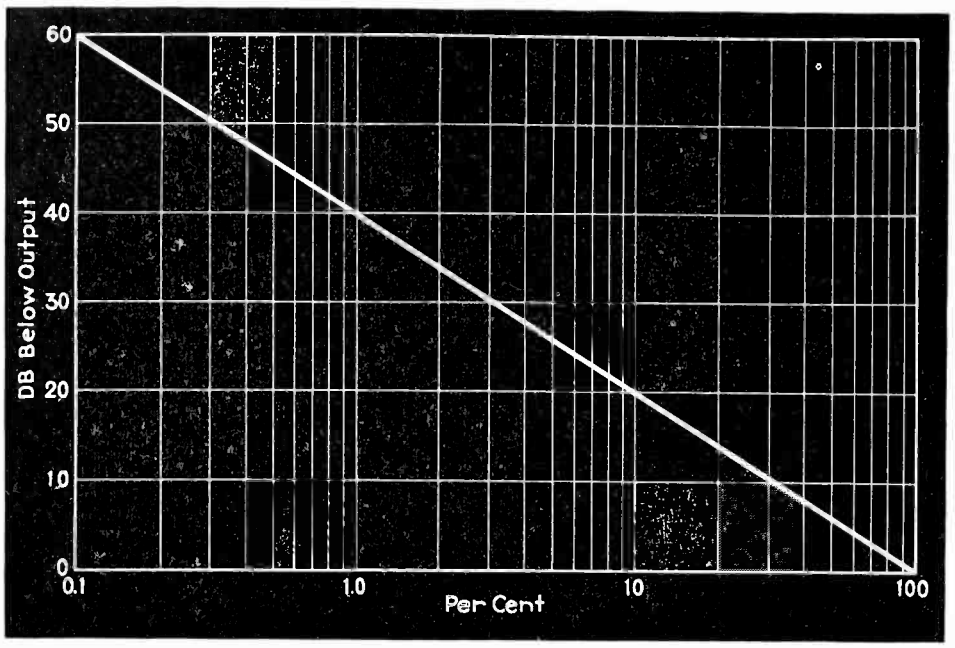


Fig. 4—Curve to determine percentage noise, hum or harmonic content. For power levels divide by 2. Voltage or current ratios read direct

The input transformer should be a high grade unit, preferably one with a triple alloy shield plus a static shield between primary and secondary. Such units may be obtained from Kenyon, Ferranti, Amertran or United Transformer. The overall frequency response of the completed level indicator will depend largely on the response of the input transformer. One with a response flat between the limits of 30 and 15,000 cycles should be chosen.

Practical Uses of the Instrument

The device has proven valuable for making frequency runs on high gain amplifiers and pre-amplifiers, for checking the overall gain of amplifiers, to check the overall response of transmitters and for checking the noise and hum level below 100 per cent modulation. The noise and hum level of amplifiers may also be checked as values below maximum output as well as the actual values in db, where those voltages are as large as minus 40 db.

The procedure in checking a transmitter has been to connect its high impedance input connection to the output of the detector and audio stage such as that shown in Fig. 3. With the transmitter modulated 100 per cent, some convenient reading is made on the level indicator, using the gain control of the amplifier of Fig. 3 to adjust the input to a proper level. Then with the modulation removed, the noise and hum level of the transmitter is measured. The difference between the level indicator reading at 100 per cent modulation and that obtained without modulation is the noise level below 100 per cent modulation. The curve shown in Fig. 4 converts db into percentage.

The attenuator network of the attenuator panel provides a means of obtaining the very low values of input desirable for making measurements on high gain amplifiers, as well as providing a means of matching the common output impedance of 500 ohms used on most beat note oscillators to the various input impedances commonly used in amplifier work.

The process used in making overall gain measurements of amplifiers has been to use an output from the beat oscillator that gives some convenient reading on the level indidator. Any desired loss can be obtained through the various pads, the amplifier input level then being the algebraic sum of the pad switches and the value of the level indicator reading. The output level will be the sum of the level indicator switches and the meter reading.

Table 1. Decibel Load Conversion Chart.

Line Impedance		Corr. Fact. db	Line Impedance		Corr. Fact. db
1.0 ohms	add	26.8	50 ohms	add	10.0
1.5	"	25.1	60	"	9.2
2.0	"	23.5	75	"	8.2
2.5	"	22.9	100	"	6.9
3.0	"	22.3	125	"	6.0
3.5	"	21.6	150	"	5.2
4.0	"	20.8	167	"	4.7
4.5	"	20.4	200	"	3.9
5.0	"	20.0	250	"	3.0
6.0	"	19.2	300	"	2.2
7.5	"	18.2	400	"	0.9
8.0	"	17.9	500	Ref. level	0.0
9.0	"	17.4	600	Subtract	0.8
10	"	16.9	750	"	1.8
12	"	16.3	1000	"	3.0
15	"	15.2	1500	"	4.7
20	"	13.9	2000	"	6.0
25	"	13.0	3000	"	7.8
30	"	12.2	4000	"	9.0
40	"	10.9	5000	"	10.0

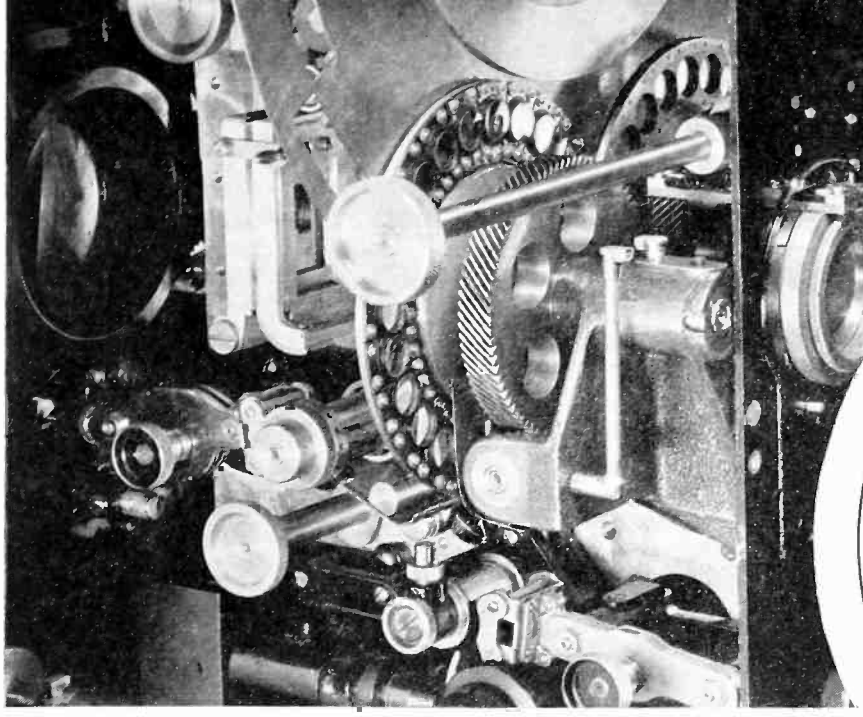


Fig. 1—Mechanism of the rotating-lens projector. The lenses do not scan the image, but present the image as a whole to the television camera

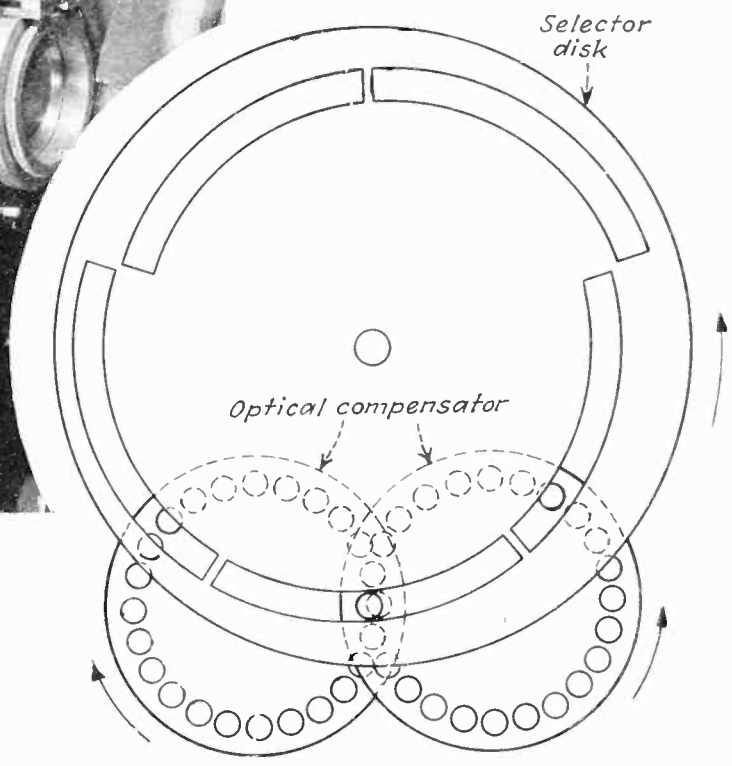


Fig. 2—Relationship of selector disc to lens motion. Every other frame is projected twice, the intervening frames being scanned three times to convert from 24 to 30 frames per second

A New Television Film Projector

By HARRY S. BAMFORD
Farnsworth Television Incorporated

THE ideal projection from standard motion picture film of images for scansion by the television pick-up camera involves for its accomplishment, consideration of the number of pictures per second and the picture transition interval, or the time required to change from frame to frame. The rate of scansion of optical images for television transmission is at present 60 per second interlaced to give effectively 30 full lined frames per second. The time allowed for flyback between scansions is 10% of the field scansion time, or 1/600 second.

Motion picture film is exposed at the rate of 24 pictures per second, and for theatre use is so projected by an intermittent machine, wherein a shutter masks the light during film movement to eliminate blur. This masking interval is necessarily considerably longer than 1/600 second. Figure 1 shows the mechanism of a 35 mm. telecine sound projector, designed to operate with a television pick-up tube of either the instantaneous or the storage type. The Farnsworth dissector is an example of the instantaneous type of pick-up tube; the iconoscope, emitron and image amplifier, examples of the storage type. A stationary image, or better, a succession of stationary images, is projected upon the photoelectric cathode of the pick-up tube in the telecine camera (shown also in Figure 1), each image having a duration equal to the scanning time, changes from image to image occurring only during the scanning flyback interval.

The film moves continuously through the film gate at 90 feet per minute, and such motion is compensated for optically to allow the projection of a stationary image, or succession of images. The machine can, therefore, be classed as of the continuous or non-intermittent type. Optical compensation is accomplished by the motion of a lens parallel with the film motion.

Figure 1 is a view of the operating side of the telecine projector, wherein two overlapped lens discs, upon which are mounted 24 well matched and highly corrected lenses, rotate to supply the compensating lens motion. In front of the lens discs is a spirally slotted disc, which selects the lenses in pre-determined order. Figure 2 illustrates the method of selection, in which the selector disc rotates in front of the rotating lens discs, occulting all but the desired lens. The spiralled slot follows the lens in its downward travel and allows the projection of a single frame for a pre-determined time, after which time the first lens is occulted and the next uncovered to project the following frame. The selector disc, as shown, is slotted to allow the projection of successive images of such time duration that they can be scanned alternately two and three times with a transition interval of less than 1/600 second. By adjustment of the phase relationship between the synchronous motor driving the telecine projector and the projector, the optical image transition intervals are made coincident with the scanning flyback intervals.

A Mazda incandescent lamp is used to illuminate the film, and the amount of light projected without film in the gate is in excess of 40 lumens. The projected image is unformly bright and substantially steady. Measurements of the projected image indicate an unsteadiness not exceeding $\frac{1}{8}$ of 1%, or in terms of line widths, about $\frac{1}{2}$ a linewidth at 441 lines.

Improving Regulator Performance

By shunting the regulator tube in a conventional electronic voltage regulation circuit increased current output may be obtained without impairing the regulatory action. Use of neon tubes to eliminate bias battery and increase sensitivity is discussed

By A. G. BOUSQUET

General Radio Company
Cambridge, Mass.

A STABILIZED voltage supply can mean the difference between excellence and mediocrity in many an application. The problem of voltage regulation is usually solved by the use of glow discharge tubes, ballast lamps, saturated-core power transformers or a vacuum tube type of regulator. The electronic regulator gives excellent regulation and is sufficiently flexible to qualify as a general-purpose laboratory tool. This system can provide a practically constant d-c voltage over a considerable load-current range in spite of line voltage fluctuations.

It is the purpose of this article to suggest a simple modification for extending the useful range of the electronic circuit to considerably higher load current. Table I and Table II indicate the results that can be obtained with the fundamental circuit and with the modified circuit when the load voltage is 400 volts.

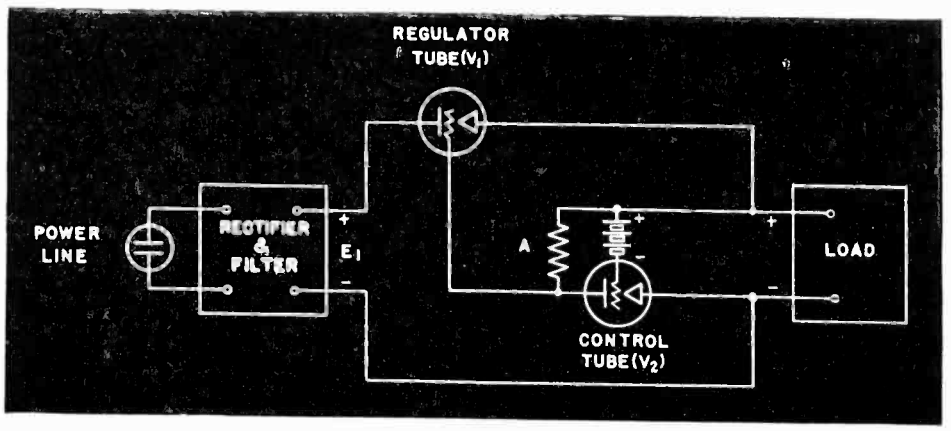


Fig. 1—Schematic diagram of conventional electronic regulator circuit. Increased output is obtained by shunting the regulator tube

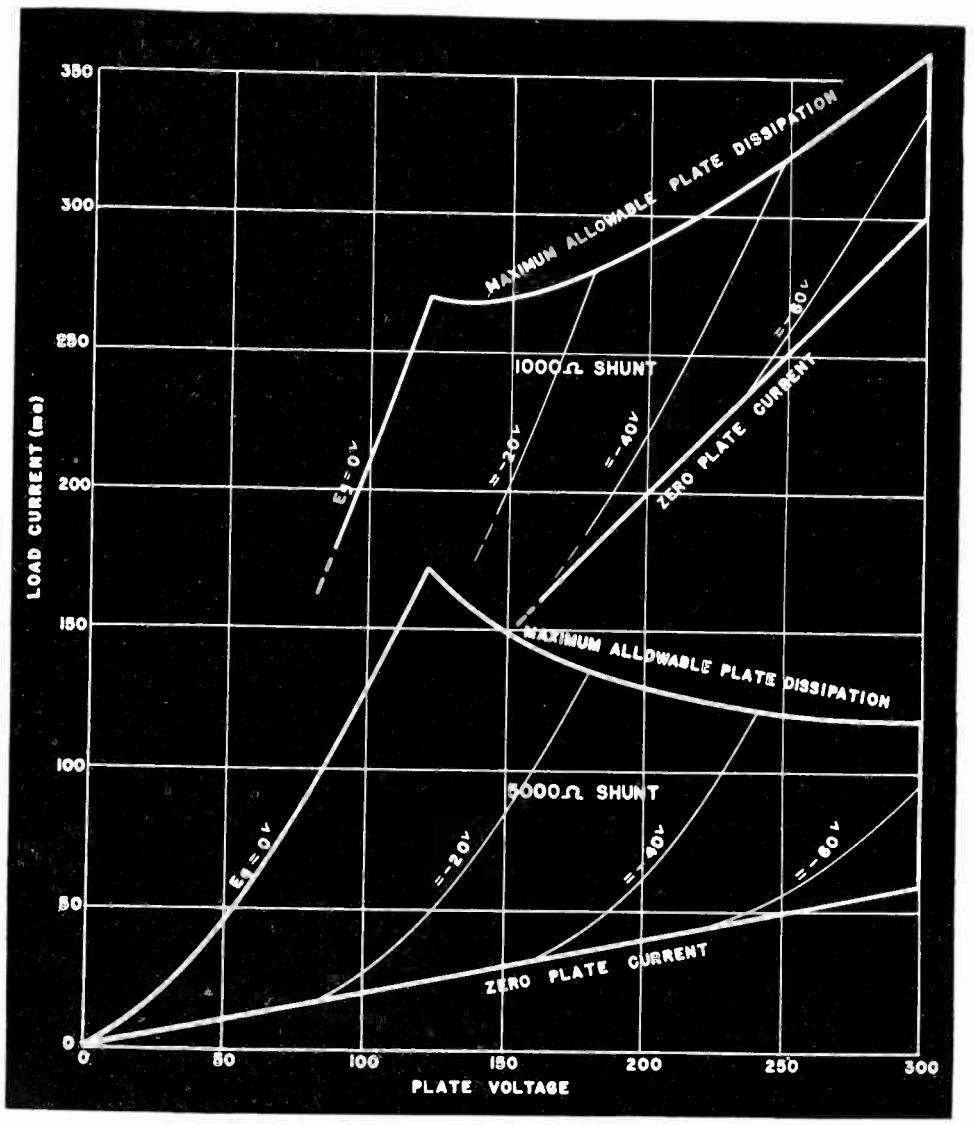


Fig. 2—The regulating range of a 2A3 triode when a shunt is employed. Shunt values of 1000 and 5000 ohms are shown

Conventional Circuit Used

A schematic of the general circuit is shown in Fig. 1. Essentially, it consists of the usual rectifier and filter system connected to a load through a vacuum tube, V_1, which serves as the regulating device. The suggested modification, not shown in the figure, consists in shunting the plate circuit of the regulator tube with a fixed resistor. A second tube, V_2, functions as a control tube to determine the operating path of the regulator tube. The grid circuit of the control tube includes a large positive bias due to the load voltage and a somewhat larger negative bias due to a battery. The net grid bias is slightly negative. The system depends on the constancy of the battery potential which is no serious limitation since there is no current flow through the battery. An increment in load voltage will be amplified by the control tube and will appear

as a large change in the voltage across the plate resistor A. Since the grid bias of the regulator tube, V_1, is provided by the voltage drop in resistor *A*, any slight change in load voltage will be accompanied by a large change in the grid bias and hence in the plate voltage of the regulator tube. This is the basis of the regulating system. Any change in the output voltage, E_1, of the rectifier filter, whether due to line-voltage fluctuations or to a change in load current requirements, will bring about a corresponding change in the plate voltage of the regulator tube and a very much smaller change in the load voltage. The degree of stabilization is dependent of the gain in the control tube circuit.

If the regulator tube is not shunted by a resistor, it must be capable of carrying the entire load current since it is in series with the load. The regulator tube functions as an automatically variable resistance. When it is shunted by a fixed resistor, the total available load current is increased. The plate resistance of the regulator tube must, however, vary over a greater range to obtain regulation and as a net result, the degree of stabilization is somewhat impaired.

The voltage-stabilized range of the load current, when there is no shunt resistance is limited by the maximum plate dissipation and the maximum safe plate voltage of the regulator tube. In addition, regulation ceases when the grid voltage is zero.

Use of Shunt Increases Upper Limit of Allowable Load Current

When the regulator tube is shunted by a resistor, the allowable load current is increased by that amount of current carried by the resistor. The lower limit, however, is no longer near zero load current but becomes the locus of the zero plate current condition.

The boundary conditions for a 2A3-type tube when the shunt resistor is 5000 ohms and when it is 1000 ohms are shown by the heavy lines of Fig. 2. As the value of the shunt resistor is decreased, the maximum allowable load current is increased at the expense of the permissible regulating range.

Figure 3 indicates the degree of stabilization obtainable as the line

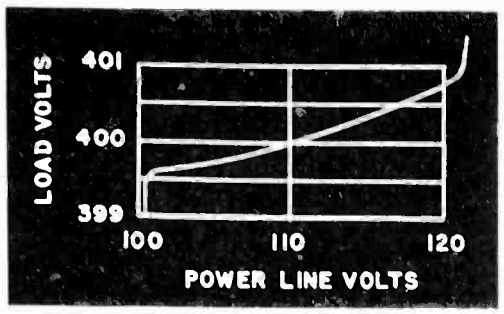


Fig. 3—Regulation against line-voltage changes

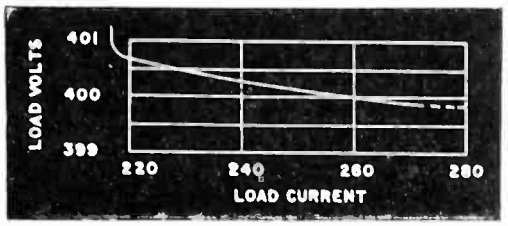


Fig. 4—Regulation against load-current changes

voltage is varied when the load voltage is 400 volts at 260 milliamperes. Figure 4 shows the stabilization ob-

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TABLE I
Regulation with Fundamental Circuit at 400-Volt Load

Line Voltage	Load Current	Regulation
100–130 volts	0–75 ma	±0.85 volt
105–120 volts	0–100 ma	±0.75 volt

TABLE II
Regulation with Modified Circuit at 400-Volt Load

Line Voltage	Load Current	Shunt	Regulation
100–130 volts	80–120 ma	5000 Ω	±0.85 volt
105–120 volts	50–135 ma	5000 Ω	±0.75 volt
100–130 volts	165–170 ma	2000 Ω	±0.85 volt
105–120 volts	130–190 ma	2000 Ω	±0.75 volt
105–120 volts	235–260 ma	1000 Ω	±0.7 volt

• • •

tainable as the load current is varied. The data were obtained for a rectifier-filter power supply of 750 ohms output impedance and for a 6F5-type control tube with a one megohm plate resistor. The shunt resistor is 1000 ohms.

The schematic shown in Fig. 1 includes a bias battery in series with the grid of the control tube. Some designs[1,2] have eliminated the battery by connecting the control tube grid to a voltage divider across the load and by placing a neon lamp in the cathode circuit of the control tube. The neon lamp provides the necessary constant negative bias. Dr. W. N. Tuttle of the General Radio Company has suggested further that a series of neon lamps be used as the upper portion of the voltage divider with the result that the entire variation in the load voltage appears at the grid of the control tube. Accordingly, the degree of stabilization is improved.

Circuit Employs Neon Tubes for Bias and Maximum Regulation

A circuit arrangement embodying these modifications is given in Fig. 5. The load voltage is very nearly equal to the sum of the neon lamp voltages. It can be set to any desired value by changing the number of neon lamps and by replacing one of the lamps with a 0-0.25 megohm rheostat. The neon lamps can be the ¼-watt type which are both small and inexpensive. If the load voltage must be materially changed the voltage E_1 at the output of the power supply must likewise be changed. This is readily done by controlling the input of the high voltage transformer with a Variac or by bringing out taps from the primary of the transformer.

1. G. Grammer, "Battery Performance from the R.A.C. Power Supply," *QST*, August, 1937.
2. RCA Type TMV-118-B.

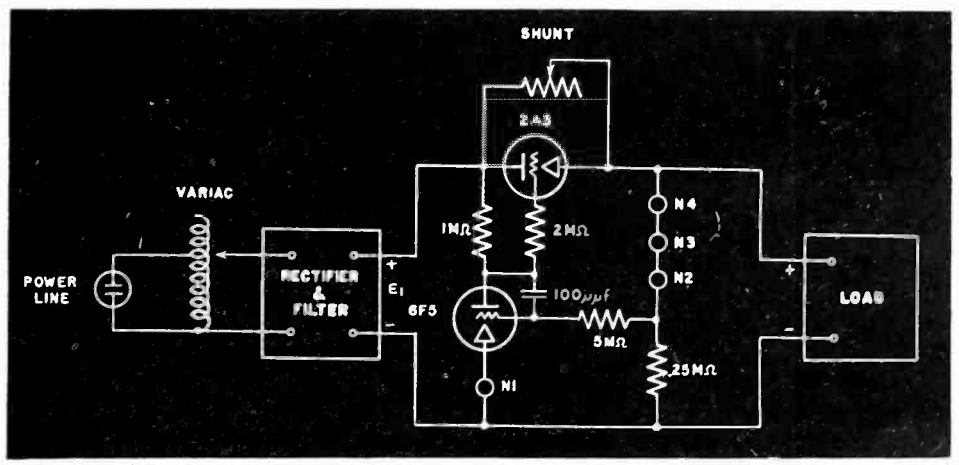

Fig. 5—Circuit arrangement employing neon tubes and shunted regulator tube, from which the curves in Figs. 3 and 4 were obtained

RMA Completes Television Standards

Recent approval by RMA Television Committee of items not heretofore standardized involves adoption of serrated type of vertical synchronization pulse, negative modulation, constant black level and "equalizing pulses"

By ALBERT F. MURRAY

Acting Chairman, RMA Television Committee

PROGRESS toward commercial television took a decided step forward on June 3, 1938, when the RMA Television Committee voted approval on the remainder of the items which complete the list of recommended television transmission standards for the United States. Hundreds of radio engineers now engaged in the sound broadcast field will design and construct the television equipment of the future, and it is for them that this article lists and explains briefly the standards.

For several years the RMA Television Committee has been working toward the formulation of not only a single set of standards, but the best standards from the practical operating standpoint, for our country. To arrive at these has required: first, the joining of various active television engineering groups (whether RMA members or not) into a united body, working for a common cause; second, a great deal of engineering, experimentation and field testing by individual companies, followed by an open discussion of the results, and, finally, conferences in which standards, having in most cases the unanimous approval of the Committee, were formulated. These standards have been approved by the RMA Board, in spirit. They may be altered in wording before transmission to the Federal Communications Commission for approval.

Complete List of Standards

In the paragraphs that follow, relating to standards, brief explanations are offered where necessary.

Number of Lines per Picture

It is recommended that there should be 441 lines per picture (or

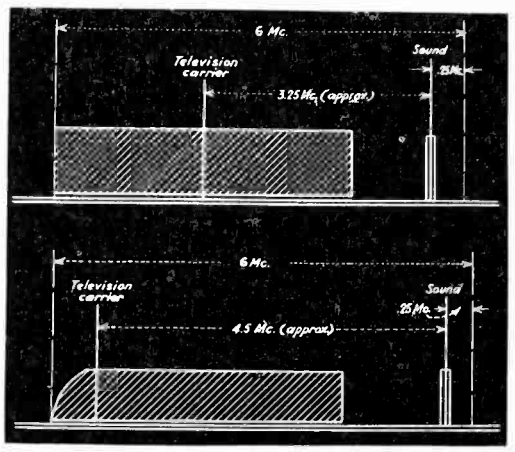

Fig. 1—(above) Typical television channel. Fig. 2—Recommended channel for single-sideband transmissions

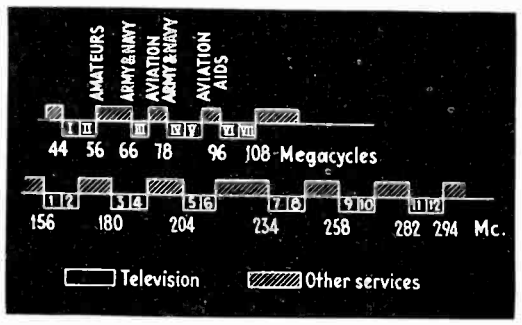

Fig. 3—Arrangement of television channels in u-h-f spectrum

frame). This number of lines is necessary to approach home motion picture quality. The exact choice of 441 was dictated by these factors:

(1) The type of interlacing specified requires an odd number of lines;

(2) To simplify the generation of synchronizing signals at the transmitter it is preferable that the number have simple factors, for instance for 441 lines we use 3x3x7x7.

Frame Frequency

A frame frequency of 30 per second, a field frequency of 60 per second, interlaced, is recommended. (A frame is one complete picture. A field is a single complete scan.) The frame and field frequencies were chosen to be high enough to eliminate flicker completely. The exact number was chosen because, being a multiple of the 60 cycle supply frequency, hum difficulties can be economically avoided. In the United States the majority of the supply systems are 60 cycle. Interlaced scanning is practically a necessity when flicker is to be avoided and a 441-line picture is transmitted in a channel 6 Mc. wide. An interlace ratio of 2:1 was selected to secure the benefits of interlacing without sacrificing picture quality.

Aspect Ratio

An aspect ratio of 4:3 is recommended to conform with existing motion picture practice.

Polarity of Transmission

It is recommended that a decrease in initial light intensity shall cause an increase in radiated power. This means negative transmission (or modulation) is used.

Channel Width

Television channels should not be less than 6 Mc. in width. With limited space in the radio spectrum available for television service channels must necessarily be limited in width to permit the greatest possible number of simultaneous programs to be broadcast. However, each channel must be wide enough to allow sufficient information to be transmitted to reproduce a picture of sufficient detail to have lasting entertainment value. To transmit the full information arising from the scan-

ning of a 441-line picture, a channel wider than 6 Mc. is necessary unless single side-band operation can be accomplished. See Figs. 1 and 2.

Television and Sound Carrier Spacing

It was previously the recommendation of RMA that the sound and picture carriers be separated by approximately 3.25 Mc. (See Fig. 1.) In view of recent developments, however, it is the recommendation of RMA that the sound and picture carriers be separated by approximately 4.5 Mc. This standard shall supersede that of "approximately 3.25 Mc." as soon as single side band operation at the transmitter is practical. (See Fig. 2.)

Sound Carrier and Television Carrier Relation

It is recommended that in a television channel the sound carrier shall be at a higher frequency than the television carrier.

Position of Sound Carrier

It is recommended that the sound carrier in the television channel be located 0.25 Mc. lower than the upper frequency limit of the channel. See Figs. 1 and 2.

Percentage of Television Signal Devoted to Synchronizing

It is recommended that if the total amplitude of the composite television signal is taken as 100% not less than 20% shall be used for synchronizing pulses. It is a television axiom that picture synchronism must be maintained even to the point where the picture signal is too weak to produce a usable image. Therefore, sufficient transmitter amplitude must be assigned to synchronizing — but more than this is not economical of power.

Transmission of Black Level

It shall be standard in television transmission that black in the picture be represented by a definite carrier level, independent of the light and shade in the picture. It is highly desirable to maintain the black level at a definite value, as mentioned below.

TABLE 1.

Specifications for RMA Synchronizing Signal

Pulse	Number	Duration	Spacing	Position
1. Horiz. sync		0.08 H.*	H	
2. Equalizing	6 before 6 after Vert. pulse	0.04 H. (max)*	0.5 H	Alternate pulses in alignment with Horiz. Pulse
3. Vertical Sync	6	0.43 H. (min)* 0.46 H. (max)*	0.5 H	Alternate pulses in alignment with Horiz. Pulse
4. Blanking — Horiz.		0.15 H. #	1.0 H	Tip leads Horiz. Pulse by 0.01 H.
5. Blanking — Vert.		0.07 V.† (min)# 0.10 V.† (max)#	1.0 V†	Tip leads first Vert. Sync. Pulse by 3 H (min) 4 H (max).

NOTE A. Sequence of Transmission { Sync. Pulses / Blanking Pulses } 1, 2, 3, 4, 5, 6, 7.

NOTE B. Wavefront of Pulses 1, 2 and 3 have time of rise equal to time of fall which is 0.005 H.

NOTE C. Amplitude of Pulses 1, 2 and 3 are equal.

* Measured at base of pulse in terms of H, which is the time from the start of one line to the start o the next.

Measured at tip of pulse.

† V — Time from start of one field to start of next field.

Synchronization

It is the recommendations of RMA that the synchronizing signal consist of the wave forms shown in the official RMA print, available later. Until the official print is ready the synchronizing signal is placed before the reader in two forms. If the reader wishes to construct equipment to generate the signal he should refer to Table 1, where the specifications and tolerances are listed. Figure 4 is for the purpose of explanation. It is a simplified diagram.

Note that the video signal is interrupted for brief periods at the end of each scanning line. During these periods horizontal synchronizing pulses are transmitted. At the completion of each picture field the video signal is interrupted for a longer period, during which the vertical synchronizing and the equalizing pulses are transmitted. These interruptions are accomplished electrically by horizontal and vertical "blanking" signals, respectively.

The fixed level of the blanking signals represents black in the picture, and is the dividing line between video and synchronizing signals, as shown in Fig. 4.

The horizontal pulses serve to start each scanning line at the receiver. The vertical synchronizing signal starts each new picture field.

To maintain horizontal synchronism during the vertical signal the latter is serrated so that the wavefronts of the serrations act to produce horizontal pulses. The serrations are spaced one-half the interval between normal horizontal pulses. The reason for the use of twice as many serrations as necessary for horizontal synchronization is to make identical the vertical synchronizing signals belonging to odd and even fields. Identical vertical signals are essential for proper interlacing.

Equalizing pulses are used before and after the vertical signal. They are of particular importance to receivers where vertical synchonizing circuits employ integration. One-half horizontal interval spacing is necessary between these equalizing pulses in order that the integrated vertical signal for both odd and even fields

(*Continued on page 55*)

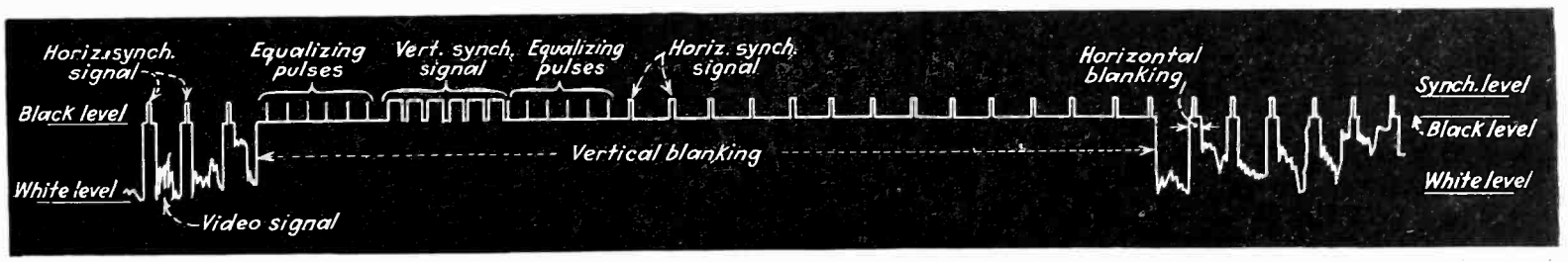

Fig. 4—Simplified diagram of the waveform of the recommended synchronizing signal. Details are given in Table 1, above

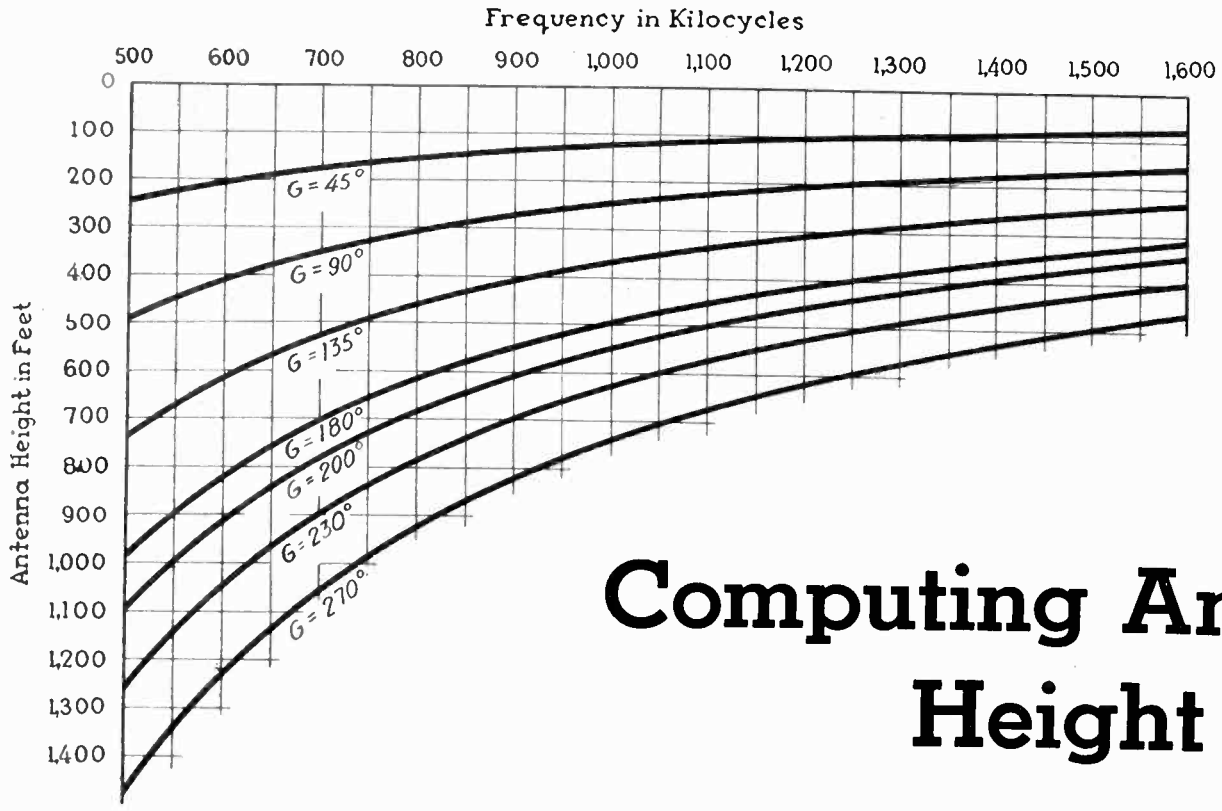

Chart for converting values used in expressing antenna height

Computing Antenna Height

By C. C. JINKS
Technical Dept., WJR

FOR many years the mode of operation of an antenna was expressed as a ratio of operating wavelength to fundamental wavelength (λ/λ_0). Gihring and Brown[1] have said that it is better to describe the antenna in terms of its height, a, measured in wavelength as a/λ and expressed in degrees as $G = 360\ a/\lambda$. As a result, later articles dealing with vertical antennas have expressed antenna height in electrical degrees.

The purpose of the chart is to determine quickly antenna height in feet when the mode of operation in degrees and the frequency in kc. are known, or to determine the mode of operation in degrees when the antenna height in feet and the operating frequency are known. The chart is based on the equation $H_{feet} = 2733.9G/kc$ which was derived from $G = 360\ a/\lambda$, in which a is the antenna height in meters and λ is the free space operating wavelength in meters.

Examples of Chart Use

A station operating on 750 kc. wishes to construct an anti-fading antenna. How high will the tower be? An anti-fading type antenna has length between 180° and 230° depending on the tower shape and soil conductivity.[1,2] Assume a 200° antenna is required. The 200° curve of the chart crosses the 750 kc. ordinate at approximately 730 feet, the actual value being 729.04 feet.

A station operating on 920 kc. has a vertical antenna 400 feet high. What is the mode of operation?

The 920 kc. abscissa of the chart crosses the ordinate corresponding to 400 feet approximately at the 135° curve. The equation gives G as 134.6° for the above condition. This antenna is known as a 3/8 antenna.

In determining the mode of operation of an existing antenna it must be known whether or not the antenna is sectionalized or has a capacity top, sometimes referred to as a "hat". Either type has the effect of increasing the effective electrical degree length over that corresponding to the actual tower height.

The chart is useful in obtaining a general picture of the top loaded and sectionalized antenna. Suppose for example a station operating on 670 kc. wishes to construct an anti-fading type antenna but the proximity of a commercial airline restricts the tower height to 500 feet. What electrical degree length must be made up by an inserted coil or a capacity top? (Assume an optimum tower height of 200°.)

The 200° curve crosses the 670 kc. ordinate at approximately 815 feet, the actual value being 816.09 feet. But the station location limits the tower height to 500 feet. From the equation it is found that 500 feet at 670 kc. corresponds to 123 electrical degrees. Thus an inserted coil or a capacity top or a combination of both corresponding to 200—123 or 77 electrical degrees must be used. Brown[3] has dealt at length with the sectionalized and top loaded antenna.

The chart and equations may also be used in determining the spacing of the elements making up a broadcast band directional antenna. The element spacing is usually given in electrical degrees. These may be quickly converted by the chart into feet when the operating frequency is known. As an example, how far apart are the towers of a two-element directional antenna operating on 550 kc. when the desired pattern requires a 45 degree spacing?

The 45 degree curve of the chart crosses the 550 kc. ordinate at approximately 223 feet, the actual tower spacing as obtained from the equation is 223.68 feet.

Tower heights given in fractions of a free space wavelength may be converted into degrees by multiplying by 360. Likewise tower heights given in degrees may be converted into fractions of a wavelength by dividing by 360.

[1] Gihring and Brown, "Tower Antenna for Broadcast Use," *Proc. I.R.E.*, vol. 23, pp. 311–356; April, (1935).
[2] S. Ballantine, "High Quality Radio Broadcast Transmission and Reception," *Proc. I.R.E.*, vol. 22, pp. 616–629; May, (1934).
[3] G. H. Brown, "Broadcast Antenna," *Proc. I.R.E.*, vol. 24, pp. 48–81; Jan. (1936).

Measuring Four-Pole Networks

A practical circuit method of measuring the phase-shift, current and voltage ratios of any four terminal circuit, when terminated in any impedance, useful for checking calculations and improving performance

By J. L. CLARKE

Bell Telephone Company of Canada Montreal

MUCH has been written about the theory of 4-pole networks but very little information has been published about the method of checking these calculations by measurements. Current ratios can, of course, be obtained by means of thermocouple measurements or other types of a-c meters but the phase relations between various pairs of poles associated with a network have always been difficult to measure.

The following method will provide an accurate means for obtaining the phase shift, current ratio and voltage ratio of a 4-pole network when terminated with any impedance.

Case I, a transformer.

In making measurements on an iron core transformer care must be taken that the flux in the core remains at the particular value at which the characteristics are desired.

The connections are shown in Fig. 1 and Fig. 1a, on the reverse side.

A-B and *C-D* are the terminals to which the 4-pole network is connected. Z_R is the terminal impedance connected across *C-D*. Z_N is the balancing impedance which consists of either a variable resistance in series with a variable condenser or a variable resistance in series with a variable inductance.

The switch S_2 is closed. Energy is supplied from an oscillator *O* and the output is adjusted by the resistance *R* until the desired current is shown in the ammeter *A*. Then Z_N is adjusted until no sound is heard in the receiver. This may require a change in the reverse switch. This also may require a readjustment of *R* to keep the current constant.

Second—open the switch S_2 and measure the impedance looking into *E-F* with an alternating current bridge using the same current as shown in the meter *A* as was used in the first test. Call this impedance Z^R_2

Then $Z^R_2 = \frac{V_1}{I_1}$ (from second test) (1)

and $I_1 Z_N = I_2 Z_R$ (from first test) (2)

where I_2 is the current through the impedance Z_R,

but $I_2 Z_R = V_2$ ..... (3)

hence $Z_N = \frac{V_2}{I_1}$ = effective mutual impedance ..... (4)

(Note the effective mutual impedance in an iron core coil varies with the core flux and terminal impedance)

From Eq. (2) we get $\frac{I_2}{I_1} = \frac{Z_N}{Z_R}$ ..(5)

Since Z_N and Z_R are vectors Eq. (5) gives the current ratio and also the current phase change.

From Equations (1), (3) and (5) we get—

$\frac{V_2}{V_1} = \frac{Z_N}{Z^R_2}$ ..... (6)

Since Z_N and Z^R_2 are vectors, Eq. (6) gives the voltage ratio and the voltage phase change.

Further if r_1 is the resistance of the primary winding and r_2 is the resistance of the secondary winding the iron loss in the transformer is given by:

Loss = I_1^2(r.p.Z^R_2) — I_2^2(r.p.Z_R) — $I_1^2 r_1 - I_2^2 r_2$ ..... (7)

where I_1 and I_2 are the magnitudes of the currents and r.p.*Z* signifies the real part of the impedance *Z*.

Case II. An unsymmetrical network, see Fig. 1 and Fig. 1b. A similar procedure to that recounted for Case *I* will give the voltage and current ratios and the power loss also the voltage and current phase shifts in the networks under any terminating condition and at any frequency at which the test is made.

Case III A symmetrical network, see Fig. 2a. In this case the same tests are made but the circuit is arranged as in Fig. 2.

The transformer T is a high impedance transformer that changes the impedance of Z_R only slightly and is used for potential balance only.

The switch S_2 is open.

R_3 is a high resistance and *P* is amplifier.

This circuit may be used with a transmission line as in 2b. In this case the line is looped back to the point of measurement and by making measurements with the line looped back at several different points, the current ratio and phase change may be measured for each case.

The circuit may also be used to measure the voltage ratio and phase relation of the input circuit and feed-back circuit of a feed-back amplifier.

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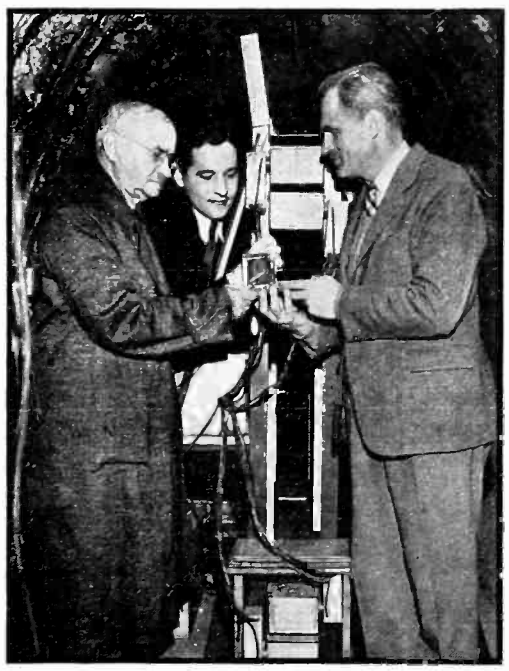
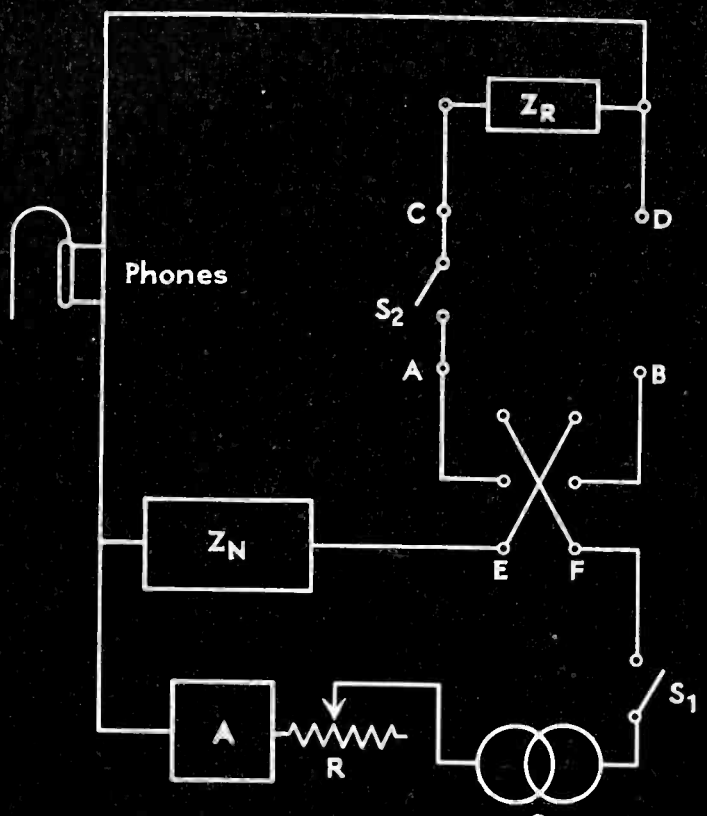
HEAVY ELECTRONS FOUND IN SUBTERRANEAN TUNNEL

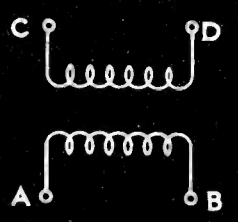


In a tunnel 50 feet below Chicago's streets, Dr. A. H. Compton has detected the presence of barytrons, the heavy electrons which are found in cosmic rays, proving their extraordinary penetrating power

Four-Terminal Impedance Measurements

By J. L. CLARKE





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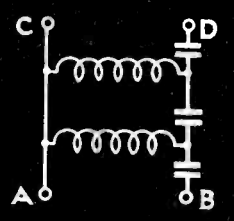
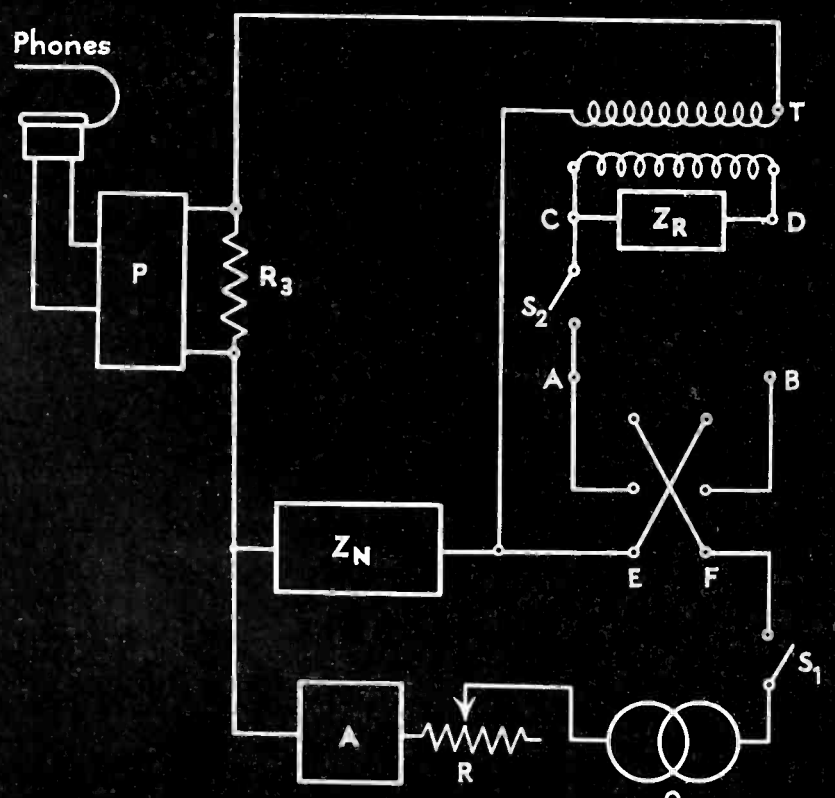
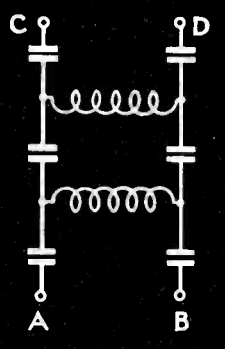


1b

FIG. 1





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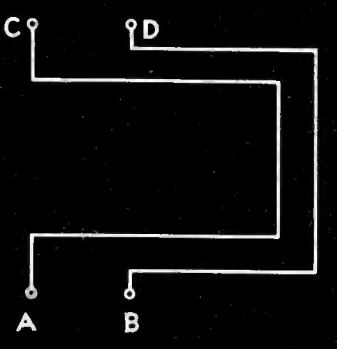


2b

FIG. 2

I.R.E. Convention, 1938

(*Continued from page 15*)

The surface noise is 55 db below the maximum recorded signal, the frequency response is substantially flat to 9000 cycles, and the records may be played 100 times without loss of fidelity or increase of noise.

Several papers on transmission lines were given. Carl Dietsch described construction details of NBC lines. Losses caused by conductor resistance, leakage and radiation were shown as a function of frequency. Currents induced by single open wire lines in a neighboring line were covered by A. Alford who described the use of coupled transmission lines to provide suitable line terminations so that a single antenna may be used for multiple frequency operation.

In a paper on the design and testing of insulators for use with coaxial lines, W. S. Duttera described measurements to determine the factors affecting the arc-over voltage for insulators for use in coaxial transmission lines at broadcast frequencies. The power handling capabilities of the transmission lines were determined to a large extent by the maximum allowable voltage. A design was derived which is mechanically strong and in which the current density is approximately uniform throughout the insulator. This insulator consists of a circular ceramic hub with a concentric core for the center wire. The insulator is fairly thick near its center or core and tapers off to a relatively thin edge. Both the inner and outer circular edges are coated with a deposit of conducting material.

R-F Voltages Encountered by Antenna Insulating Material

A knowledge of the r-f voltages in the insulation of broadcast tower antennas is important to the design engineer, since too large a factor of safety may add unduly to the power cost. In George H. Brown's paper attention is first given to the base insulator voltage.

It was shown that the voltage across the insulator at the base of the tower varied from about 100 volts to approximately 3,000 volts for broadcast stations operating with powers as great as 50 kw. In the case of WLW operating at 500 kw, the voltage across the insulator was approximately 13,000 volts.

It was shown that for one type of installation, the voltage across the guy wire insulators varied from about 150 to 500 volts. For another type of tower the voltage across the guy wire insulators was approximately 300 volts minimum and 1,100 volts maximum for 50 kw installation. Through proper proportioning of guy wire lengths, the voltage across the guy wire insulators due to the radiated fields may be kept less than 1,000 volts, so that here again the insulation problem need not be serious. An important consideration in the case of guy wire insulators, however, is the voltage built up across it as a result of static charges. These static charges may initiate a condition of arcing which might easily be maintained by the normal r-f field voltage across the insulator.

It was pointed out that for antennas of approximately 1/6 wavelength and for powers up to 50 kw, the electrical requirements on the base insulator were not very strenuous. Short guy wires were desirable and small strain insulators were suitable for use in the guy wires up to and including powers of 50 kw.

Deviation of Short Radio Waves

C. B. Feldman, Bell Telephone Laboratories, delivered a paper revealing that propagation of short radio waves from England to New York has been found to involve many anomalous effects. Studies have been made of transmission from Rugby, directed toward New York, and of broadcasts from Daventry, using various transmitting arrays. Three multiple unit steerable antennas located at Holmdel, N. J., experimental receiving station of the Bell Telephone Laboratories have been used. One of these is the end-on "musa" described in a recent paper by Friis and Feldman, in the *Proc. I.R.E.* for July, 1937. The other two are broadside musas steerable horizontally to permit exploration in azimuth. The B.B.C. antennas, together with the British Post Office transmitting antennas in use on the London-New York radio telephone circuit have provided simultaneous comparisons which are, to a limited degree, representative of the effects of steerable transmitting directivity.

Among other effects it was found that when the transmitting antenna directivity is appropriate propagation often takes place in two paths sufficiently different in azimuth to be separable by one or the other of the broadside multiple unit steerable antennas.

Substantial deviations to the north of the great circle course have been rare. Southern deviations appear to be associated with ionosphere storms. In storms of moderate severity, southern deviations appear with noticeable consistency, even on Rugby transmission, directed to New York. Under such circumstances Daventry transmissions to the West Indies have been received much better with a low gain broadside musa steered 60 degrees south of the great circle, than a transmission in the same waveband directed nearly to New York and received with a rhombic antenna directed toward England.

In a paper presented by Dr. N. Smith, T. R. Gilliland and S. S. Kirby of the National Bureau of Standards propagation data covering a wide range of frequency and distance were given in graphical form and the use of these curves to determine the optimum frequency of transmission between two points was given. By correlating these curves with magnetic storms and height of the ionosphere layer, it is expected that it will ultimately become possible to predict weeks or even months in advance the optimum frequency to use over any transmission path.

The effects of turbulence and increased virtual heights during ionosphere storms, which produce poor and erratic sky wave transmission at a higher frequency were discussed by the authors mentioned above. The effects of ionosphere storms are more pronounced at the higher latitudes. The effects of ionosphere disturbances in a region where reflections take place were illustrated by means of transmission data taken during the magnetic storm of May 10-12.

Wideband Propagation Characteristics

A paper by R. W. George, RCA Communications, described the studies entered into as part of the television field tests to determine

data on the ether path. It was demonstrated that signals reflected from buildings and other large objects introduce distortion in the received signal because of their relative time delay and phase relation. This distortion is especially evident in the form of blurred and multiple images in television reception. Data on the relative merits of vertically and horizontally polarized waves transmitted from the Empire State Building were obtained at the two frequency ranges of 81 to 86 Mc and 140 to 145 Mc. The radiated power was about 750 watts at the lower frequency and 68 watts at the higher frequency band.

Receiving antenna locations were chosen which might be considered suitable for a television antenna. In some cases, such as on the roof of the RCA Building, measurements were made at several antenna positions.

Geometric means of the maximum to minimum field strength ratios for each polarization and frequency range indicate that the indirect, interfering signals were from 10 to 20 per cent stronger at a higher frequency and were strongest with vertical polarization at both frequencies.

Measurements using circular polarization were made at three types of locations using the 81 to 86 Mc transmitter. These locations were, South of Newark Airport in a clear area, in the roof of the 75 Varick Street Building and from a north side window on the 26th floor of the Woolworth Building. To obtain relatively accurate information, measurements of both horizontal and vertical polarization were made consecutively for direct comparison. The summary of these measurements showed circular polarization to be in general less desirable than horizontal and possibly somewhat more desirable than vertical polarization.

One conclusion substantiated by the data is that vertically polarized waves are propagated along indirect paths more efficiently than are horizontally polarized waves. The relatively large differences observed between direct and indirect paths show that the reflecting objects involved must generally have been the vertical walls of buildings rather than their roofs or ground.

Communication by Phase Modulation

Practical methods of generating and receiving phase modulation opening up the possibilities of using phase modulation as a communication system were described by Murray G. Crosby of RCA Communications. A new receiver was described which uses an off-neutralized crystal filter and provides a simple practical receiver which has not been heretofore available for phase modulation. Other methods of reception were described.

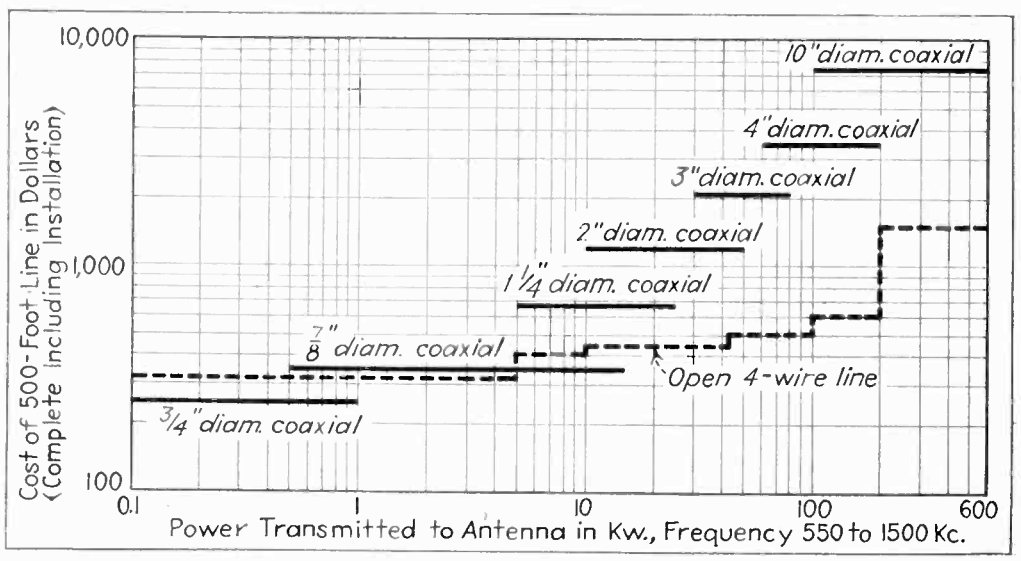
Propagation tests conducted between California and New York indicate that the propagation characteristics of phase modulation are substantially the same as those of amplitude modulation. The author showed that the signal-to-noise ratio of the output of the phase modulation receiver is equal to the product of the phase deviation in radians and the carrier-to-noise ratio.

The main advantage obtained by the use of phase modulation is realized at the transmitter. For a given complement of tubes in the transmitter, practically four times the carrier power output can be realized by phase modulation as can be obtained with amplitude modulation and this gain of 6 db is fully realized in terms of receiver signal-to-noise ratio. The main difficulty encountered at the transmitter is increased susceptibility to the introduction of a-c hum.

The receivers are somewhat more complicated than those for amplitude modulation and the chief difficulty of the receiver is the increased susceptibility to microphonics in the oscillator tube. In the oscillator of a superheterodyne receiver, receiving a signal in the vicinity of 10 Mc, the microphonics produced by a person walking around in the room are strong enough to be only a few decibels less than the receiver output, due to full modulation. This susceptibility requires special treatment of the high frequency oscillator.

Selection of broadcasting transmitter locations, according to William B. Lodge, is governed by many factors. A broadcasting station should provide satisfactory reception to as many homes as possible. Most of the engineering considerations which determine the station performance and coverage may be treated analytically. However, ability to serve a large audience is greatly affected by the excellence of the transmitter location selected, and this selection must be governed by experience and by intangibles not subject to calculation.

Although 10 mv/m may appear adequate in some cities, experience has shown the desirability of building a transmitter which will deliver 50 mv/m in the congested areas. In rural communities, one-half mv/m is generally acceptable. In residential areas, 2 to 5 mv/m is often adequate, although in some instances 25 mv/m is insufficient to overcome local electrical disturbances. Industrial centers and office building areas are the most difficult to serve, and in cities where the population exceeds 100,000 it is desirable to place a 25 to 100 mv/m signal in the business district.



Graph showing cost of transmission lines and coaxial cables for broadcasting stations having powers of from 100 watts to 600 kw. From paper by Carl Dietsch of N.B.C., delivered at I.R.E. technical session on transmission

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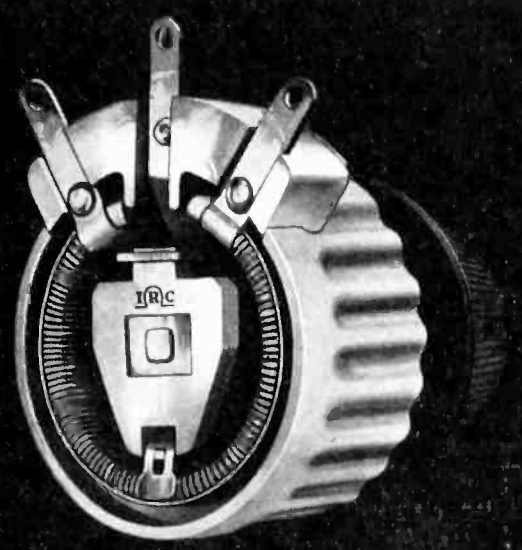

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The 25 watt rating of these unique, All Metal IRC Rheostats is based on a hottest spot temperature rise of only 140° C. with power distributed over the entire element. This same rating applies for as low as 25% of full rotation with only a minor temperature rise increase to 160° C. In other words, the IRC 25-watt rating means exactly what it says. *You can use IRC Rheostats up to their full rated load without excessive temperature rise.*

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TUBES AT WORK

WBZ engineers searching out a new home with a balloon, a new method of receiving and identifying many stations simultaneously, and a new tube duet for tuning indication are in the electronic news this month

Balloon Antenna Explorers New Location for WBZ

BEHIND THE RECENT application of the Westinghouse Company to move the WBZ transmitter from Millis, Mass. to Hull, Mass. is a long series of tests conducted by engineers to obtain data on a more suitable location. The town of Hull has several miles of sea water between it and the mainland, and the salt marsh of the proposed location makes for a very high antenna efficiency. In order to prove the point, a test was made with a so-called kite balloon. The balloon, hydrogen filled to a capacity of 1700 cu.ft., was held aloft at a height of 250 ft. by a copper wire which acted as a quarter wave antenna. During a period of approximately two weeks many field intensity measurements were made throughout the coverage area. As a result of these tests, the application claims that much better service can be given to a larger population from the Hull location than from the present Millis location. If the application is granted, a directional antenna consisting of two vertical 500-ft. towers, space one-quarter wave apart and excited with equal antenna currents at 90 degrees out of phase, will be employed. The result signal strength in the direction of Boston will be that corresponding to 100 kw., as against 50 kw. with a non-directional system.

Supporting a quarter-wave vertical wire, this balloon indicated a new and better location for WBZ

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"Panoramic Reception" shows Promise in Radio Navigation

THE EDITORS ARE indebted to Marcel Wallace, consulting engineer of New York and Paris, for the following information concerning his system of panoramic reception. In brief this system makes use of a radio receiver which is tuned periodically from one end of a given band of frequencies to the other, by some such system as a motor driven condenser, at a rate of perhaps 30 times per second. In such a system, the receiver does not reveal what message each station in a given band of frequency is sending, but it does reveal the relative signal strength and frequency separation of all the stations within the band. This information may be put to considerable use in the problems of radio navigation.

To allow a simultaneous indication both of signal strength and frequency separation, a cathode ray tube is used as the indicator. The vertical deflection plates of the tube are connected directly to the output of the receiver, and thus indicate relative signal strength. The horizontal plates are connected to a source of sweep voltage which varies periodically with the change in frequency of the receiver, so that the horizontal axis is one of frequency. Consequently patterns of the type shown in the illustrations are obtained from the screen in the tube, each "hump" in the pattern representing a station whose signal strength and frequency are determined by its height and position on the screen, respectively. Aural reception of the signals has little meaning, unless the frequency of an auxiliary oscillator is changed at the same rate as the frequency of the antenna tuning circuit, as in the conventional superheterodyne. By varying the frequency interval between such an oscillator and antenna circuit, any one station in the receiving band may be selected for aural reception and identification thereby established.

A simplified circuit diagram of such a receiver is shown in Fig. 1. The motor driven shaft operates condenser C_1 and at the same time operates a commutator switch, which discharges the condenser C_2 periodically thus providing the requisite sweep voltage on the horizontal cathode ray tube plates.

The application of the panoramic

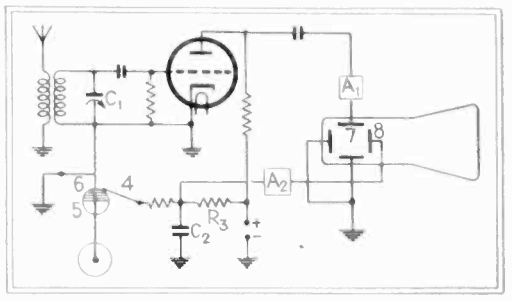
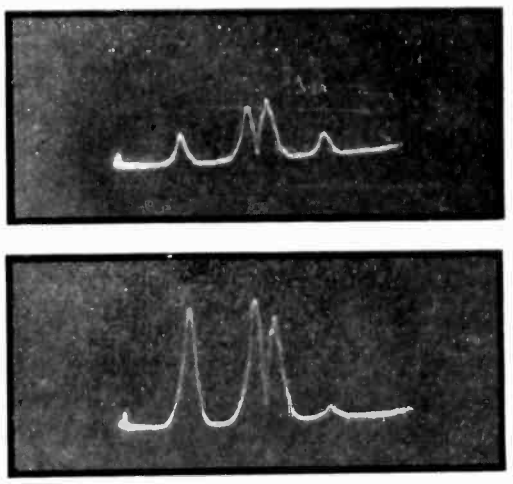
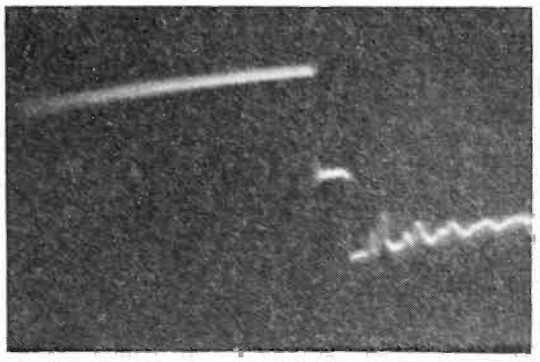


Fig. 1—Simplified diagram of "panoramic" receiver

system of reception to radio navigation involves a receiver using a loop antenna. The terminals of the loop antenna are reversed periodically and at a fairly rapid rate of speed. Simultaneously the terminals of the vertical deflecting plates of the cathode ray tube are reversed. Consequently two sets of station "images" appear, one above and one below the horizontal axis, but due to the persistence of vision, both images appear simultaneously. Now if the loop is rotated about its axis, the vertical height of the several "humps" on the cathode ray pattern will change according to the direction of the station with respect to the loop antenna. Even if the loop is allowed to remain in one fixed position, it is possible to determine the direction of several stations being receved simultaneously. For example, in Fig. 2 is shown the pattern of a typical loop antenna, the dotted curve being that of the reverse dots occurring when the loop terminals are reversed. Stations lying within the sector A appear equally above and below the horizontal axis of the pattern, while those in region B appear higher on one side than on the other. Those occurring in



Examples of cathode-ray reception "panoramas". The band covers 250 kc., centering around 15 Mc. Four stations, two interfering are shown. The lower picture shows an increase in strength of the station at the left, a decrease of that on the right



Photograph of a high-speed transient taken with 326C Cathode Ray Tube. Fundamental frequency of oscillation is 1 megacycle, with 3 megacycle component showing. Vertical line (right) represents a spot speed of 63 Km/sec. on screen of tube.

Actual photograph showing 3 sinusoidal traces, taken with 330C Cathode Ray oscillograph.

They'll give you the whole story on "*split microsecond*" phenomena!

To meet today's exacting requirements in the field of time and frequency measurements, you need Western Electric's improved Cathode Ray Tubes. They assure the quality performance that helps you get the whole story.

The study of such "split microsecond" phenomena as that illustrated above, requires a tube combining high intensity with a sharply defined pattern. This photograph also shows the value of Cathode Ray Tubes as recording instruments—furnishing permanent records of phenomena.

For observation and recording of 2 or 3 simultaneous phenomena, Western Electric's 330 series three trace tube is unique. It permits on-the-spot comparisons, showing phase relations and relative magnitudes. You'll find it useful in studying many problems.

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GENERAL CHARACTERISTICS

	325 TYPE	326 TYPE	330 TYPE
Max. Length (in.)	16½	22	23-1/16
Max. Screen Diam. (in.)	4⅝	7⅛	7⅛
Heater Voltage	5.0 Volts	5.0 Volts	5.0 Volts
Heater Current	0.55 Amps.	0.55 Amps.	1.65 Amps.
Accelerating Voltage	1000-5000 Volts	1000-5000 Volts	1000-5000 Volts
Deflection Sensitivity with 2000 volts Accelerating Potential	130 Volts/inch	80 Volts/inch	80 Volts/inch

SCREEN CHARACTERISTICS

325A, 326A, 330A	325B, 326B, 330B	325C, 326C, 330C
Green. Medium persistence, for visual observation and photography with green-sensitive film.	Blue-green. Long persistence, for observation and photography of non-recurrent and low frequency phenomena.	Blue. Highly actinic, for photography with blue-sensitive film.

Western Electric
CATHODE RAY TUBES

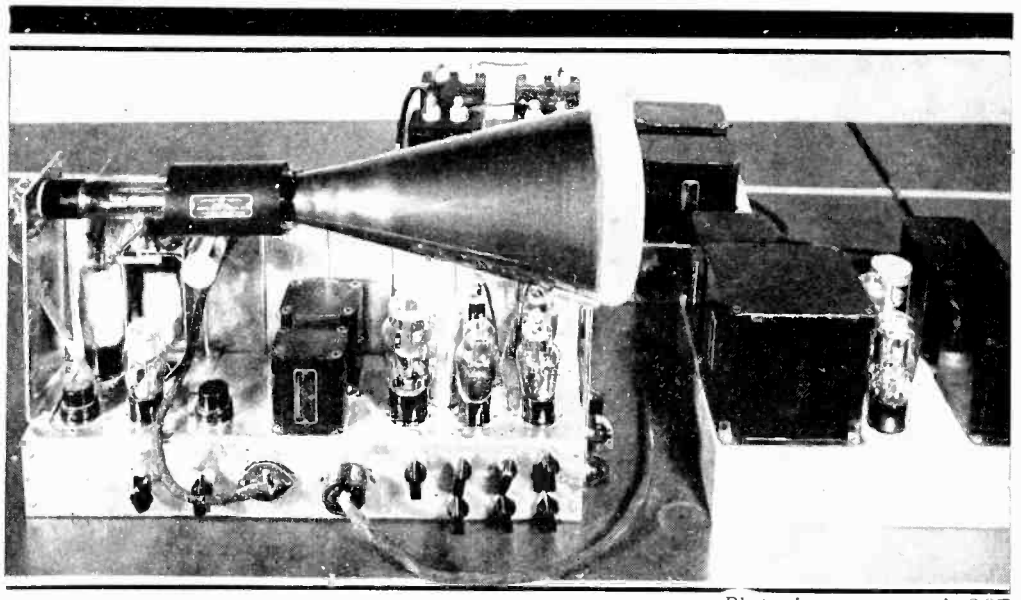

Photo by courtesy of QST

region *C* appear only on one side of the horizontal axis. In this manner when several stations are received simultaneously, and are identified by their frequency or aural monitoring, it is possible to determine their direction

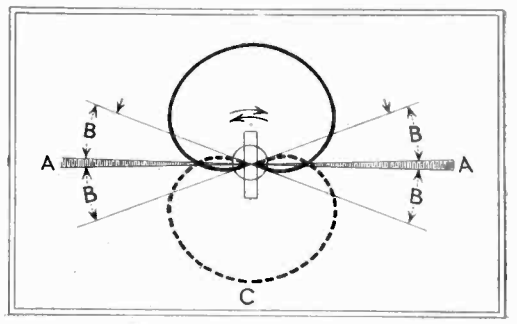

Fig. 2 — Directional pattern of commutated loop

in several zones without rotating the loop. By rotating the loop, the exact direction of any one station may be specified. The possibilities of obtaining simultaneous bearings on three or more stations is of great importance in aerial navigation, where the high speed of flight makes it desirable to obtain the three bearings within a sufficiently small time interval so that the plane is not moved an appreciable distance, between bearings.

Another, and perhaps even more important, application of the system involves the use of special transmitting stations, each of which emits two sig-

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NO WIRES, NO PLUGS, NO TROUBLE

Philco's new mystery control demonstrated by President J. M. Skinner. The remote tuning unit contains a small battery-operated radio transmitter tuned to a receiving control unit in the console. No wires or plug-in connections with the receiver are used

nals on different carrier frequencies. From such stations the pilot can obtain the position and direction of each beacon transmitter. In such a system the beacon frequencies selected correspond to the geographic "x" and "y" coordinates of the station itself. Furthermore, the directions of the transmitted signals are restricted to north-south for the "x" frequency and east-west for the "y" frequency. By arranging the deflection of the cathode ray tube with the necessary commutation, it is possible to place the hump on the received pattern in a verical direction for the north-south stations and in a horizontal direction for the east-west station. Consequently the position of each station, which corresponds to the frequencies on which it operates, will be given on the cathode ray screen directly. A transparent map made to fit over the cathode ray screen will then indicate the location of the stations, and if three or more stations were received would indicate the position of the plane. While such a project would involve considerable investment in transmitting stations, Mr. Wallace urges that it is a practical and simple method of aerial navigation.

A further extension of the principle involves beacon transmitters which transmit on variable frequency. Such a transmitter would appear on the cathode ray screen as a moving hump, the horizontal position moving in correspondence with the frequency. The rate and amplitude of the motion could be used as an identification of the station. Suppose now also that the direction of the signal from the transmitter varied simultaneously with the variation of frequency. Then it is possible to set up a contour of positions over the terrain which have a definite frequency and geographical relation. In this manner it is possible for the pilot to follow a curved path of what-

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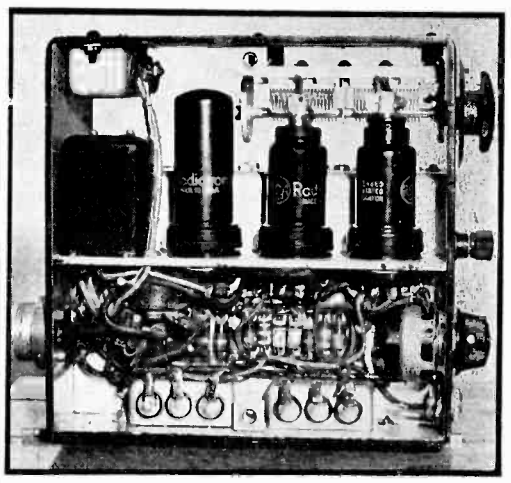
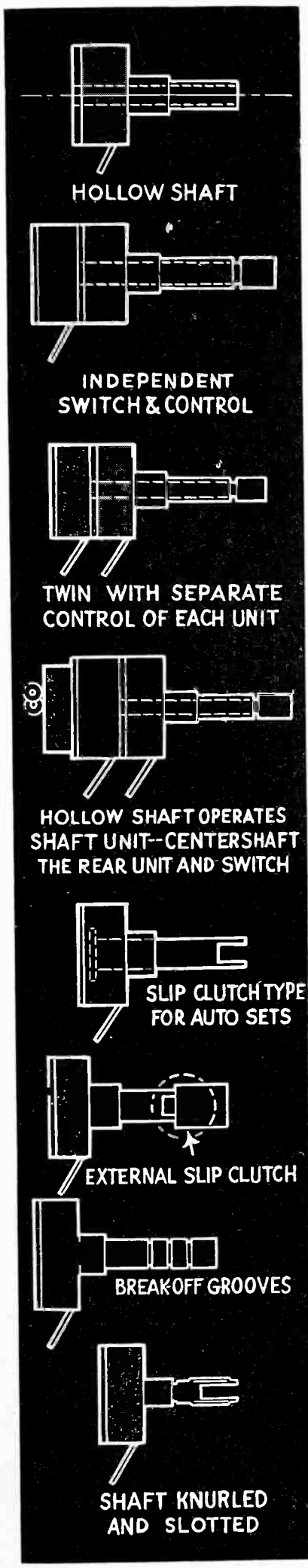
MIDGET AIRCRAFT RECEIVER



This superhet receiver weighs only seven pounds and its longest dimension is 6½ inches. It was designed by John Lee of the Coast Guard service, for aircraft use

Who said, 'It can't be made'?



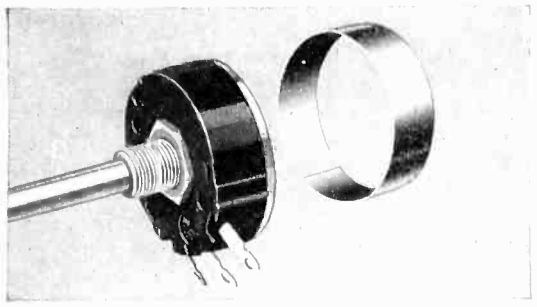
They came to us with a quizzical apologetic gleam in their eye—hoping against hope that we would comply with their specifications . . . and here on this page are some of our answers—taken at random from our collection of unique made-to-order controls.

• Special mechanical assemblies for auto or house sets to provide economy of space or convenience are designed every day by Centralab engineers. Concentric shafts . . . ultra small controls . . . slip clutches . . . special shaft slots and mills . . . they all have their day when auto sets are in the making.

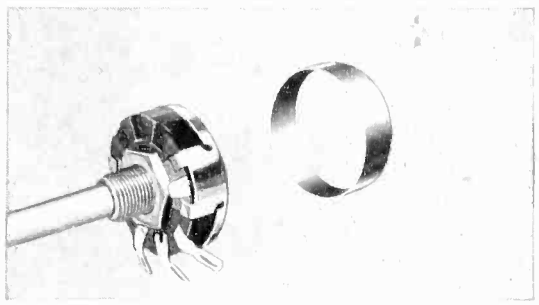
• House sets come in for their share of unique design too. Break-off grooves to adapt one control to several receivers and Centralab's slotted and knurled knob assembly both mean savings in inventory and labor. Special switch action . . . combination tone and I.F. selectivity control . . . midget size for compact receivers . . . they're all available with Centralab controls.

• Available special resistance features are endless. Multiple taps . . . special tapers . . . dual or triple resistance units . . . these PLUS mechanical features available, assure the designer that Centralab can furnish the control to fit his ideas.

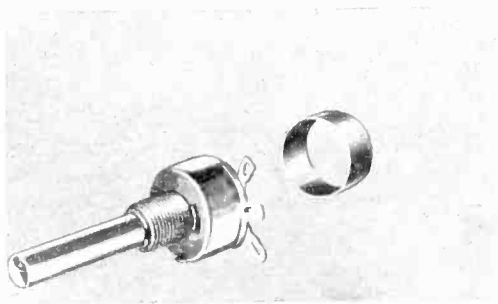
Send us YOUR particular problem. Our extensive experience guarantees a solution.



STANDARD RADIOHM



MIDGET RADIOHM



SUB-MIDGET CONTROL

Centralab

CRL

CENTRAL RADIO LABORATORIES
MILWAUKEE

ever configuration is desired, simply by preserving a fixed relation of the humps on the cathode ray screen, each hump corresponding to a given transmitter. One method by which this can be carried out is to have the change in direction and change in frequency so coincide that the "peak" frequencies received from each of two stations are the same along the entire route. Similarly it is possible to have the difference between peak frequencies of the two transmitters a constant along any routes parallel to the desired one. Since the cathode ray screen indicates not only the peak frequency but the frequency difference between the stations, it is possible to follow either the desired path or any one parallel to it. The details of the mechanisms required to produce these signals have been worked out by Mr. Wallace, and it seems that they can be practically realized if the advantages of the system are worth the necessary economic investment.

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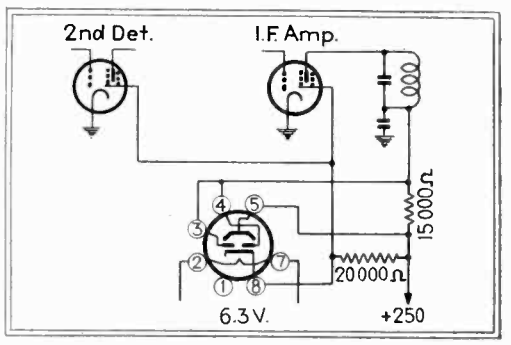
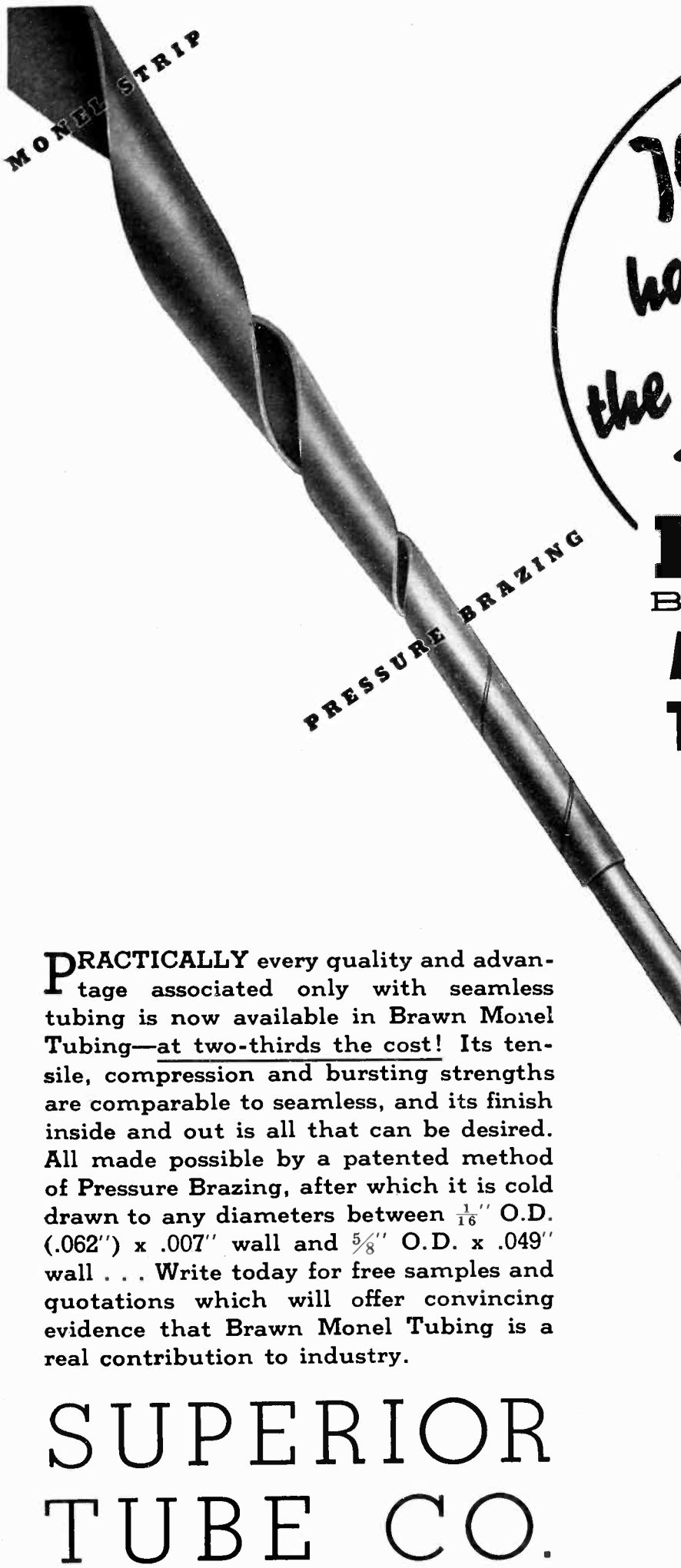
New Tuning Indicator Divides Control Range Between Two Elements

A NEW TUNING indicator tube, type 6AD6G has recently been announced by the National Union Radio Corp. The tube is a cathode ray type of tuning indicator containing the usual target, and two separate control electrodes. Each of these control electrodes is brought out to a separate terminal, so that separate voltages may be applied to them for indicating two entirely separate effects, or two different degrees of sensitivity of the same effect. By connectng the two grids to-



Double-indication tube in i-f amplifier circuit

gether, the tube will function in essentially the same fashion as the earlier types of indicator tubes such as the 6E5. For use in conjunction with the 6AD6G, the same company has announced a double plate tube, the 6AE6G, a tube which contains one cathode, one grid, and two symmetrically disposed plates. When this latter tube is used as a direct current amplifier, it is possible to apply the control voltages from one plate to one of the control electrodes in the indicator tube, while that from the other plate is applied to the other control



If PRICE has prohibited the use of Seamless Tubing-consider

BRAWN

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MONEL TUBING

PRACTICALLY every quality and advantage associated only with seamless tubing is now available in Brawn Monel Tubing—at two-thirds the cost! Its tensile, compression and bursting strengths are comparable to seamless, and its finish inside and out is all that can be desired. All made possible by a patented method of Pressure Brazing, after which it is cold drawn to any diameters between $\frac{1}{16}$" O.D. (.062") x .007" wall and $\frac{5}{8}$" O.D. x .049" wall . . . Write today for free samples and quotations which will offer convincing evidence that Brawn Monel Tubing is a real contribution to industry.

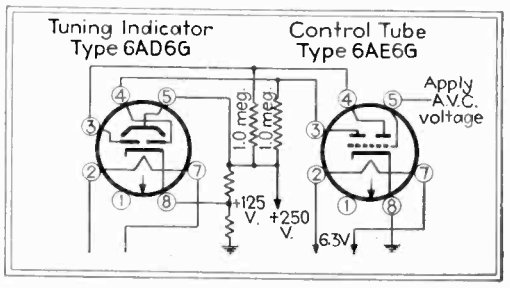
SUPERIOR TUBE CO.

NORRISTOWN, PENNA.

Manufacturers of Lockseam Cathode Sleeves under U. S. Patents

and fine small seamless tubing in various metals and alloys.

electrode. The arrangement of the plates is such that one displays a remote cut-off characteristic, while the other displays a sharp characteristic. Consequently, when used with the indicator tube, one of the shadows displays sensitivity limited by the sharp cut-off while the other has a much wider range of sensitivity corresponding to remote cut-off. The coupling circuit employed, as shown in the diagram, is identical for both plates, the difference in sensitivity being obtained simply in



Use of tubes for extending range of tuning indication

the differences in the cut-off characteristics. The advantage is that the change-over from high sensitivity of tuning indication to low sensitivity is accomplished automatically. A simple method of employing the tuning indicator tube directly in the i-f amplifier of a superheterodyne is shown in the second figure. The maximum target voltage of the 6AD6G is 150 volts. The target current at this rating is 3 milliamperes. The control electrode voltage ranges from —50 to +75 volts for complete control of the shadow.

• • •

PHOTOELECTRIC CHECK-SIGNER

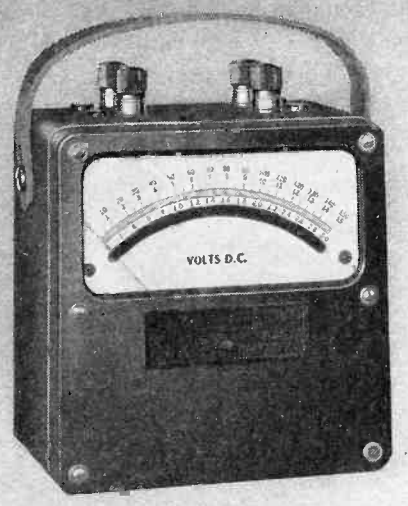
A photoelectrically controlled facsimile machine, intended for controlling check-signing machines and similar large-scale duplicators has been developed by Glenn W. Watson of Detroit

Trustworthy

. . . For Every Test Requirement

MODEL 310 LINE

Precision portables (electrodynamometer type accurate within ¼ of 1%) for critical test work, available for AC and DC, in voltmeters (single, double and triple range), ammeters, milliammeters, wattmeters, etc. Scale length, 5¼ inches.



MODEL 430 LINE

Rugged portables for maintenance work. A full line of *DC instruments* (Permanent Magnet Moving Coil type—accurate to ½ of 1%). *AC instruments* (Movable Iron Type—accurate to within ¾ of 1%). Also *wattmeters* for DC and AC (accurate within ½ of 1%). Scale length, 4 inches (approx.).

MODEL 622 LINE

Single and multi-range *ultra-sensitive DC instruments* for measurement of minute currents in radio, telephony, thermocouple work, electro-chemistry, and the like. Shielded, double-pivoted instruments (Permanent Magnet Movable Coil type—accurate within ½ of 1%). Scale length, 6 inches.

For maintenance work, for industrial or school laboratories—wherever portable test instruments are employed—the name WESTON is recognized as a symbol of trustworthy electrical measurement.

WESTON "Portables" are designed in several types, with specifications and ranges to meet the particular requirements of all varieties of test work. Behind all the specifications, however, is the same "engineering-from-bedrock"—a consistent application of the design factors that make for rugged dependability as well as rated accuracy.

After all, when you buy a WESTON—whatever the type or specifications—you get an extra increment of experience which stems from a half-century of instrument building. Why not check with the WESTON representative as to the type of meter best suited to your needs?

Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

WESTON *Instruments*

THE ELECTRON ART

Programs directed over German wired radio system. Television transmitter at Paris inaugurated for general service. Review of electron multiplier design

A Practical Wired Radio System

CARRIER CURRENT broadcasting systems provide independence from international frequency allocations and elimination of fading. Moreover, the problems of noise reduction are simplified considerably because of the practically constant signal-to-noise ratio which is practically independent of the distance from the transmitter. Finally, in order to obtain greater coverage in wired systems it is necessary only to add low power booster amplifiers, while in wireless systems the transmitter power must be raised considerably to extend coverage.

With these points in mind an experimental wired radio system was installed in Germany and tested to study the case of wired versus wireless radio communication. Broadcasts were sent over the regular toll telephone systems at radio frequencies within the range of ordinary home broadcast receivers and were intercepted with consistently good quality by receiving equipment connected to the telephone lines through suitable and simple filters. The description of the experimental work and apparatus, as given by A. Wiessner in *Lorenz Berichte*, December 1937, pp. 128–155, is reproduced here in abbreviated form.

A broadcast frequency range of 150-300 kc/s was chosen as a happy medium between minimum obsolescence of existing home radio receivers and efficient transmission over the established country wide telephone lines. A typical set-up for radio program distribution is shown in Figs. 1 and 2. Low pass and high pass filters with sharp cut off characteristics were installed together in tamper proof boxes at both the transmitting and the receiving ends. Figs. 3 and 4 show such a filter arrangement and the filter response of a typical installation.

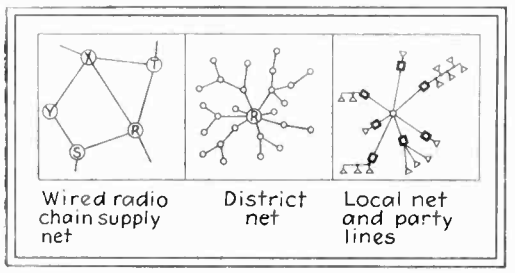


Fig. 1—Schematic diagram showing the organization of wired radio networks permitting strategic control from centralized points

When transmitting over cables ($Z = 150\Omega$) it was found that the minimum receiver input signal level of 25 mv. was determined by receiver sensitivity, and not by the noise level.

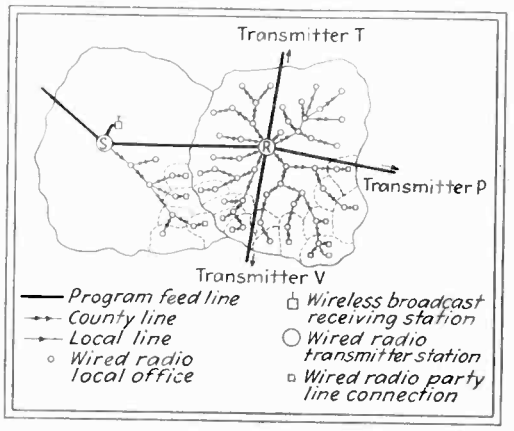


Fig. 2—Detail of district net indicating connections between transmitting and receiving equipment

With open wire lines ($Z = 600\Omega$) however, the inherent noise level necessitated a 100 mv. signal for satisfactory reception. From considerations of line attenuations and economy it was decided to limit the transmitting radius of a county radio control net to distances which were equivalent to 170 db of line attenuation. This called for six line amplifiers inserted at low level points in such a way as to maintain a satisfactory level at all receiving stations of the net.

The wired radio transmitters were flexible units designed to cover from 150 - 300 kc/s. Each unit was equipped with a three stage, high frequency, power amplifier which boosted the transmitter carrier to 2.5 watts. This was then diode modulated up to 80%, giving a 2 volt signal (at 30 – 10,000 cps) at the high impedance modulator input. Four complete transmitter systems together with the necessary metering equipment and a.c. mains operated individual power supplies for each transmitter unit, were mounted in a standard telephone rack. The amplifiers were designed to use the same tubes throughout. Power requirements for a single transmitter and amplifier combination were in the vicinity of 180 watts.

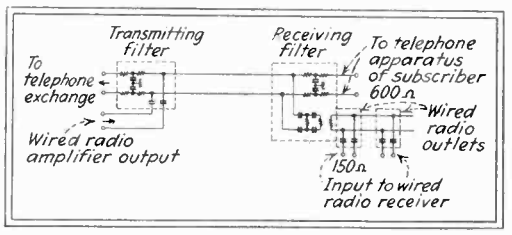


Fig. 3—Schematic wiring diagram of filter network which permits wired radio programs to be sent over telephone lines

Both tuned and broad band type amplifiers were used. Broad band amplifiers, with negative feed back, and a power rating of 2.5 watts, were found most desirable in multiple program service where the load requirements were low, while 4 watt channel amplifiers were provided for heavier load service. The channel amplifiers were tunable to any frequency between 150 and 300 kc/s.

Due to the drooping frequency response of telephone lines there was a decided difference in required transmitter power requirements at different frequencies. For example, in order to maintain equal signal levels in a four program line at the frequencies 150, 180, 210 and 240 kc/s, the transmitter powers had to be in the ratios of 1 : 1.35 : 1.9 : 2.43.

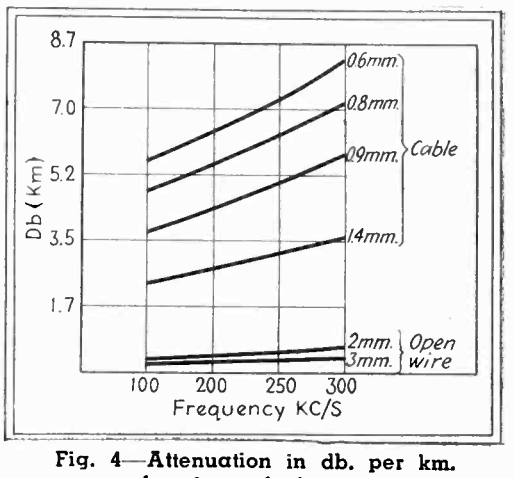


Fig. 4—Attenuation in db. per km. as a function of frequency for open wire and cable

The transmitters were installed in supervised telephone exchanges wherever possible. Booster amplifiers and unattended transmitting units in outlying districts were remotely controlled by an economical high frequency impulse device which started and stopped the remote stations as required, and which in addition was capable of transmitting warning signals to personnel at the nearest station whenever any unit failed to perform normally. At the conclusion of a broadcast transmission the entire carrier current system is usually shut down automatically, or by the attendants, as the case may be.

25 KW. Television Transmitter at Eiffel Tower Goes into Operation

THE TELEVISION transmitting station in the Eiffel Tower, Paris, was inaugurated for general service recently by a gathering of French government officials, headed by the Minister of Posts and Telegraphs. The power of the transmitter has been raised to 25 kw. but it is expected that this power will be raised to 30 kw. before long.

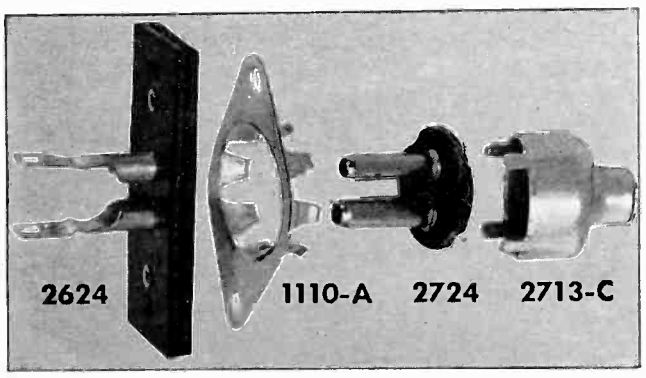
ANY WAY YOU LOOK AT IT...

ALL WAYS DEPENDABLE —STANDS UP UNDER "PUNISHMENT"

(ABOVE)

SHELL 2719 · PLUG 2779 · SOCKET 2684
PHOTOGRAPHED 1½ TO TWICE ACTUAL SIZE

A dependable socket (below), completely adequate for purposes where used. In it is embodied the fine customary "Cinch" workmanship, material and features.



A real shielded plug; high protective collar having integral resilient spring for positive contact with shell. No chance for leakage.

Complete and compact. Consists of shell, polarized plug with long center "finder" prong and one-piece socket, supplied with two to five prongs.

Perfect and positive alignment; mounting holes supplied tapped for screws or plain for rivets.

Rigid and sturdy; eliminates breakage.

Flexible; adaptable for any shielded connection.

"Cinch" and Oak Radio Sockets are licensed under H.H.Eby Socket Patents.

CINCH

MANUFACTURING CORPORATION
2335 WEST VAN BUREN STREET, CHICAGO, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORPORATION, CAMBRIDGE, MASS.

The design and construction of the television antenna and transmitter have involved not only the solution of new and difficult technical questions but also the solution of many installation problems, including that of installing the feeder cable between transmitter and antenna. This cable has a total length of 1,250 feet, is more than 5 inches in diameter, weighs 12 tons and had to be installed without interferring with normal elevator service in the Tower.

Two television studios containing the most modern equipment have been installed. These studios are 1½ miles and 3 miles from the transmitter and are connected to the station at the Tower by special cable of the coaxial type developed for multiplex telephony and television. The cable has a characteristic impedance of 71 ohms, a maximum attenuation of 4.8 db per mile at 1 mc., 6.6 db at 3 mc. and 12.6 db. at 8 mc.

Because amplifiers covering a wide frequency ratio are difficult to manufacture with satisfactory characteristics, the 0 to 2.5 mc. television signal is impressed upon the high frequency carriers for transmission over the cable. For transmission of the image band a carrier frequency of 5.5 mc. is used, so that the range of transmission extends from 3 to 8 mc.

The equipment for modulating the 5 mc. carrier consists of a crystal controlled oscillator, a 5.5 mc. decoupling amplifier, a balanced oscillator and two push-pull amplifiers. The television signal is supplied directly from the amplifier connected with the scanning device at a level of 60 milliwatts in 70 ohm termination. This is sufficient to modulate the grid of the modulating amplifier. The complete signal is then amplified in two linear stages and applied to the coaxial cable.

At the receiving end the incoming modulated carrier is amplified and then demodulated in a symmetrical circuit. The 60 milliwatt television signal produced across the 70 ohm output is applied to the modulating amplifier of the television transmitter. In the case of the longer length of cable, a repeater is necessary to restore the level to its normal value. The repeater consists of a three stage amplifier having an input and output impedance of 70 ohms, with a gain-frequency characteristic which is substantially flat over the range from 3 to 8 mc.

Since there is, as yet, no definite world-wide standardization as to the most preferable type of image scanning, it was necessary to incorporate sufficient flexibility in the transmitter to enable operation for any type of scanning system, provided the modulation frequencies remain within the specified band. The transmitter is designed to operate on a frequency between 40 and 50 mc. but is operating at 46 mc. at the present time. The transmitting and other equipment was engineered and installed by Le Materiel Telephonique.

INTER-OFFICE CORRESPONDENCE

McGRAW-HILL PUBLISHING COMPANY·INC

TO Promotion Department — FROM H. W. Mateer

LOCATION New York — LOCATION New York

SUBJECT PROOF OF ELECTRONICS' VALUE — DATE June 18, 1938

Here is another unsolicited letter from an advertiser who checks results carefully and finds that "when you want to reach the best people in the industry who want to know what is new, ELECTRONICS serves that purpose best." Such proof of the value of ELECTRONICS advertising is certainly gratifying, and I think other advertisers and prospects should know about it.

Webster Electric Company

ESTABLISHED 1909

Racine, Wisconsin.

June 16, 1938

Mr. H. W. Mateer
Electronics
McGraw-Hill Building
330 West 42nd Street
New York, New York

Dear Mr. Mateer:

Recently we announced to the Radio Trade some new developments in Crystal Cartridges and Tone Arms and used ELECTRONICS to tell the trade about them.

I thought you might be interested in knowing that careful analysis of the results of this publicity showed a surprisingly large number of inquiries from both the engineering and management end of the Radio Industry.

In addition, a considerable number of dealers and jobbers asked for information about our new products.

We have found that when you want to reach the best people in the Industry who want to know what is new, ELECTRONICS serves that purpose best.

Yours very truly,

WEBSTER ELECTRIC COMPANY

Henry Kahnke.

Assistant to the President

The monitoring equipment for a television transmitter is considerably more complicated than that for sound broadcast station, because the modulating wave shapes are neither sinusoidal nor symmetrical, and because harmonic and phase distortion, as well as frequency distortion, impose much more stringent requirements in a video transmitter than in an audio transmitter. At present, the easiest method for accomplishing the monitoring of a television transmitter is by means of cathode ray tubes upon whose screens various images and wave forms may be produced. Consequently, five oscillographs are mounted in the monitoring bays, together with their associated equipment. These are used to give rapid indications of, (a) the envelope of the high frequency output to the antenna, (b) the signal components at the input to the modulating amplifier, (c) the signal components from a linear rectifier coupled to the output of the transmitter, (d) the television image at the input to the transmitter and (e) the television image as received from a linear rectifier at the output of the transmitter.

Electron Multiplier Design

A NON-TECHNICAL DISCUSSION of one method of approach in the design of electron multipliers is contained in the *Bell Laboratories Record* for May. The article, "Electron Multiplier Design" by J. R. Pierce gives a general outline of the method of operation of multiplier tubes, and discusses briefly some of the early work in this field.

In order to eliminate the complexity and accessory equipment which must be provided when the flow of secondary electrons is guided by both electric as well as magnetic fields, the Laboratories undertook an investigation of multipliers containing only electric fields. The design of a satis-

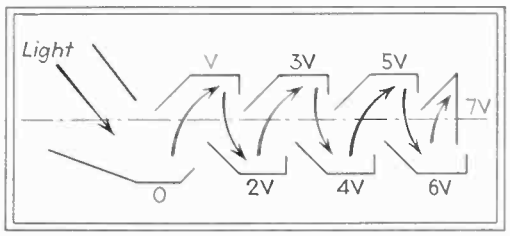
• • •

NEW N.A.B. HEAD

Neville Miller (left), recently elected president of the National Association of Broadcasters, takes a few tips from Mark Ethridge outgoing temporary chairman. Miller will have dictatorial powers under the newly organized N.A.B. charter

factory multiplier of this type was sufficiently involved that electron ballistics were of little use in arriving at an engineering solution, because of the complex mathematical relations which had to be solved.

To determine the path of primary as well as secondary electrons, a model consisting of a thin, tightly stretched rubber sheet in a rectangular frame, small marbles or balls, and various blocks of wood were employed in the electro-mechanical analogy. The variations in relief of the rubber sheet represented the potential distribution.



Note similarity of this electron multiplier design and that shown on page 12

The blocks of wood represented surface configurations of the electrodes, and the marbles simulated electrons. Under the influence of gravitational attraction, caused by dents in the rubber sheeting, the paths of the marbles represented the paths of the electrons under the influence of an electric field.

By means of such models, electron multiplier tubes were designed. It is reported that, with an overall anode voltage of 750, one multiplier design will produce a safe output of a few milliamperes per lumen, with a maximum output of about 30 milliamperes per lumen, instead of perhaps 20 to 100 microamperes per lumen, as obtained in ordinary vacuum and gas phototubes. This design uses seven stages of multiplication, has an output resistance of about one megohm.

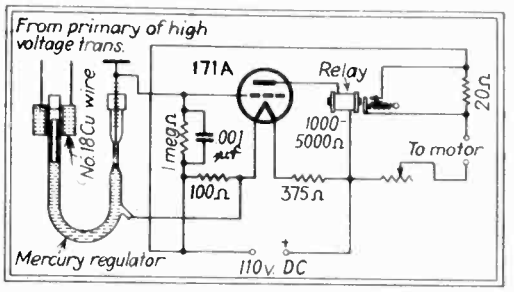
The electron multiplier has a number of advantages as compared with a photoelectric cell and an equivalent vacuum tube amplifier. It is much smaller than the combination of phototube and amplifier tube, and is, in fact, not much larger than the phototube itself. For high frequency operation, the multiplier is less noisy than the photo-amplifier combination. The multiplier is practically non-microphonic, and the noise in the output circuit is little higher than the unavoidable shot noise of the phototube, multiplied by the gain of its associated amplifier.

An additional advantage of the electron multiplier, not mentioned in the article, is that with a moderate voltage supply, the multiplier can be made to actuate inexpensive meters, relays, or other equipment having a sensitivity of a few milliamperes, directly, and without the use of troublesome direct current amplifiers. While of course the barrier type of photoelectric device does actuate a milliammeter directly, the light sensitivity of this latter combination frequently leaves much to be desired.

Electron Tube Controls Current Through X-Ray Tube

A METHOD of controlling the current through a gas-type of x-ray tube is described by E. N. Bunting in the May issue of the *Review of Scientific Instruments*. The circuit operates by controlling the current through the primary of the high voltage transformer which current is used to control the speed of the oil pump evacuating the tube, provided the pump is driven by a d-c motor.

The current for the primary winding of the transformer is passed through a solenoid and controls the po-



Solenoid, mercury column, and triode with relay control current to an x-ray tube

sition of a magnetic rod floating in one side of a U-shaped tube filled with mercury. The rod is surrounded by oil to prevent sticking to the walls of the containing tube, as shown in the diagram. The other end of the mercury regulator tube makes and breaks contact to the grid circuit in a triode whose plate current operates a relay. The plate circuit relay controls the amount of resistance in series with the motor operating the oil pump. With the regulator properly adjusted, the motor increases its speed when too much current passes through the x-ray tube, but decreases when the current in the x-ray tube decreases.

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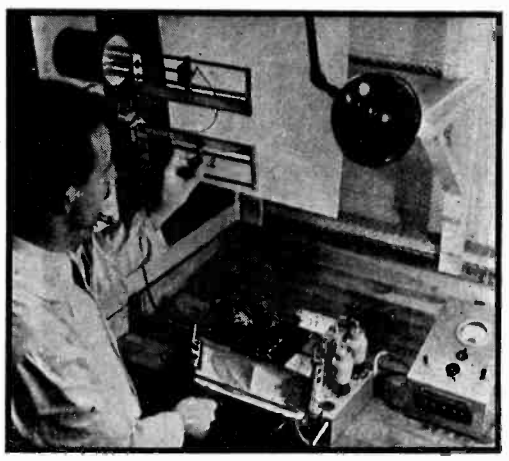
SLIDING CONTROL IN SELECTIVITY TESTING



At the Telefunken works in Berlin, the frequency of the signal generator, used in selectivity tests, is varied by sliding controls, rather than the usual rotating dials. Quicker or more accurate readings are claimed

Measuring Magnetic Fields

(*Continued from page 21*)

nichrome in order not to influence the magnetic field to be measured.

The operating characteristics of the present developmental tube may be summarized as follows:

Direction of Field

To determine the direction of magnetic field, the tube is held with its axis at right angles to the field lines. The beam then describes a circle in a plane which is also at right angles to the field lines. The original orientation of the tube axis is easily accomplished since the beam spirals off to the side wall of the tube when the tube axis is not at right angles to the field. In the proper orientation the beam returns to the axis of the tube. The normal to the plane of the circle, then, offers a convenient visualization of the field vector.

Magnitude and Variation of Field

The diameter of the semi-circle formed by the beam may be read off markers on the mesh. This distance

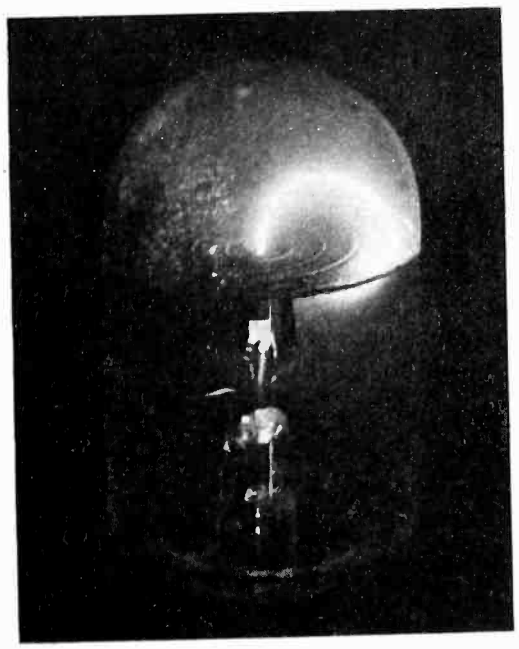


Fig. 2—Enlarged view of the circle formed by the electron beam

in cms. inserted for d in expression (1) will give the magnetic field in gausses.

When the tube is used to explore the field in space the changing circle diameter and changing orientation of the plane of the circle give a direct visual picture of the variation of magnitude and direction of the mag-

netic field. The magnetic field is characterized at each point by a vector whose direction is normal to the plane of the circle and whose length is inversely proportional to the diameter of the circle.

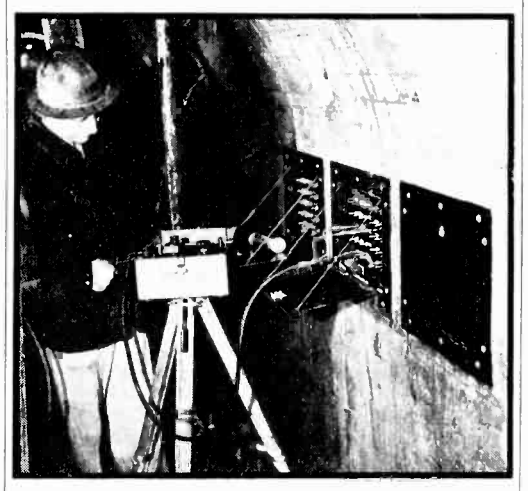
Range

According to expression (1) the range of magnetic fields that may be measured by the tube is determined by the upper and lower limits of usable beam voltages and the upper and lower limits of observable circle diameters. For a range of beam voltages from 50 to 500 volts and of circle diameters from 0.5 to 30 cms., the range of magnetic fields is 1.5 to 300 gausses. With large circle diameters the beam will of course not be able to describe a complete circle but will strike the glass wall of the tube. The glass wall may, according to the geometry of the tube, be marked off in circle diameters.

Precision

The accuracy of any reading made on the tube is determined mainly by the ratio of the beam cross-section to the diameter of the circle formed by the beam. For a range of fields from 16 to 150 gausses the diameter of the circle may, by adjusting the beam voltage, be made to fall in the range of 1 to 3 cm. The beam cross-section may be as small as 0.5 mm. In this range of fields, the accuracy of measurement will be 1 to 5 per cent.

MONITORING TEMPERATURE OF COULEE DAM



As the concrete in the Grand Coulee dam cures, an accurate record of the heat given off is recorded through some 25 resistance thermometers buried in the structure and connected to this terminal board

RMA Standards

(*Continued from page 29*)

be identical, permitting proper interlace.

These are the recommended standards—sufficiently comprehensive so that the type of signal radiated by transmitters following these standards will be uniform. Philco's experimental television transmitter, W3XE in Philadelphia, is already transmitting signals according to these standards. It is believed the NBC television transmitter at the Empire State Building, New York City, soon will be radiating signals conforming to the RMA Standards. Other experimental transmitters will follow.

In these days of pre-commercial television these standards are naturally tentative. The RMA Television Committee realizes there will be changes and additions as television development moves onward.

Now that standards have been drafted, after being in the formative stage for several years, researchers in the television field feel that at this time they can confidently plan concentrated work along the definite lines indicated by the chosen standards.

Editors Note: The work of the RMA Television Committee is an outstanding example of cooperation in a highly complex technical and commercial situation. In view of the many compromises necessary between different points of view, the members of the committee, listed below, are to be commended for completing a difficult job.

RMA Television Committee

Group 1. Members: J. E. Brown, Zenith Radio Corp.; R. B. Brown, Philadelphia Storage Battery Co.; E. W. Engstrom, RCA Manufacturing Co.; I. J. Kaar, General Electric Co.; H. M. Lewis, Hazeltine Service Corp.; R. H. Manson, Stromberg-Carlson Tel. Mfg. Co.; H. V. Nielsen, Sparks Withington; H. J. Tyzzer, Crosley Radio Corp. This committee reports to Virgil M. Graham, Sections Chairman, who in turn reports to W. R. G. Baker, RMA Director of Engineering.

Group 2. Invited members (not representing RMA Member Companies): R. Bown, Bell Telephone Laboratories; P. C. Goldmark, Columbia Broadcasting System; A. N. Goldsmith; J. V. L. Hogan, Radio Pictures; R. M. Morris, National Broadcasting Co., Inc.; P. T. Farnsworth, Farnsworth Television Inc.; A. F. Murray (Acting Chairman), Philco Radio & Television Corp.

MANUFACTURING REVIEW

News

✦ At the Chicago Radio Parts Show, Howard Radio Co., Chicago, displayed several new amateur and communications receivers . . . Frank D. Fessler, development engineer for Electrical Research Products, Inc., since 1929 has assumed a similar position with Motiograph, Inc. . . . Headquarters organization of Westinghouse Radio Stations has opened new quarters in Baltimore. This organization supervises the operation of stations KDKA, KYW, WBZ, WBZA, WOWO and WGL. Personnel is made up of S. D. Gregory, Ralph N. Harmon, Gordon Hawkins, and J. B. Rock. In July, Walter C. Evans, Manager of the Radio Division, will move to Baltimore from Chicopee Falls, Mass., with his manufacturing organization . . . Illinois Condenser Co., Chicago, has moved to larger quarters at 1160 North Howe Street.

✦ RCA paid dividends amounting to 87½ cents a share on the first preferred stock and a $1.25 a share on the B preferred stock for the period April 1 to June 30th . . . American Emblem Co., Utica, N. Y., has purchased the assets and business of the Eddie Mfg. Co., Chicago, Manufacturers of radio dials, drives, scales and tuning mechanisms . . . Driver-Harris announced the opening of a warehouse in San Francisco. The Electrical Specialty Co., Ltd., are the Driver-Harris west coast representatives . . . Philco, according to Larry Gubb, President, is invading the air-conditioning field. The product will be a portable unit called Cool-wave which can be placed in any room of a home, in offices, hospitals, or hotels . . . Radiotone, Inc., has broken ground for a new plant at 7356 Melrose Ave., Hollywood, to manufacture recorders.

✦ "What's new in Radio" . . . Not what you say, but how you say it is frequently the difference between conveying an idea correctly or incorrectly. The article, under the above title, in the June issue is a case in point. Recognizing the extensive design and manufacturing development carried out by P. R. Mallory & Co., of Indianapolis, the editors failed to emphasize that Mallory manufacturers electrolytic condensers having standardized electrical and mechanical characteristics, and licenses other manufacturers under its patents. Several electrolytics were measured by Benny French and the editors at the recent I. R. E. show and were found to be "right on the button." . . . M. W. Kenney has been appointed chief engineer for the Seeburg Radio Corporation of Chicago. He was formerly connected with Motorola in the same capacity.

Literature

Manufacturers' literature constitutes a useful source of information. Readers who wish copies of items listed below may obtain them by writing to the manufacturers.

Thyratron. Bulletin TD-88 gives technical information on WL-629 tube. Westinghouse El. & Mfg. Co., Bloomfield, N. J., Lamp Division.

Cathode-Ray Tube. Application Note No. 92 fully describes the application of the improved Type 906 Cathode-Ray Tube at low voltages. RCA Mfg. Co., Harrison, N. J.

Water-cooled Tubes. Complete engineering data on water-cooled and air-cooled tubes. Instructive and interesting information is contained in General Instruction Sheets. Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y.

Tubes. Receiving Tube Chart 1275-B, in booklet form, gives characteristic data on all glass, glass-octal, and metal types in numerical-alphabetical sequence, and includes socket designs. Air-cooled Transmitting Tubes, Booklet TT-100 classifies RCA tubes according to triodes, tetrodes, pentodes, rectifiers, and miscellaneous types. RCA Mfg. Co., Harrison, N. J.

Tube Shields. Bulletin TS-5, illustrates new 1100 Series form-fitting tube shields. Goat Radio Tube Parts, Inc., 314 Dean St., Brooklyn, N. Y.

Amateur Tube Uses. "Handbook of Amateur Tube Uses" is an encyclopedia of technical information for amateurs. Includes temperature color chart. Raytheon Production Corp., 420 Lexington Ave., New York City.

Broadcast Station Equipment. An elaborate spiral-bound general catalogue of broadcast station equipment, including a new line of transmitting and speech input equipment, tables in which differences and similarities of apparatus are listed and the conditions of use outlined. Photographs, drawings and charts. Price 50c. RCA Mfg. Co., Camden, N. J.

Voice Coils. Instructions for centering voice coils in Magnavox Speakers. The Magnavox Co., Fort Wayne, Ind.

Dynamotors. Power supply equipment for sound systems, police units, aircraft, marine and broadcast service. Also bulletin on heavy duty power plants Types GA and GD. Pioneer Gen-E-Motor Corp., 466 W. Superior St., Chicago, Ill.

Welding Tips. Specification Bulletin on spot welding tips and water-cooled holders including dimensions, drawings, etc. A table gives data on spot welding of similar and dissimilar metals with Mallory alloys. Also data on new pointed type tip. P. R. Mallory & Co., Indianapolis, Ind.

Checking List. An index and checking list revised June, 1938. Also bulletins on heavy duty rheostats, midget magnet relays, sensitive relays, time delay relays, speed regulators, and voltage regulators. Ward Leonard, Mt. Vernon, N. Y.

Rheostats and Resistance Units. Stock Catalogue No. 17 lists and describes line of products for industrial radio and electronics fields. It includes extensive tables of ohms, current and voltages for the different units. Ohmite Mfg. Co., 4835 W. Flourney St., Chicago, Ill.

Pickup Inspection. Use of a microscope for testing high fidelity pickups. Brush Development Co., 3322 Perkins Ave., Cleveland, O.

Weston Pointer. New house organ published in the interest of the radio serviceman by Weston Electrical Instrument Corp., Newark, N. J.

Cords. A rubber armored cord known as "Tricord" which can be bent, tied into a knot, and abused without injury, Type S. is a heavy duty flexible all-rubber cord for use on portable tools, lights, etc. Triangle Conduit & Cable Co., Inc., Elmhurst, N. Y.

Transmitters. A 16-page illustrated catalogue descriptive of radio-telephone and telegraph transmitting equipment for multi-frequency operation. Included are: portable transmitters, marine, radio-telephone, transmitter and receiver installations, and automatic frequency controlled transmitters licensed under patents of AT&T for state, county, and municipal police service. Transmitter Equipment Mfg. Co., Inc., 130 Cedar St., N. Y. C.

Motors. June, 1938 bulletin "Motorgram" describes Finch Facsimile System and gives data on lubrication of fractional hp motor bearings. Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

Micro Switches. Bulletins 14 and 15 give dimensions and characteristics of standard and type Z units. Bulletin 16 describes type LK interchangeable precision limit switch. Micro Switch Corp., Freeport, Ill.

Vibration Control. Reprint of a paper presented by S. Rosenzweig, before the ASME at Dallas, June 7. It is a comprehensive treatise covering the subject of machinery vibration transmission and its elimination. Korfund Company, 48-15 32nd Place, Long Island City, N. Y.

Electrical Insulating Materials. "Lamicoid", Price List No. 105 gives complete information on sheets, tubes and rods. Bulletin No. 110-B gives prices, description and application of Translucent Lamicoid. Lamicoid Fabricators, Inc., 636 N. Albany Ave., Chicago, Ill.

Time Switches—Flashers. Bulletin describing six time switches including a spring wound unit, a twin time switch, and data on on-and-off flashers. Spellers and interference elimination are also included. Automatic Electric Mfg. Co., Mankato, Minn.

Tube Manual. "Quick Reference Radio Tube Manual", is spiral bound and groups tubes by function. It gives considerable data on practical uses including design considerations. National Union Radio Corp., 57 State Street, Newark, N. J.

Machinist's Manual. "How to Run a Lathe" is a revised edition containing 128 pages, 350 illustrations, describing all phases of lathe set-up, and methods for handling all important machining operations. South Bend Lathe Works, South Bend, Ind. Price 25c.

New Products

New Tubes

RECENT additions to the tubes available to engineers are the following: The OA4G, the gas-filled cold cathode triode described in *Electronics* May, 1938; the 4A6G, a twin triode class B amplifier for 90 volt battery receivers; the 6P5G, an octal base triode otherwise identical with 76; the 6S7, a metal counterpart of the 6S7G; the last three tubes are from Raytheon.

The 6AF6G a twin indicator electron ray tube. This tube announced by RCA, is a high vacuum heater cathode tube designed to respond visually by means of two shadows on a fluorescent target to changes in voltages applied to the control electrodes. It acts as a voltage indicator and is useful as a convenient and non-mechanical means to indicate accurate tuning of radio receivers.

National Union have developed a two ray tuning tube, the 6AD6G, and a special control tube to go with the tube known as the 6AE6G. The latter is a tube having a single cathode around which is the grid having evenly wound grid turns for a portion of this length, and for the remaining portion the grid turns are unevenly spaced. Surrounding this grid are two plates. National Union engineers have developed special circuits for use with these tubes.

Sylvania announces a Type 1231 triple grid high mutual conductance amplifier for use in television, video circuits, etc. A new type of construction permits very short leads with a result that the maximum grid plate capacity is 0.015 $\mu\mu$f.

New battery tubes operating with a nominal voltage of 1.4 and a current of 0.05 amp. have been added to the Hydgrade Sylvania list. These are the 1A5G and 1C5G, power output pentodes, the 1A7G, a pentagrid converter, the 1H5G, a diode triode detector amplifier, and 1N5G which is a pentode suitable for i-f and r-f amplification.

Time Cycle Control

A NEW TWO-SPEED controller manufactured by the Electric Switch Corp., Columbus, Ind., simplifies recycling operations. Model 635 utilizes varied speeds on a single camshaft. In recycling operations, a number of operations must occur for exceedingly brief periods at short intervals, cease for a longer period and then begin again. Ordinarily, more than one camshaft speed is required because of the limitations of the cam action with a single fixed speed. In Model 635 motors of different speeds are placed at either end of the camshaft and utilizing speed reducers and overriding clutches at proper places on the shaft the cycling operation is accelerated or slowed at any point desired in the cycle.

Electronic Voltmeter

A NEW SENSITIVE electronic a-c voltmeter, Model 300, having several novel features has been announced by Ballantine Laboratories, Inc., Boonton, N. J. Very much more sensitive than the conventional type of vacuum tube voltmeter it is capable of reading down to one millivolt and covers the entire range of voltage up to 100 volts in five decade steps. The frequency range of 10 to 100,000 cycles covers the audio, supersonic and carrier current frequencies. The accuracy is about 2%, which is unaffected by fluctuation in line voltage, variation in tube characteristics, circuit constants and temperature.

The main feature is the logarithmic scale, calibrated from 1 to 10, which permits switching in decade steps with but one scale to read. This type of scale also provides uniform percentage accuracy of reading over the entire range. An auxiliary uniform scale in decibels is also provided. The instrument is very compact, 4½ in. x 5¾ in. x 11 in., and weighs 9½ lbs.

Bakelite Laminated Material

THE INTRODUCTION of a new material has been announced by the Synthane Corp., Oaks, Pa. In place of the usual paper or fabric base, this material uses a woven glass fabric. Glass, tests show, gives a low moisture absorption which has not been duplicated previously in laminated phenolic resinoid materials. Other advantages reported are a minimum change in electrical characteristics, and greater resistance to the action of corrosive liquids.

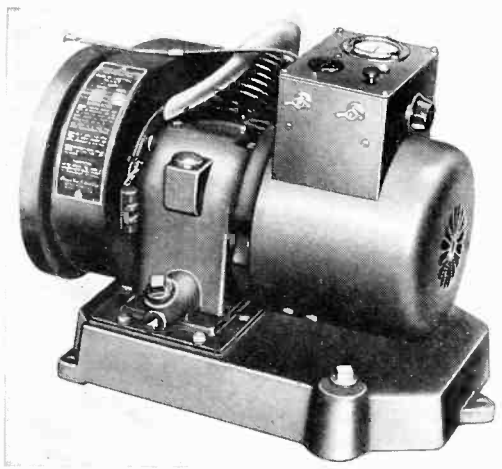
Thread Cutting Screws

"HI-HOOK" THREAD-CUTTING screws are expressly developed for plastic materials by Shakeproof Lock Washer Co., Chicago. A specially designed double width slot gives an acute cutting edge that cuts a clean, sharp thread in all types of plastic compositions, both molded and laminated. This construction materially reduces the high driving torque normally encountered and enables fast, easy driving with a minimum of breakage common to molded plastics.

Because the screw cuts a standard thread, it may be replaced if necessary by a conventional machine of the same size without damaging the tapped hole. The need for a separate tapping operation or threaded inserts is eliminated, the only requirement being that the screw be inserted in a molded or drilled hole of the proper size and driven home with a hand or power driver.

Gas Electric Plant

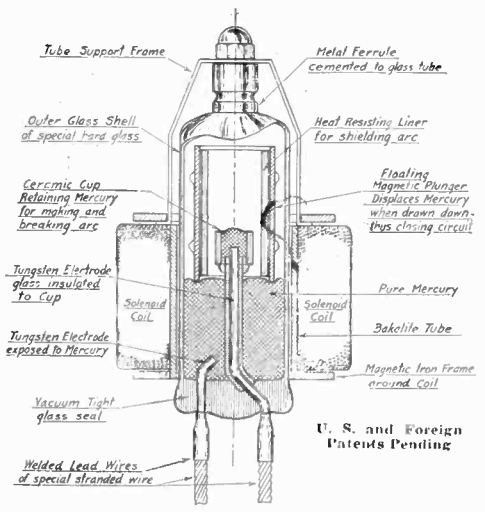
A NEW "BLUE DIAMOND" portable two-in-one electric plant is announced by Pioneer Gen-E-Motor Corp., 466 W. Superior St., Chicago. Operating without flicker, the A. C. plant has a capacity of 110 volts, 300 watts, at 60 cycles. It will furnish adequate supply of D.C. for charging batteries: 200 watts, 6 volts; 250 watts, 12 volts; or 325 watts, 32



volts D.C. The 4-pole, steel-shell generator has direct connection to the crankshaft of the engine. The 4-cycle single-cylinder air-cooled § hp. engine has a mechanical governor to maintain a constant speed of 1800 r.p.m., and has a cast iron fuel tank base and also ignition shielding. The plant is compact, overall dimensions of 19½ x 14 x 14 in. and operates 12 to 16 hrs. on one gallon of gasoline. Different types are available: push-button starting, auxiliary rope-pull starter, and remote control type.

Mercury Switch

A PLUNGER RELAY with a single moving part, capable of handling 30 amps. and 110 volts a-c is made by the H-B Electric Co., Philadelphia. It will operate in any position within 45° of the vertical. A plunger within a glass tube is pulled downward when the



coil is energized, this action displaces mercury in the tube and floods the contacts. When the coil is de-energized the plunger floats to the top of the mercury opening the circuit.

Monel Tubing

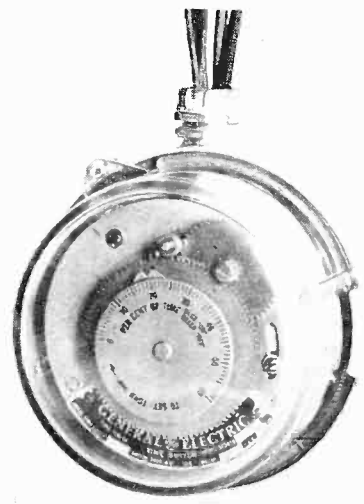
A TUBING FORMED by spiraling stripped metal but with practically all the physical characteristics of seamless tubing is manufactured in the United States by Superior Tube Co., Norristown, Pa. It is known as "Brawn" monel tubing, a word coined from BRaze-DrAWN. It is available in sizes from $\frac{1}{16}$ in OD (.062) x .0007 in. wall to § in. OD x .049 in. wall.

Indicating Lamp

A NEON LAMP for annunciator applications, or for elevator signals, night light, or on-and-off switches is announced by H. R. Kirkland Co., Morristown, N. J. The lamps are available in 3 or 6 watt ratings for voltages up to 120 in screw or bayonet base.

Automatic Time Switch

A NEW AUTOMATIC time switch, Type TSA-14, has recently been announced by General Electric, for use in a wide variety of applications such as process timing and sign flashing. The new unit is sturdy, accurate, and has an all-glass cover to facilitate easy inspection. The total time cycle of each switch is fixed dependably and accurately as the contact-making mechanism is driven through the spur gear train by a Tele-



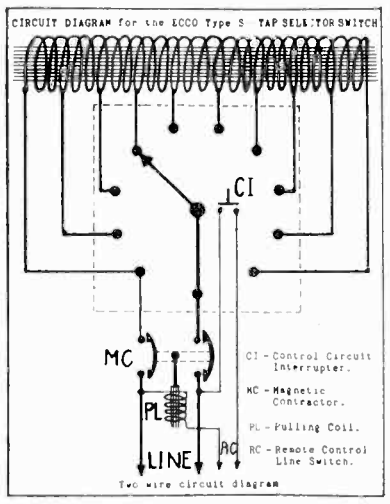
chron motor. The dial of the instrument is marked in "per cent of total time." The percentage of "on" time may be varied by the user merely by rotating the dial until the desired percentage of "on" time is indicated by the pointer. Silver contacts are mounted on the brushes, which bear on rotating cams. Stops in these cams snap the contacts "open" and "closed" at the desired intervals.

Chronograph Watch

FOR RADIO ENGINEERS, announcers, and anyone who wants split second timing, the Jardur Import Co., 21 West 19 St., New York City, offers the Multichron which is in one unit a wrist watch, stop watch, time-out watch, tachometer and telemeter. This chronograph has a 15 jewel Swiss movement.

Selector Switch

FOR SELECTION of taps of a-c reactive circuits, Ecco High Frequency Corp., 120 W. 20th St., New York City, has developed a selector switch embodying an interlock contactor arrangement



which is tied in with a magnetic contactor switch. A combined electrical and mechanical sequence eliminates arcing or a moment of short circuit when tap changes are made.

Crystal Phonograph Pickups

NEW PICKUPS of Webster Electric Co., Racine, Wis., incorporate new principles in construction of the crystal cartridge. The crystal element of rectangular shape, torque type, is moisture-proofed. It is housed and completely sealed in a molded flexible rubber housing. A metal outer shell serves as an electro-magnetic or electrostatic shield.

This construction offers the greatest possible protection against the damaging effects of moisture or humidity, and at the same time offers greatly increased protection against accidental breakage of the element.

The crystal element is of a high capacity and low reactance; has low needle point impedance and improved tone; leads are brought directly out of the cartridge, eliminating any necessity of soldering; good damping quality of the rubber housing eliminates internal reasonance. This new crystal cartridge is offered in a solid walnut hand-rubbed tone arm of unusual appearance. The tone arm is designed to minimize tracking errors down to 3 to 4%. Full lift facilities needle insertion.

Condensers

A NEW LINE of trimmer and padding condensers have been announced by P. R. Mallory & Co., Indianapolis. All types are made with fine India ruby mica, and are designed to prevent drift, or change with temperature or moisture. The adjusting screws are equipped with fine threads for accurate setting.

Available in four general types:—BT, low-priced bakelite based units in single, double, triple and quadruple sections; CT, a midget ceramic base trimmer condenser having the same capacity range as the BT (3–30 $\mu\mu$f); CTX, single section ceramic base condensers for applications requiring more capacity than available in the CT; CTD, ceramic base dual condensers having wide application because of their small size and high capacity range.

Paper Condensers

MOLDED IN LIVE rubber jackets offered by Aerovox Corp., Brooklyn, for r-f use. In the manufacture of these units no moisture is released by the vulcanizing process which is accomplished at a temperature below the vacuum-impregnation cycle of the section, as contrasted with elevated temperatures of usual phenolic resin molding. Therefore there is no absorption of moisture by the condenser section. There is no need for high pressures since the paper section is fully safeguarded in the rubber-molding process.

The new units are available in capacities up to 0.25 μf in 200 volt, 0.1 in 400 volt, 0.05 in 600 volt, and 0.01 in 1000 volt.

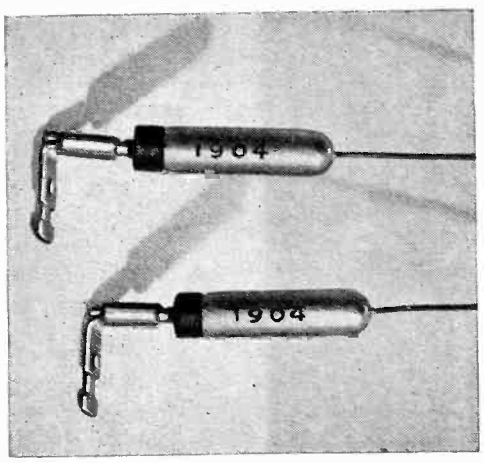
Silver-Mica Condensers

ERIE RESISTOR Corporation announces two new condensers of the silver-mica type, with unusually stable characteristics. The Type F, which measures approximately $1\frac{3}{8}$" x $\frac{5}{8}$" x $\frac{7}{32}$" thick has a positive temperature coefficient of capacity of approximately .000025 $\mu\mu$f/uuf/°C. They have practically no change in capacity with time and have a power factor of about .04%. Type F condensers can now be supplied in production quantities in ranges from 15 $\mu\mu$f to 2500 $\mu\mu$f. They are impregnated and sealed with high grade waxes in a low loss ceramic case that provides excellent protection against humidity.

The Type A silver-mica condenser is similar in construction to the Type F, but much smaller in size. It has a positive temperature coefficient of approximately .00005 $\mu\mu$f/$\mu\mu$f/°C. As it measures only $\frac{3}{4}$" x $\frac{1}{2}$" x $\frac{11}{64}$" thick, the Type A is ideal for mounting in close spaces such as the inside of i-f shield cans. This midget condenser is now available in production quantities in ranges from 40 $\mu\mu$f to 120 $\mu\mu$f. Specially designed Silver Condensers can be supplied up to 250,000 $\mu\mu$f.

Liquid Condenser

SPRAGUE SPECIALTIES Co., N. Adams, Mass., have introduced compensator condensers utilizing a liquid dielectric. They show an accurate and readily measured decrease in capacity with rise in temperature. Since the action is not dependent on the expansion of loose electrodes it is mechanically stable and will return to its given value at a given temperature. It is not affected

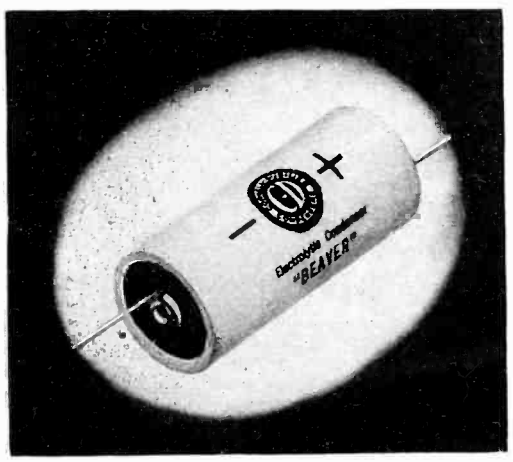


by humidity nor is it possible for dust to reach the dielectric and cause damage. From 0.5 to 2 Mc. the ratio of capacity to Q is about 0.04.

Sprague also introduced recently an automatic push button tuner system in which drifting or changing in capacity is not over 1% under severe changes of temperature and humidity. The unit is connected to the radio chassis by two wires and a ground connection.

Electrolytic Condensers

SPECIAL VENTS in the new Cornell-Dubilier Electric Corp., So. Plainfield, N. J., type BR "Blue Beaver" electrolytics permit normal dissipation of the harmless, odorless electrolytic vapor, and afford a great safety factor under all operating conditions. The formation process used in these units affords a



high voltage breakdown. Tubular, compact construction provides ease of wiring into circuit and a new varnished protective sleeve is spun-over at both ends to prevent possible short-circuits of leads to the aluminum container.

Resin

A NEW impregnating resin No. 278 for increasing the density of certain types of casting has been developed by General Plastics, Inc., N. Tonawanda, N. Y. Such a resin has the property of decreasing porosity of castings resulting from several causes.

Noise-Balancer

AN ANTENNA circuit noise balancer for use on aeroplanes, airships, tanks, etc., is announced by Whisk Laboratories, 145 W. 45th St., New York City. It is a 3-antenna balancing filter system that eliminates all engine ignition noise and eliminates the necessity for shielding engines.

Audio Oscillator

BEAT FREQUENCY oscillator, known as Model 133, of Clough-Brengle, Chicago, has high thermal stability designed particularly for laboratory research and production testing. It offers six watts of output power into a 500 ohm load.

Tuning is accomplished on two hand calibrated frequency dials covering ranges of 15 to 15,000 and 15 to 420

cps. This instrument provides flat output frequency characteristic and good wave form. Calibration is rapid and accurate. An output meter covers 4 voltages and 4 db ranges. It is a-c operated.

Oscillographs

A 9-IN. PRECISION oscillograph, Type 169, is announced by Allen B. DuMont Labs., Passaic, N. J. In addition to the natural advantage of the large screen and a brilliant pattern, there are several additional means of control in this oscillograph. There are two independent power supplies, two identical amplifiers providing push-pull electrostatic deflection, and the third amplifier for grid modulation useful in television or in other applications where the third variable is desired.

Several pickup units for translating sound, vibration, impact, heart-beat and other phenomena into electrical terms which can be observed as visual patterns are also available from the DuMont Laboratory.

Noise-Eliminating Antenna

A NEW NOISE-REDUCING antenna has been developed by RCA Victor, Camden, N. J., to give the ultimate in noise-free radio reception regardless of location. The antenna operates on principles different from those formerly employed. Instead of depending on location for its noise-reducing qualities, it has a special counterpoise coupling arrangement which permits an individual balancing adjustment to be made on each installation.

The master antenna covers a range of 140 to 23,000 kcs., and consists of the antenna wire, a transmission wire, a hermetically sealed junction box, the counterpoise, supporting wires and insulators. After the antenna and transmission wires have been installed, the counterpoise is placed parallel to the transmission wire, so adjusted that its length equals half the transmission wire length plus 10 ft., so that if the transmission wire is 40 ft. long, the counterpoise will be 30 ft. in length. The counterpoise is then fastened to the antenna near the transmission junction box by means of an insulated suspension wire.

Vibration Pickup

TWO PIEZO electric instruments for the measurement and analysis of vibration in industry have been developed by Shure Bros., Chicago. Model 61B has a linear voltage acceleration characteristic up to approximately 1000 cps. Model 62B has a voltage output four times that of the 61B and a linear characteristic up to 500 cps. Data sheet No. 163 available from Shure Bros. has considerable technical information giving response characteristics and in an appendix are the principles underlying the measurement of vibratory motion.

Level Indicator

IN COOPERATION with the Bell Telephone Laboratories, NBC, and CBS, Weston Electrical Instrument Corp. has developed a new volume level indicator. It has dynamic characteristics that result in a pointer action which is better damped, and therefore less fatiguing to the eye and which follows the signal, as impressed on the ear by the loud speaker, more exactly than is the case with present instruments.

Action of the new pointer is deliberate and there is no impression of a high speed action difficult for the eye to follow. These results have been arrived at after extended study of the physical and psychological problems involved in the proper monitoring of a program and it is believed that this new instrument will materially minimize fatigue in this work and thereby result in more accurate monitoring.

Soldering Iron

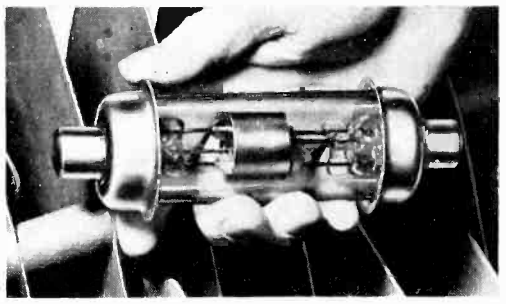
A NEW SOLDERING unit especially designed for light delicate work, on radios, telephones, small motors, instruments, etc., has been added to the line of Ideal Commutator Dresser Co., Sycamore, Ill. It is 6½ in. long by $\frac{7}{16}$ in. in diameter, and consists of a handle with two heating carbons—one fixed and the other movable against a spring. When the two carbons contact metal an electric circuit closes and soldering temperature is reached very quickly.

Contact

LIGHT TOUCH, dust proof, sturdy contact, operating on a pressure of 5 ounces and up to 25 times per second describes the "King" Contacts, a product of Robert Hetherington & Son, Sharon Hill, Pa. Movement required to open or close the contact is $\frac{3}{64}$ in. 30 amperes at 110 volts, or 15 amperes at 220 volts a.c. can be handled.

Tank Condenser

VACUUM TANK condensers having great power capabilities although they are physically small because the dielectric is a vacuum are now available from Eitel McCullough, Inc., San Bruno, Cal. The maximum overall length of the condenser is 6½ in. and the maximum of the diameter is 2¼ in. It carries a peak r-f voltage rating of 32,000 volts and a current rating of 20 to 50



amps. depending upon the frequency. These condensers resemble vacuum tubes in their physical appearance and may easily be connected in multiple. A series-parallel arrangement illustrated in a recent Eimac folder makes possible a 250 $\mu\mu$f condenser with a peak r-f voltage rating of 64,000 volts.

Fluorescent Compounds

A LETTER from Pfaltz & Bauer, Inc., Empire State Bldg., New York, states that considerable new material is available on the fluorescent compounds imported by them. Among the new materials is one which will give a pure white fluorescence. Data on the use of these compounds is available in a mimeographed letter from the importers.

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(New advertisements must be received by July 27th for the August issue)

Elect.

POSITION VACANT

RADIO ENGINEER experienced in loud speaker and audio transformer design and construction. Give age, education, experience, salary expected. P-151, Electronics, 330 W. 42nd Street, New York City.

POSITION WANTED

See also Selling Opportunity Wanted

ELECTRICAL ENGINEER; Purdue graduate. Laboratory and field experience in communication and special electronic circuits. Licensed radio operator; broadcast operating experience. Age 26; single; available immediately any location. PW-150, Electronics, 520 N. Michigan Ave., Chicago, Ill.

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Salesmen—Additional Lines

OPPORTUNITY WANTED

WANTED COMMUNICATION FROM FIRMS desiring sales representation in metropolitan New York. Experienced sales engineer, New York telephone and address. RA-152, Electronics, 330 W. 42nd Street, New York City.

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Specialists on all makes and types

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Used Meters Bought, Sold, Exchanged
Correspondence invited

Associated Research, Inc.
16 N. May Street CHICAGO, Illinois

New "SEARCHLIGHT" Advertisements

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Meters repaired, made more serviceable. Conversion to higher sensitivity as high as 10 microamperes for Weston type I or 24-57.

Sensitive vacuum thermo-couples For Sale used Weston panel meters. Rawson microammeters, Brown pyrometers. *Reasonable Prices*

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RCA-832 Hits New Performance High At Ultra-High Frequencies!

Read these interesting facts about RCA's new Push-Pull U-H-F Beam Power Tube

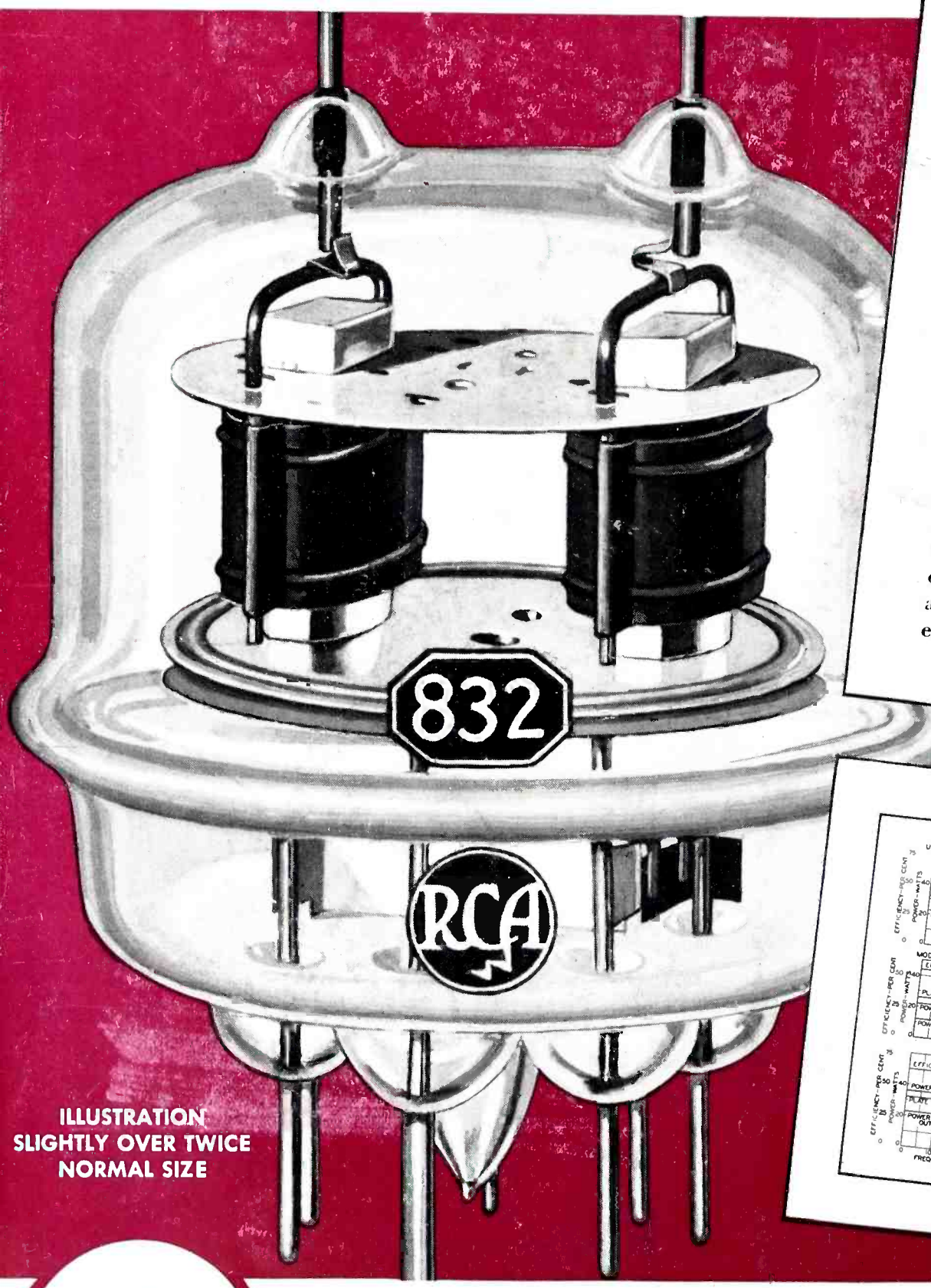

ILLUSTRATION SLIGHTLY OVER TWICE NORMAL SIZE

• The RCA-832 is a new RCA development which gives exceptional performance at frequencies from 100 to 300 Mc. It is well-suited for use in transmitters intended for line-of-sight communication.

This new tube contains two beam power units in one envelope. It is designed primarily for use as a push-pull u-h-f power amplifier with maximum ratings at wavelengths as short as two meters. With reduced ratings it may be operated at wavelengths down to one meter.

The excellent performance of the RCA-832 results from its compact, balanced structure and close electrode spacing. Its internal shielding eliminates the need for neutralization in properly designed circuits. Short internal leads minimize internal lead inductance. The terminal arrangement provides excellent insulation and facilitates symmetry of circuit layout.

For use in class C telegraph service, the RCA-832 has a maximum d-c plate voltage rating of 400 volts, a maximum total plate input of 36 watts and a maximum total plate dissipation of 15 watts. The heaters are arranged for operation from either 6.3- or 12.6-volt supply. $28.75

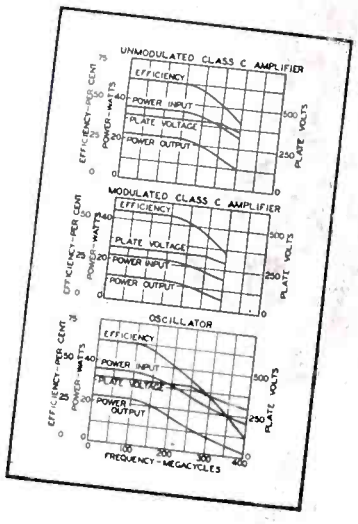

Chart shows frequency performance characteristics of RCA-832 for different classes of service.

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