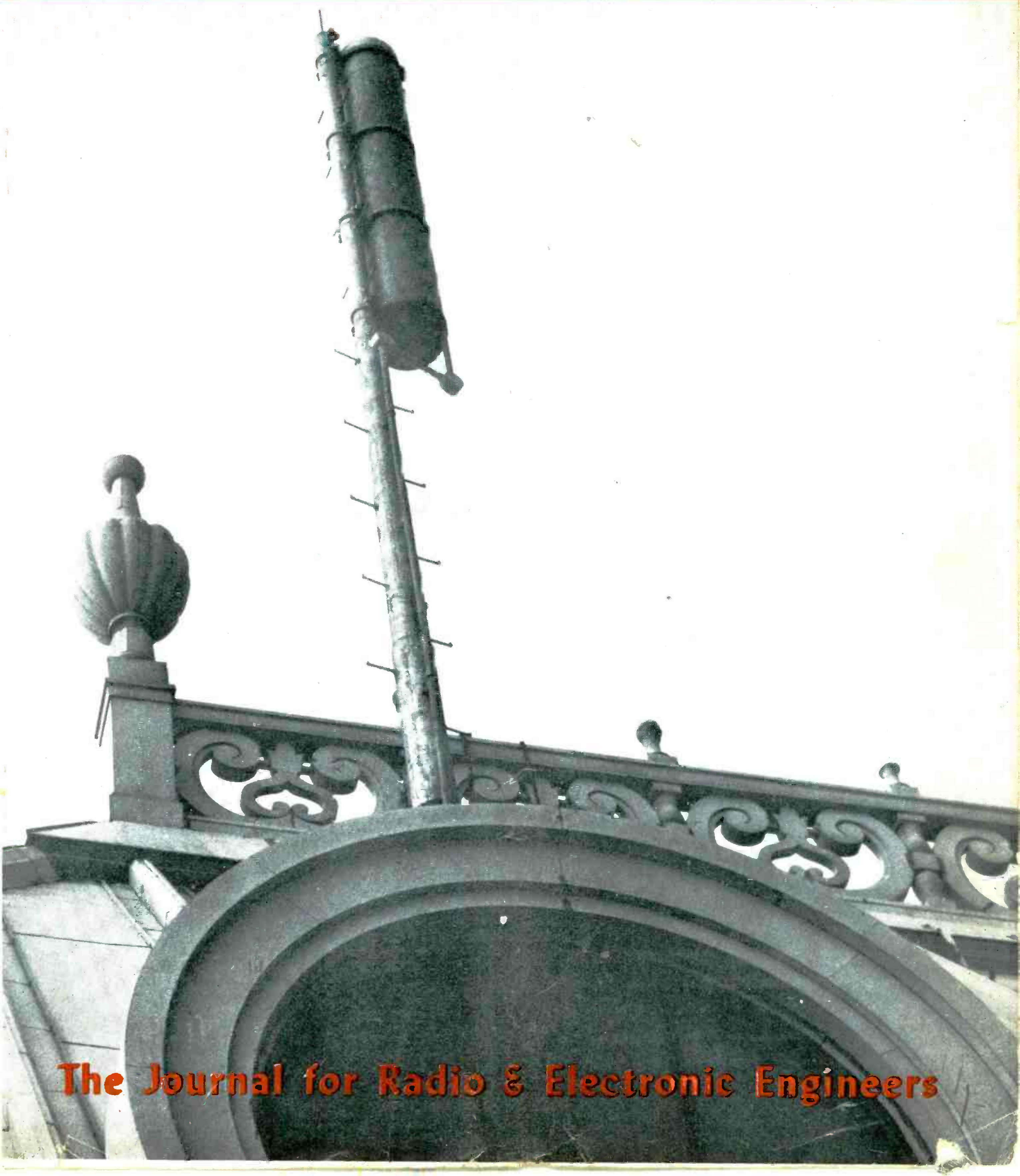
RADIO

Design • Production • Operation

DECEMBER, 1945

WITH
FM-FAX
SKYROCKET ANTENNA



The Journal for Radio & Electronic Engineers

A SECRET NO LONGER

Jefferson's part in Connection with

RADIO PROXIMITY FUZE

Now Can Be Told

The veil of secrecy that shrouded one of the most important factors in the war just past, can now be lifted. This development, the Radio-Actuated or Radio Proximity Fuze, has been placed second only to the Atomic Bomb in importance and scientific development.

In one of the darkest moments this Fuze halted the German drive in the Belgium counter attack, helped break Jap air power in the Pacific, and in England finally stopped the buzz bombs that Germany frantically released prior to the end of the European War.

Jefferson Electric's contribution in connection with this device can now be revealed. Also credit, which was withheld due to the utmost secrecy of the project, now can be given to the skilled and loyal workers, and the inventive genius of the engineers and production experts who worked so untiringly.

One of the vital requirements was a safe operating switch that would insure against detonating the shell as it left the gun but still operate at the precise moment desired. The time between leaving the gun and firing in most instances is measured in tenths of seconds. Improper timing in the fuze of a shell results in premature detonation, commonly referred to as muzzle bursts, and is hazardous to the gun crew.

To obtain reliable operation with many different types of projectiles a switch design was developed jointly by personnel of Jefferson Electric Company and Applied Physics Laboratories of Johns Hopkins University. The result was a switch 0.315″ in diameter and 0.530″ long — not only remarkable because of the small size but because it was actuated by centrifugal force of the spin of the projectile rather than by the usual tilt action.

No less than 12 classes of mercury switches (all smaller than a seamstress' thimble) were made to suit the various types of guns in which Radio Proximity Fuzes were eventually used. While developing these sensitive, small mercury switches was a major accomplishment — the mass production to high standards of uniform quality and accuracy was, if anything, a greater feat. This proved again Jefferson Electric's manufacturing skill, producing — as with its transformers, ballasts and fuses — to fixed high standards at mass output rates.

Jefferson is proud to relate the success in the development of this hitherto unthought-of device — of the constant improvements made, and of the staggering rate of production attained in so short a time.

JEFFERSON ELECTRIC

E ★★★

Because of the secrecy of the entire VT Fuze project, the Navy "E" Award for excellency was withheld lest it draw unnecessary attention to the plant. Now the Award with 3 stars has been made.

Jefferson Electric Company

BELLWOOD (SUBURB OF CHICAGO) ILLINOIS

In Canada: Canadian Jefferson Electric Co. Ltd., 384 Pape Ave., Toronto, Ont.

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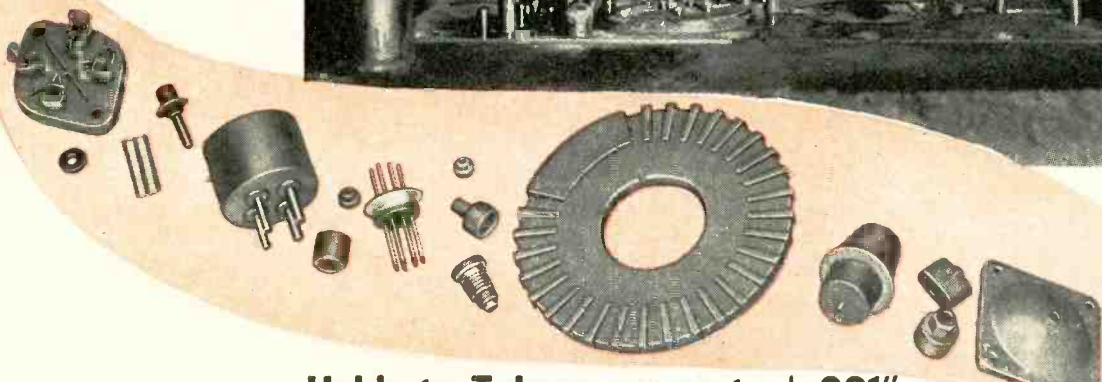
Molded TO YOUR SPECIFICATIONS

MYKROY
PERFECTED MICA CERAMIC INSULATION



Holds to Tolerances up to ±.001"

In part after part, and in any quantity, Mykroy molds and *holds* to critical tolerances. In this, the only ceramic which can be molded under heat and pressure to such close tolerances, are combined many other highly desirable properties that distinguish Mykroy from all other types of insulating materials.

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SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

DEC. *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

NEW, SENSATIONALLY SMALL SYLVANIA TUBE WILL PERMIT RADIOS OF CIGARETTE-PACK SIZE

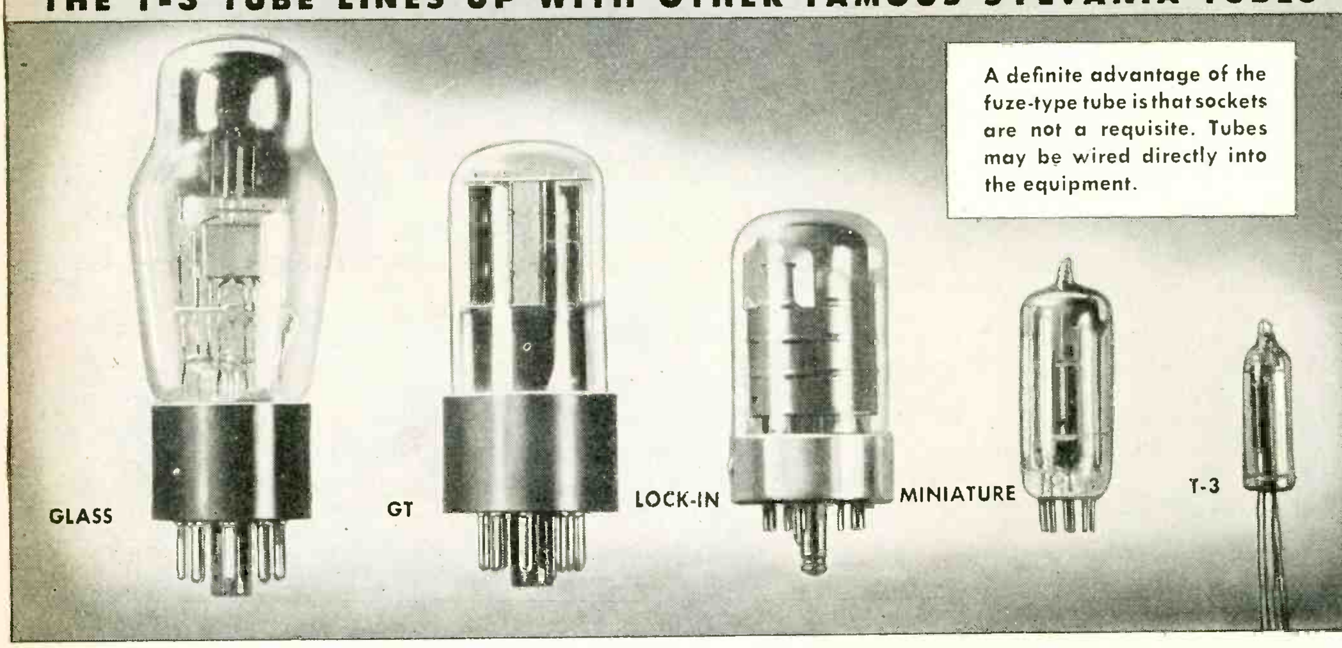
Fuze-Type Tube Adaptable To All Battery Sets

Sylvania Electric announces a revolutionary new radio tube, the size of a peanut, which is as significant to the development of sets as the famous Sylvania Lock-In Tube.

Originally designed as the T-3 fuze-type tube, this tiny electronic unit is the commercial version of the radio proximity fuze tube developed by Sylvania. These tubes are being made in low-drain filament types. They have long life and are so rugged that they won't break when dropped. Their low-drain characteristics take advantage of a new miniature battery developed during the war — permitting the design of radios ranging from the size of a package of cigarettes up to a deluxe farm receiver.

The new, tiny, complete electronic unit will provide electrically and mechanically superior features similar to the Sylvania Lock-In Tube. Since the T-3 type of tube was originally designed to withstand the shock of travelling inside a spinning artillery shell, it will be even more rugged than the Lock-In, which has become known for its superiority for all types of sets.

THE T-3 TUBE LINES UP WITH OTHER FAMOUS SYLVANIA TUBES



SYLVANIA ELECTRIC

Emporium, Pa.

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RADIO

Published by RADIO MAGAZINES, INC.

John H. Potts . . . . Editor
Sanford R. Cowan . . . . Publisher

DECEMBER 1945 Vol. 29, No. 12

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COVER

The completed 'Skyrocket' FM-FAX antenna of WGHF

ARTICLES

MISCELLANEOUS

John H. Potts . . . . President
Sanford R. Cowan . . Adv. Mgr.—Sec'y-Treas.
Harry N. Reizes . . . . Adv. Sales
David Saltman . . . . Adv. Prod. Mgr.
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New!

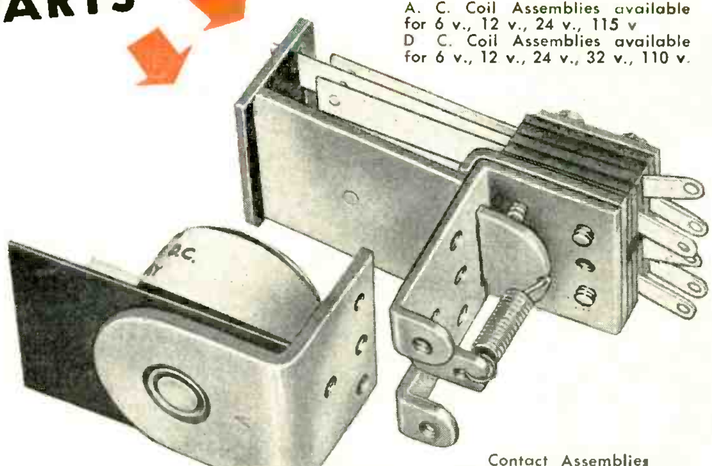
Series 200

A RELAY BY GUARDIAN with *Interchangeable Coils*

BUILT IN TWO PARTS

A. C. Coil Assemblies available for 6 v., 12 v., 24 v., 115 v
D C. Coil Assemblies available for 6 v., 12 v., 24 v., 32 v., 110 v.

★ Two basic parts — a coil assembly and a contact assembly — comprise this simple, yet versatile relay. The coil assembly consists of the coil and field piece. The contact assembly consists of switch blades, armature, return spring, and mounting bracket. The coil and contact assembly are easily aligned by two locator pins on the back end of the contact assembly which fit into two holes on the coil assembly. They are then rigidly held together with the two screws and lock washers. Assembly takes only a few seconds and requires no adjustment on factory built units.



SERIES 200 RELAY

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Single pole double throw
Double pole double throw

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See it today! . . . this amazing new relay with interchangeable coils. See how you can operate it on any of nine different a-c or d-c voltages — simply by changing the coil. Ideal for experimenters, inventors, engineers.

TWO CONTACT ASSEMBLIES

The Series 200 is available with a single pole double throw, or a double pole double throw contact assembly. In addition, a set of Series 200 Contact Switch Parts, which you can buy separately, enables you to build dozens of other combinations. Instructions in each box.

NINE COIL ASSEMBLIES

Four a-c coils and five d-c coils are available. Interchangeability of coils enables you to operate the Series 200 relay on one voltage or current and change it over to operate on another type simply by changing coils.

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Transients

PROGRESS IN MICROWAVE TRANSMISSION

★Now that information on many war-time developments in microwave transmitting equipment has been declassified, it is possible to speculate on their probable application in the postwar radio picture. Development of cavity magnetrons capable of delivering over a million watts peak power, under pulsed conditions, at frequencies as high as 3500 mc has direct application in aircraft instrument landing systems, obstacle indicators, and as an aid to ships coming into a harbor under severe weather conditions. Beyond these applications, it is likely that other similar systems, such as pulse time modulation for broadcasting, and the new English method of pulse transmission for television, which eliminates the need for a separate sound channel in the receiver, may likewise employ cavity magnetrons, perhaps in a modified form.

For the more conventional methods of microwave broadcasting, the resnatron, which has been used in a continuous wave transmitter delivering 30 kw at 500 mc, has still greater possibilities. This tube, which was developed during the war, should enable broadcasters to lay down far better signals under adverse conditions than was heretofore feasible at these frequencies and should aid greatly high definition television and FM broadcasting.

HAM BANDS RELEASED

★Since the announcement on Nov. 15th by the Federal Communications Commission that hams could return to the air on the 28, 56, and 144 mc bands there has been a tremendous amount of activity on these bands. It is hard to realize that amateur activities have been curtailed for such a long period, so lively are these bands now. And if this enthusiasm is any indication of the future, thousands upon thousands of new entrants into the ham radio field will be applying for station licenses in a relatively short time.

Four new bands in the microwave region are also assigned to amateurs. As the older bands become more and more crowded, it is likely that a great many hams will turn to the microwaves. Many will be satisfied simply to get their rigs operating and making contacts over normal ranges, but the confirmed DXers will undoubtedly try to find new methods of communicating quickly over long distances. One possibility which comes to mind is the development of automatic relay stations, or at least, semi-automatic ones, by which the station operator uses a received signal from one station to modulate his carrier and thus shove the signal along to the next station in line. Links of hundreds of such microwave stations dotting the country could enable coast-to-coast transmission at extremely high frequencies.

When the lower frequency bands are again opened, of course combinations of microwave and short wave relays would make possible world-wide ham communication for the owner of a simple microwave rig. Not that he'd be satisfied with this for any great length of time; he would still want the thrill of a direct contact over half the circumference of the earth, or to remote, hard-to-get stations. But he could start off with his little rig.

Undoubtedly the greatest field for ham experimentation with microwaves is in the development of small, portable rigs for short distance communication. We feel that these extremely high frequencies, requiring only miniature antennas and associated equipment for local work, should create a demand for additional rigs to supplement a higher-powered outfit in much the same way that personal radios serve broadcast listeners. And if the new generation of hams can do as much with microwaves as the preceding one did with short waves, we shall see a great many improvements in microwave apparatus.

CABINET STYLING

★What the radio industry has always needed is a style of cabinet which more definitely marks the period in which the receiver was made. In the automobile industry, it is easy to distinguish a car which is three or four years old from the latest model by the difference in its body lines. And, unquestionably, this is one of the major factors in encouraging owners to buy new cars more often. While unique designs in radio cabinets appear every year, in normal production times, they follow no definite trend, as is the case in the automobile industry. As a result, the prospective radio purchaser hesitates to invest in a new receiver if the cabinet design is radically different from those of all other manufacturers, because he is not convinced that it represents a new trend.

If some of the larger manufacturers would get together and turn out receivers with more attractive and more unique housings, it is possible that the public would take kindly to the idea. There would still be plenty of room for individuality in each manufacturer's product, and the purchaser would be more readily convinced that the advantages of the newer cabinet types had received general acceptance by a large segment of the industry.

Action along these lines is particularly needed now, when the psychology of getting along with the old and obsolete has become rather fixed, due to the war. A good many are finding that the widely heralded pent-up demand requires more sales effort than was anticipated. And, because it will be some time before many technical advances can be incorporated into civilian receiver production, better cabinets are the logical means of encouraging purchases. —J.H.P.

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TECHNICANA

CRYSTAL FILTER THEORY

★ Extremely narrow-band filters may be designed by using quartz crystals as the filter elements. Some of the design calculations involved are discussed by Messrs. F. J. Lehany and K. G. Dean in an article entitled "An Unbalanced Narrow-Band Crystal Filter" which appears in the July 1945 issue of the *A W A Technical Review*, published by Amalgamated Wireless (Australasia) Limited.

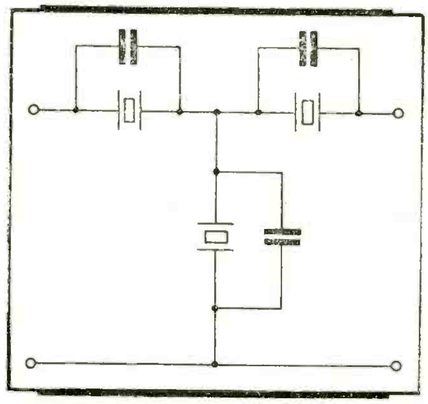


Figure 1

Only the T-section filter is discussed. This type filter is illustrated in *Fig. 1*. Its electrical equivalent, lattice-section equivalent, and characteristics are shown in *Fig. 2*.

The antiresonant frequency of the shunt arm crystal of the T-section coincides with the series resonant frequency of the series arm, and is f_2. The series resonant frequency of the T-section shunt arm is f_0, and f_4 is the antiresonant frequency of the series arm. It is demonstrated that f_0 and f_4 are the only two possible frequencies having infinite attenuation.

The frequencies are shown to be:

$$\omega_2^2 = \frac{C_2 + C_4}{L_2C_2C_4} = \frac{1}{L_1C_1}$$

$$\omega_4^2 = \frac{C_1 + C_3}{L_1C_1C_3}$$

$$\omega_0^2 = \frac{1}{L^2C^2}$$

When the desired bandwidth is known the circuit constants are obtained as follows:

[see page 16]

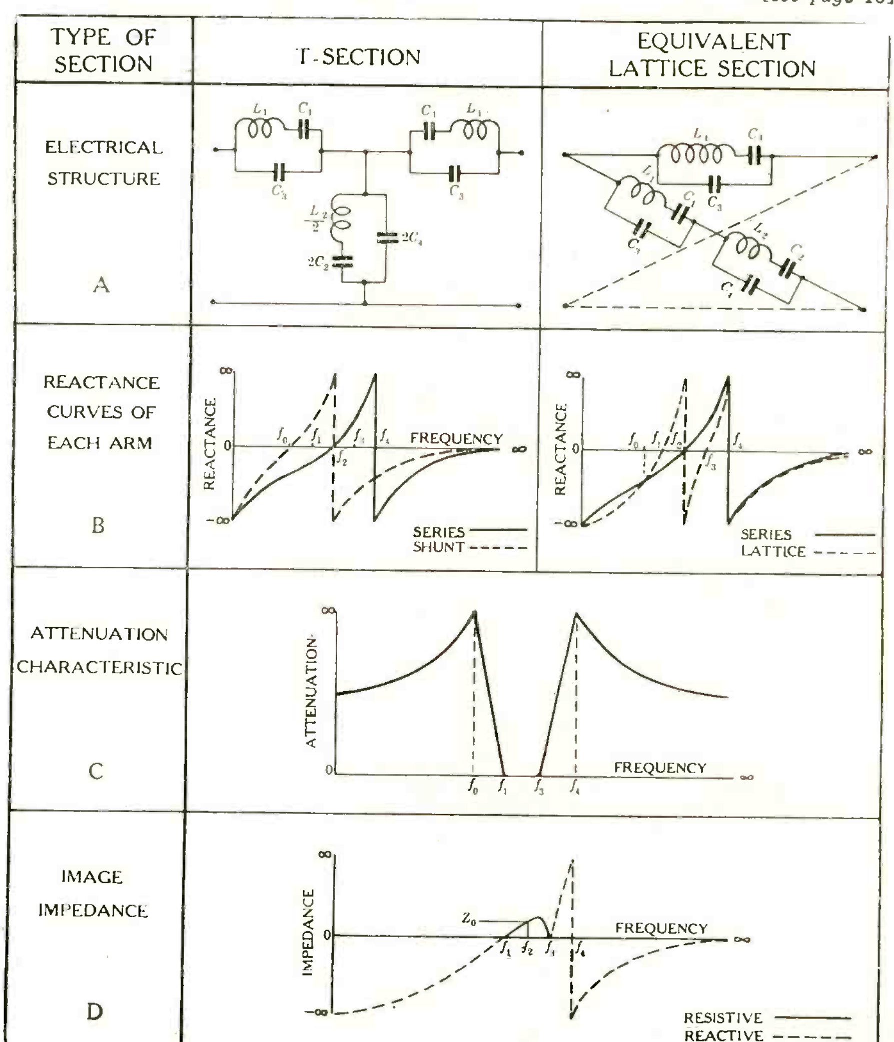
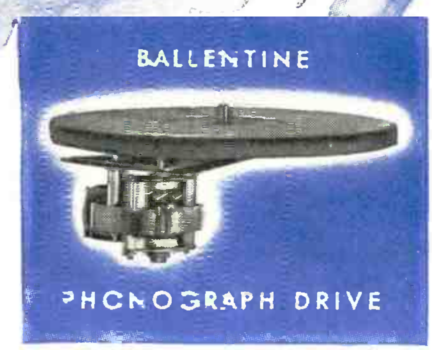


Figure 2

[Courtesy of AWA Technical Review]



The Ballentine Phonograph Drive is designed for just one purpose—to provide a reliable mechanism with the least possible background noise or rumble.

The high degree of perfection achieved by the Ballentine Phonograph Drive is the result of *precision dynamic balance,* excellence of design, rigid adherence to close tolerances plus modern manufacturing methods and equipment.

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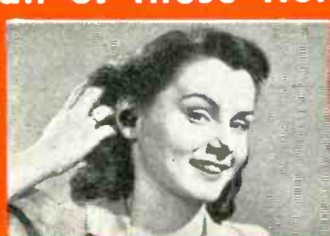
knowledge in all of these fields

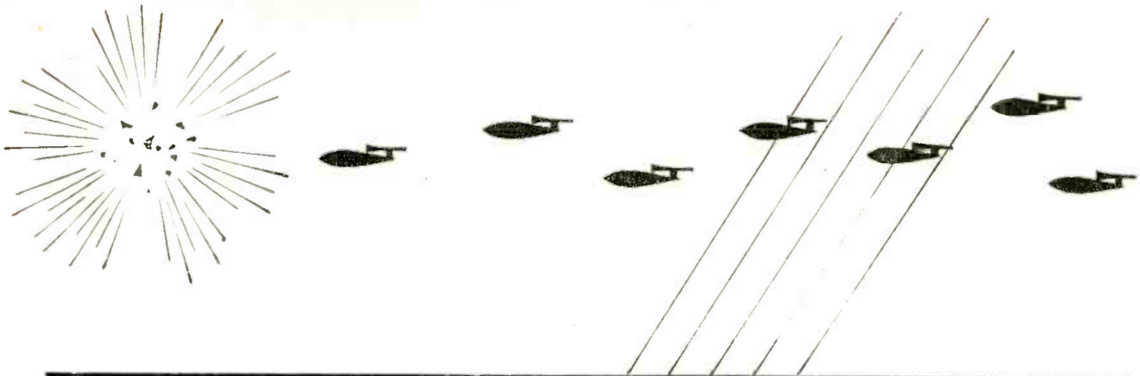
MOBILE RADIO



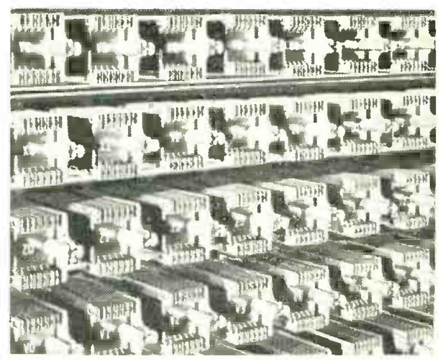
HEARING AIDS

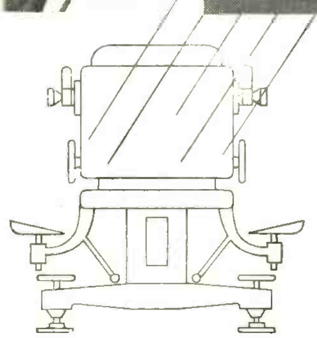
SOUND MOTION PICTURES

VACUUM TUBES



Target practice with Relays and Keys





(Left to right) The operator punches the problem data on tape, which is fed into the computer. The solution emerges in the teletype receiver. Relays which figure out the problem look like your dial telephone system.

In designing the gun-control systems which shot down enemy planes, Army ballistic experts were faced by long hours of mathematical calculations.

So Bell Laboratories developed an electrical relay computer. It solved complicated problems more accurately and swiftly than 40 calculators working in shifts around the clock.

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In battle action, Electrical Gun Directors are, of course, instantaneous. Such a director helped to make the port of Antwerp available to our advancing troops by directing the guns which shot down more than 90% of the thousands of buzz bombs.

Every day, your Bell System telephone calls are speeded by calculators which use electric currents to do sums. Even now, lessons learned from the relay computer are being applied to the extension of dialing over toll lines.

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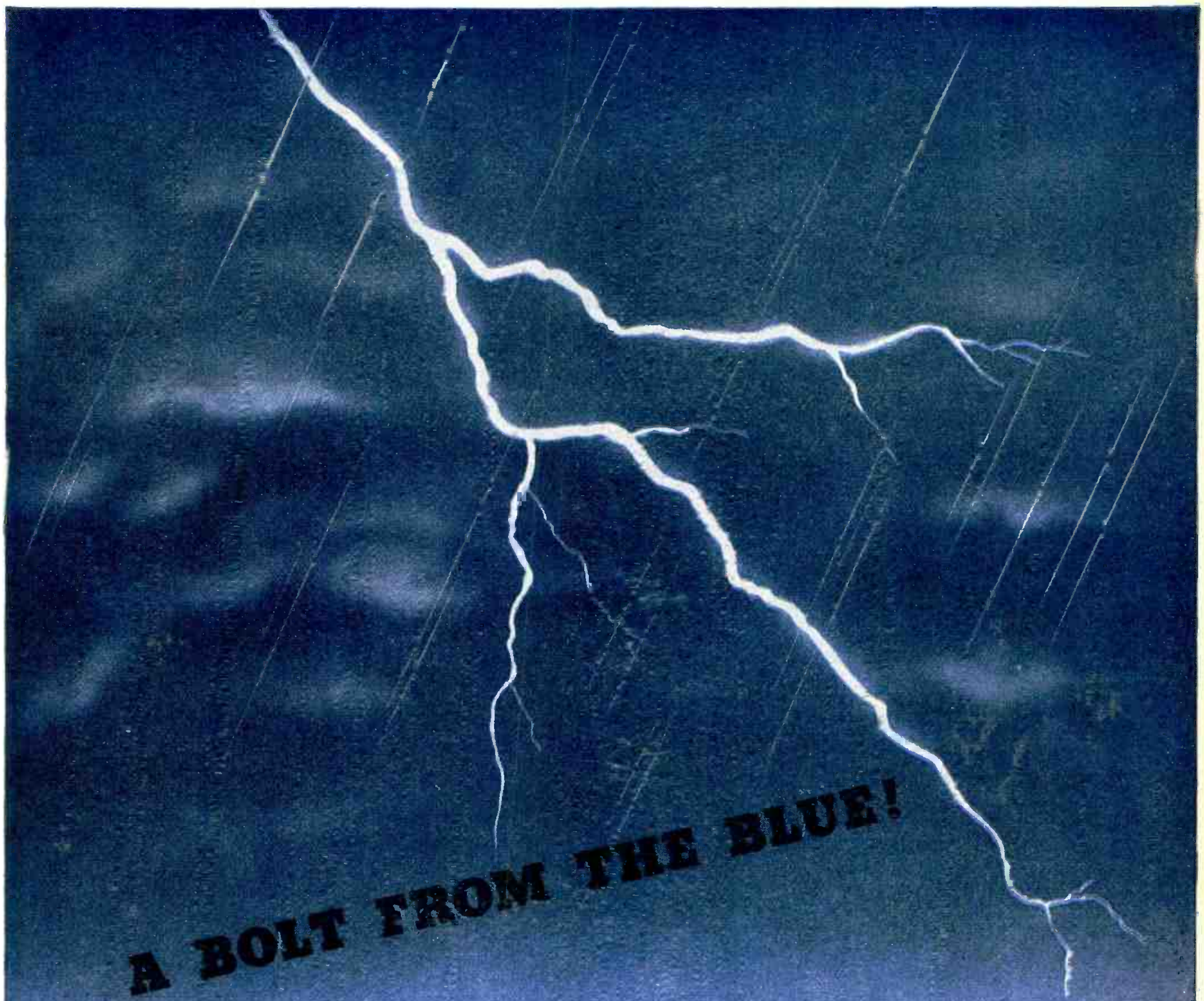

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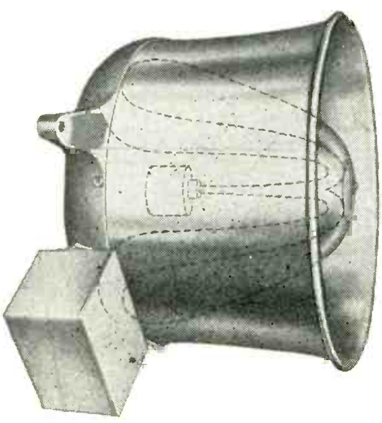
Most manufacturing plants will soon order sound installations. Specify RACON Speakers! All types now available in unlimited quantities.



Left: MARINE HORN Speaker, approved by the U. S. Coast Guard. Several sizes available. Re-entrant type, suitable for indoor or outdoor use — may be used as both speaker and microphone. 2½', 3½', 4½' and 6' sizes available.
Right: RE-ENTRANT TRUMPET; available in 3½', 4½' and 6' sizes. Compact. Delivers highly concentrated sound with great efficiency over long distances.

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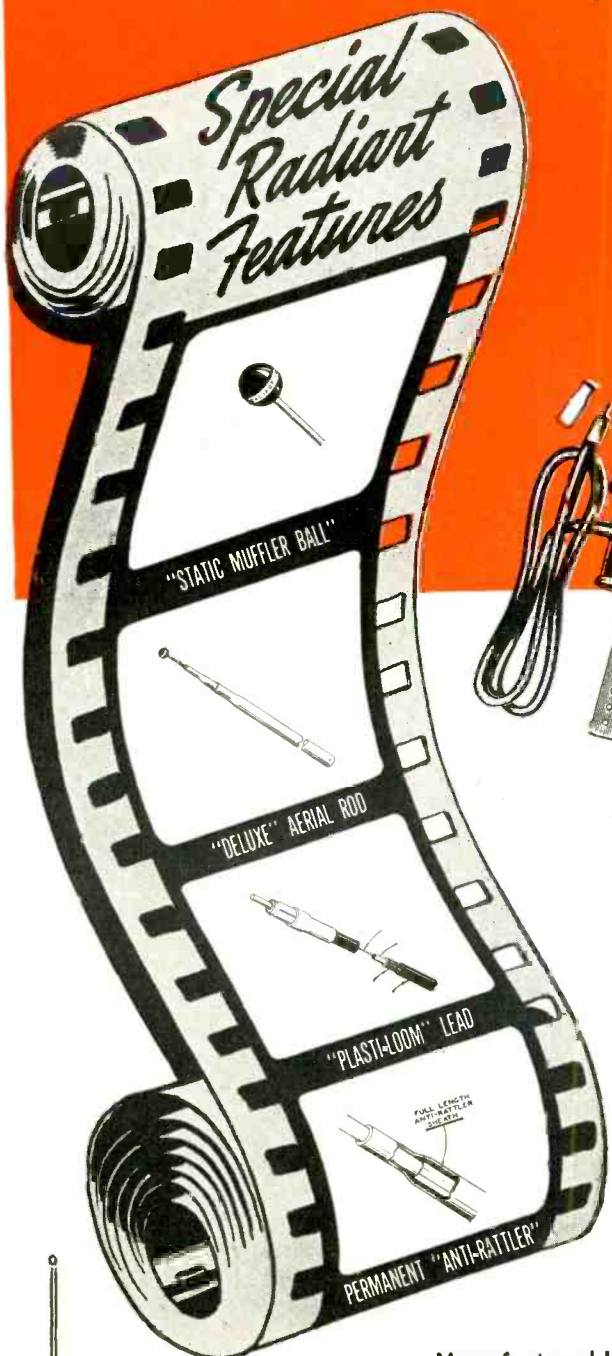
RADIART
1946 "DELUXE" AERIALS



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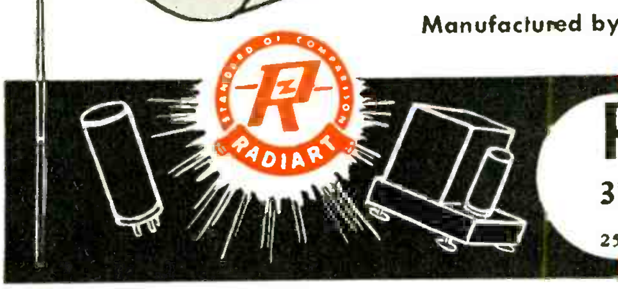
Ask your Radiart Jobber how you can get one of these snappy RADIART AERIAL COUNTER DISPLAYS.

Manufactured by the Makers of RADIART "Correct Replacement" Vibrators.



Radiart Corporation

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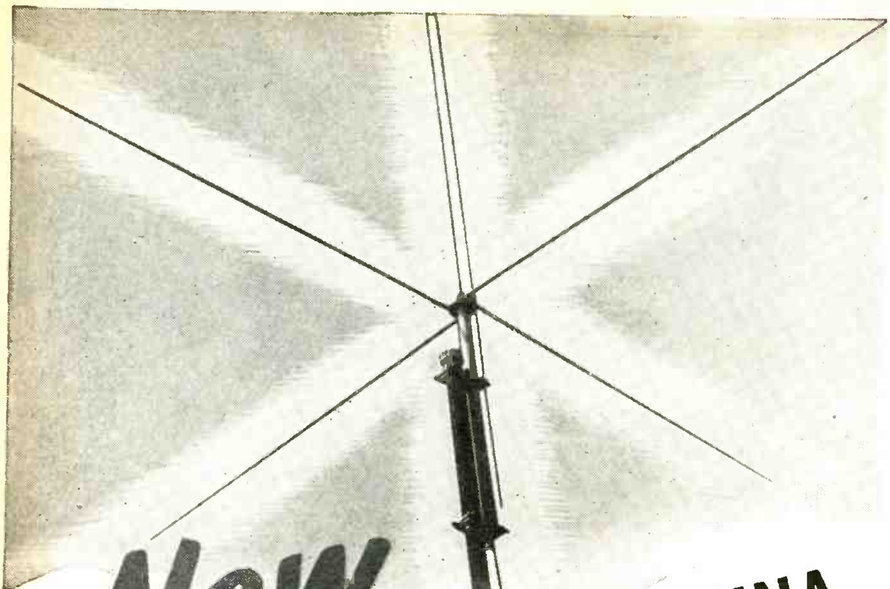

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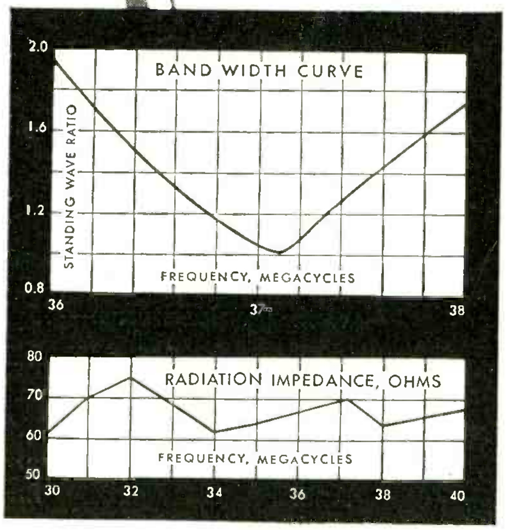
Concentrating on *electrical performance,* Andrew engineers have designed a unique Folded Unipole Antenna which—according to comparative tests—*easily outperforms other antennas at several times the price.*

Used for transmitting and receiving at frequencies from 30 to 40 MC and for powers up to 5,000 watts, this antenna has proved so successful that similar models for higher frequencies are now being designed.



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- "Slide trombone" calibration permits exact adjustment for any frequency between 30 and 40 MC, using only a wrench. Optimum performance for that frequency is guaranteed without "cut and try" methods.
- Proper termination of coaxial transmission line. Unlike other "70-ohm" antennas, the Folded Unipole actually provides a non-reactive impedance with a resistive component varying between 62 and 75 ohms (see lower curve).
- Excellent band width, ideal for FM (see upper curve).

Andrew Co. specializes in the solution of antenna problems. For designing, engineering and building of antenna equipment, consult Andrew Co.

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363 EAST 75th ST., CHICAGO 19, ILL.

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WRITE FOR FULL INFORMATION

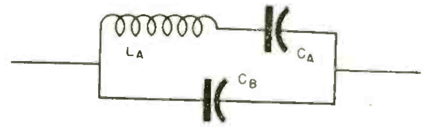
TECHNICANA

[*from page* 8]

$$C_1 = C_3(\omega_1^2 - \omega_2^2)/\omega_2^2$$
$$C_2 = C_1(\omega_2^2 - \omega_0^2)/\omega_0^2$$

These equations define the circuit elements, but since the physical dimensions of the crystals incur practical limitations, the filter characteristics are restricted accordingly.

For a normal X-cut crystal, for which the ratio of optical to mechanical axes = 0.5, the following relations are approximate.



$L_A = 230\ x$ henries
$C_A = .00157\ y^2/x\ \mu\mu f$
$C_B = .201\ y^2/\mu\mu f$
x = thickness in cm of electrical axis
y = thickness in cm of mechanical axis
$C_B/C_A = 128$
$f = 265/y$ kc

The series resonant frequency of the crystal is particularly critical, and may be adjusted after fabrication of the crystal. It is pointed out that either $(f_1 - f_2)$ or $(f_2 - f_0)$ for an X-cut crystal cannot exceed 0.4% of f_2, the center resonant frequency. Therefore, the bandwidth $(f_1 - f_0)$ must always be less than 0.8% of the center frequency.

The design calculations are further limited by the fact that the ratio of the thickness of the series crystal to the thickness of the shunt crystal equals $2C_2/C_1$, for an X-cut crystal, and practical thickness values must be employed.

The characteristic impedance for practical filters lies between approximately 10,000 ohms and 100,000 ohms for 100 kc operation. The insertion loss characteristics are also shown for a typical filter.

QUARTZ CRYSTAL MEASUREMENT

★ The Performance Index of a quartz crystal may be measured directly by use of a Performance Index meter. The instrument is described by Mr. C. W. Harrison in the April 1945 issue of the *Bell System Technical Journal.*

Performance Index has been established as $PI = \dfrac{1}{\omega^2 C_0^2 R_1 (1 + C_1/C_0)^2}$ or $PI = \dfrac{M}{\omega C_0 (1 + C_1/C_0)^2}$ where the figure of merit of the crystal is $M = \dfrac{1}{\omega C_0 R_1}$. The values refer to *Fig. 3,* the generalized equivalent circuit of a crystal oscillator.

In *Fig. 4* the crystal is considered to

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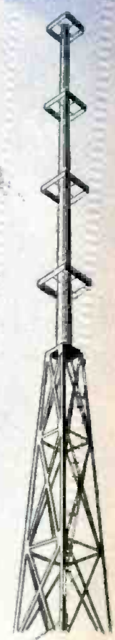

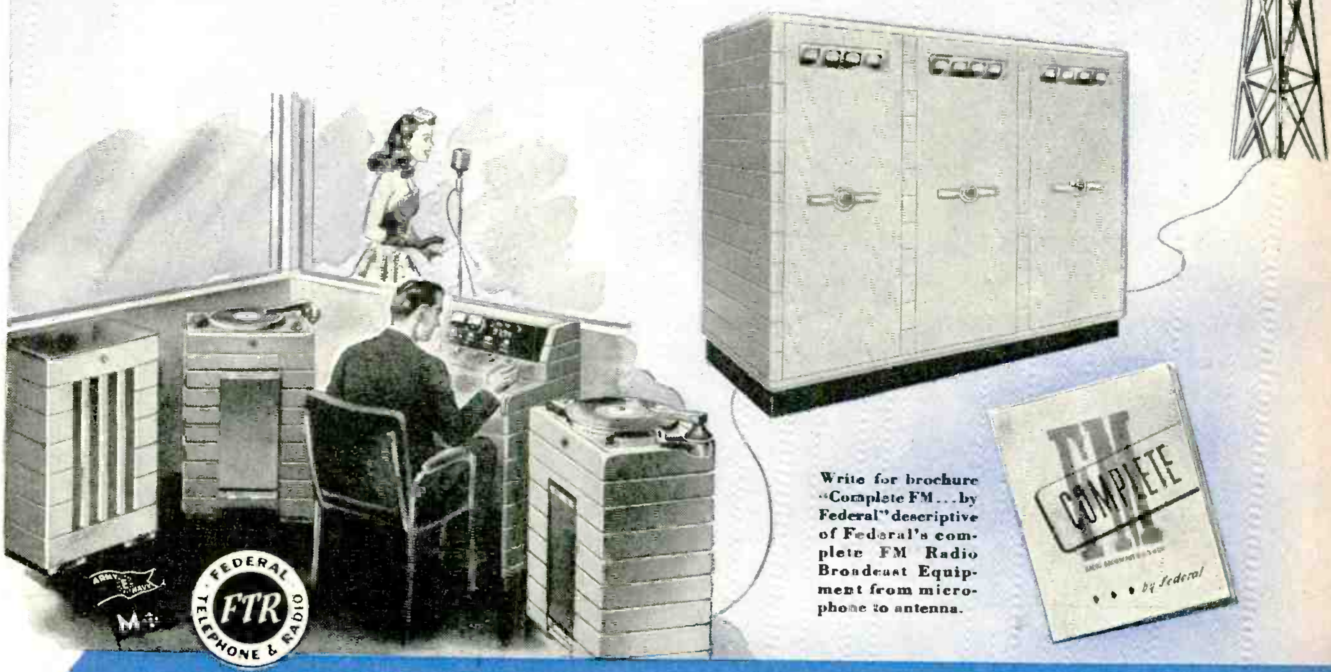

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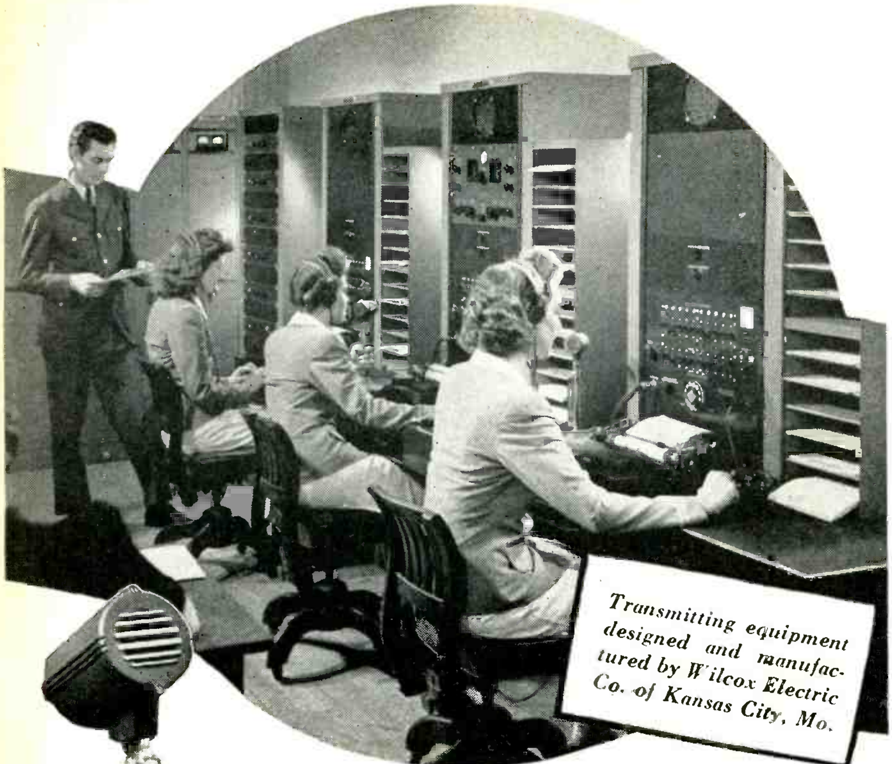

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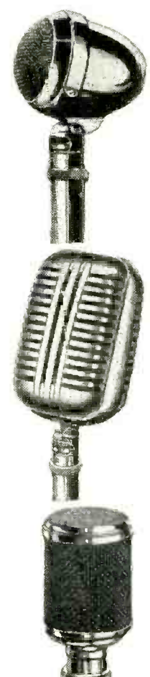

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[*from page* 16]

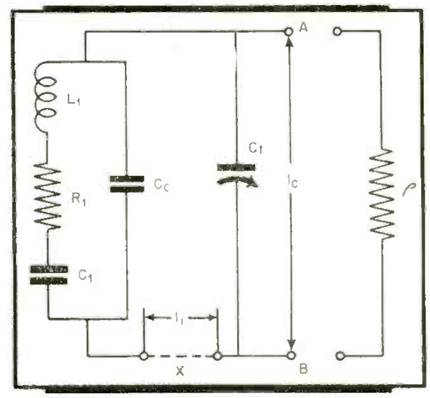

Figure 3

be operating as an inductance and resistance only, looking into a shunt capacitance and negative resistance in the oscillator. For these values $PI = \frac{\omega L_o}{\omega C_t R_c} = Q_1 X_t$ where $Q_1 = \frac{\omega L_o}{R_o}$; the effective Q of that part of the circuit containing the resistance R_c, and X_t is the reactance of C_o at the operating frequency.

A variable frequency generator, having low internal impedance and constant output voltage e_1, is inserted at point *X*, *Fig. 3*. This circuit, excluding ρ, is similar to a Q meter circuit, and e_o/e_t is at all times proportional to Q_1.

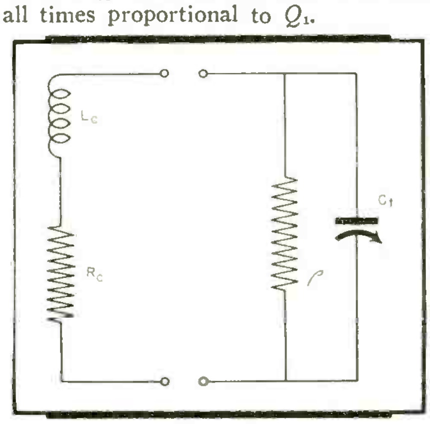

Figure 4

An attenuating network is now inserted between terminals *AB* and the voltmeter. The attenuator is to vary with frequency in the same manner as does C_t. The voltmeter reading will then be proportional to *PI*.

In order to facilitate analysis the circuit is redrawn as *Fig. 5*. The crystal is now represented by that portion in the dotted rectangle. Capacitance C_t is now shown by $C_x + C_s + C_k$ in series, where C_x is the capacitance of the crystal socket. The capacitive attenuator *A* furnishes an input voltage to the vacuum tube amplifier, so that the e_p reading is inversely proportional to frequency and proportional to *PI*.

To obtain direct readings the voltmeter must be calibrated, by use of the calibrating circuit, *Fig. 6.* The subscript *c* denotes "calibrate" conditions. In *Fig. 7* the "operate" and "calibrate" circuits are combined into the *PI* meter circuit employed. With the switch at *Cal*, calibration readings are taken. The *PI* position is the "operate" position. The *M* position is employed for measurement of e_t, which is externally supplied.

In this circuit the reactance of C_A is very much greater than R_A, and since the tube plate resistance is very much greater than the reactance of C_p, the $R_A - C_A$ network cancels the attenuation-frequency variations in the plate circuit of the tube. To calibrate, the e_{pc} reading is obtained with the attenuator reading set at unity. The e_{pc} reading is then duplicated in the "operate" position, by adjustment of the attenuator.

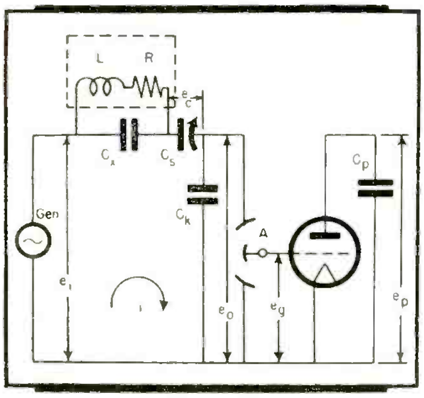

Figure 5

The author shows that absolute calibration is obtained in terms of *A*, R_A, C_A, and C_k, all of which may be determined with good accuracy. The scale of C_s must also be calibrated, in terms of C_t, which may be measured across the crystal terminals, with the generator shorted.

In the *PI* meter circuit the frequency of the oscillations producing e_t is controlled by the crystal, by feedback through C_k. AVC is furnished so that the amplitude of e_t is constant for all frequencies. Capacitor C_r is adjusted for resonance, which is observed with switch *S* in the "operate" position when e_p is maximum.

When *PI* meter readings are to be

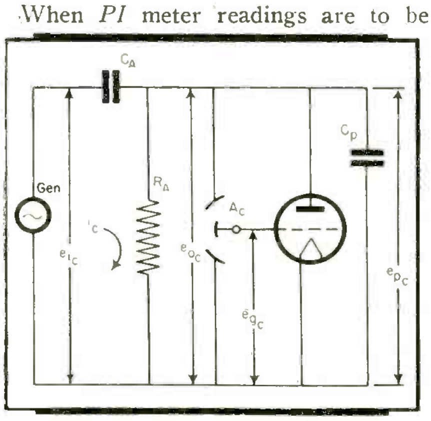

Figure 6

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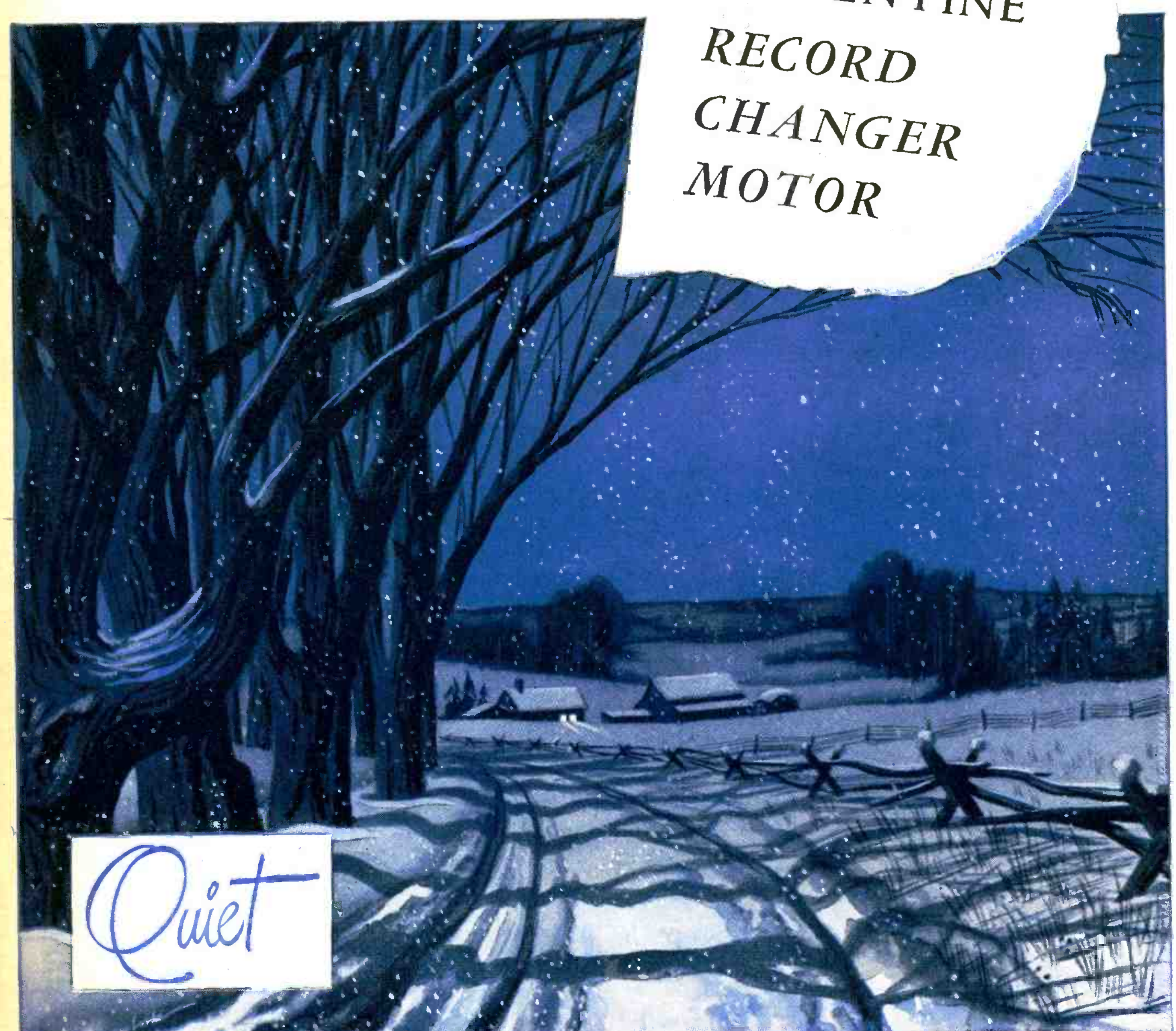

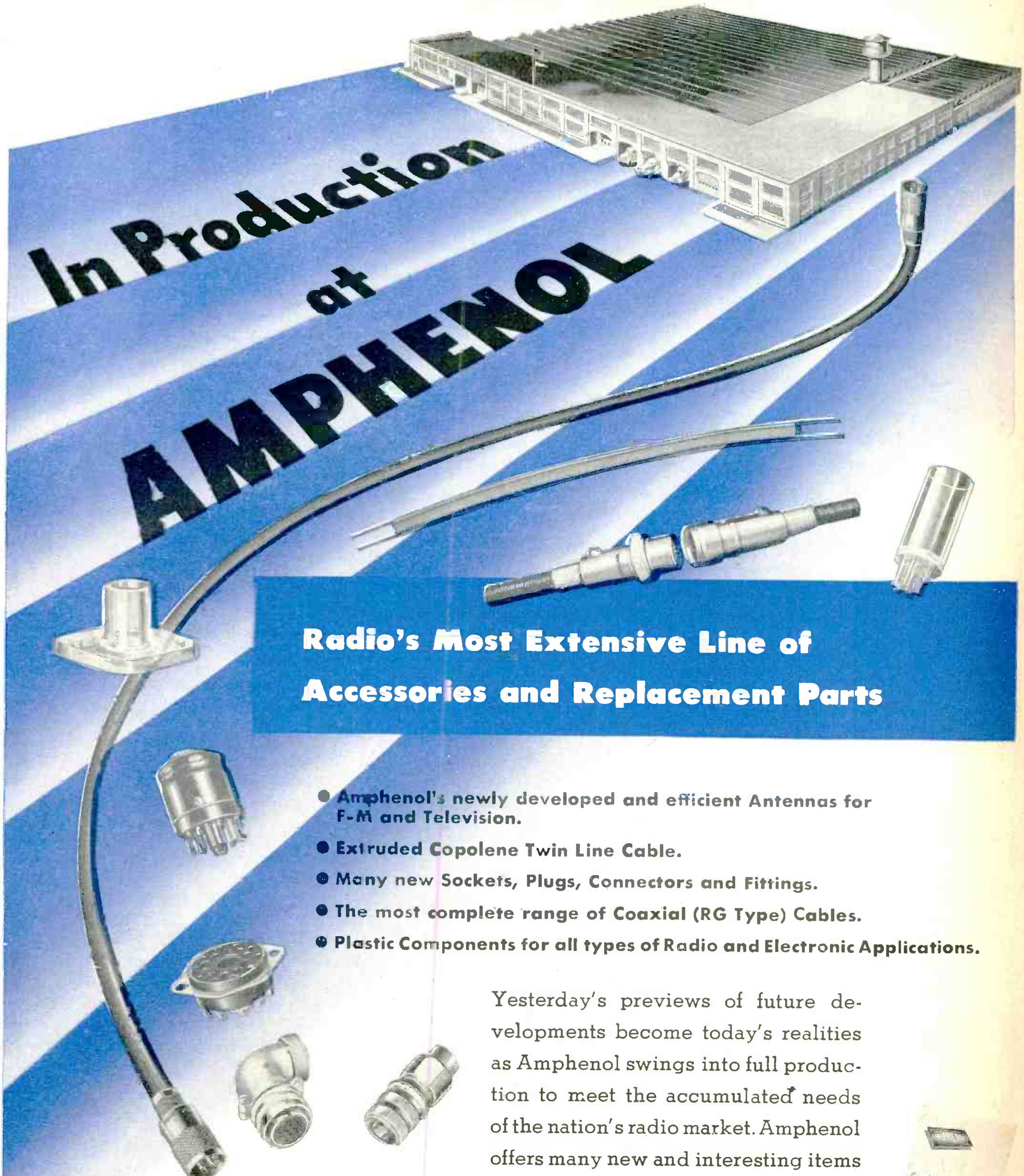

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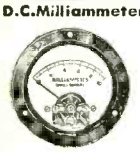

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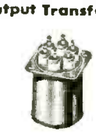

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TECHNICANA

[from page 19]

correlated with performance in a separate oscillator, the amplitude of e_i should be equal to the average value in the oscillator in which the crystals will be used.

The generator which furnishes e_i should be capable of utilizing the feedback from C_k for frequency control, and permit AVC to maintain constant voltage. It must also be capable of oscillating all crystals whose performances are to be measured.

The *PI* meter, together with a capacitance bridge and a frequency meter, can be used to measure all the circuit constants *pf* of *Fig. 4*. Some examples of the variation of these constants with frequency are presented. Typical curves are also shown to illustrate relationships between *PI* and grid current activity.

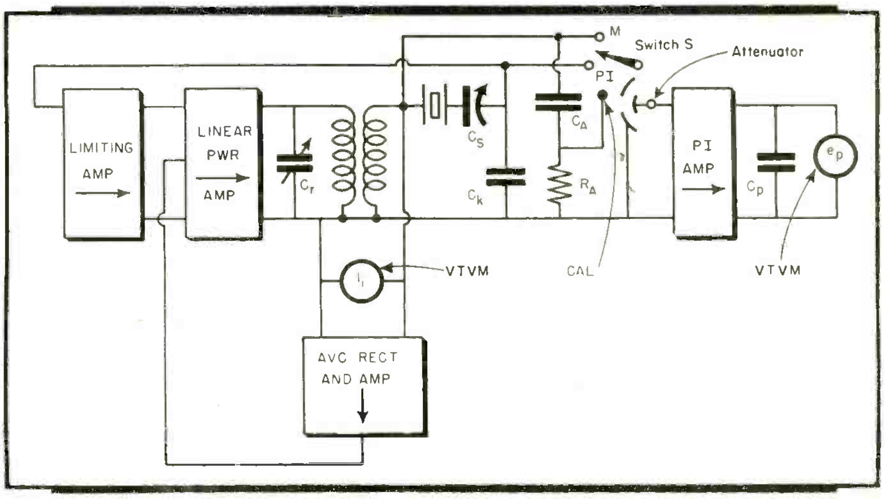

Figure 7

CONTRAST EXPANSION

★ Expansion of the a-f signal at the receiver has been used to balance volume compression introduced at the broadcast studio. Discussion of various methods of accomplishing contrast expansion is continued by Mr. J. G. White in the October 1945 issue of *Wireless World*.

Variable negative feedback, having the advantages of minimum distortion, noise reduction, and increased stability, has been used. This principle is employed in the circuit described in this article, and shown in *Fig. 8*.

To overcome the high output impedance without using an output transformer, the voltage feedback is taken over two stages. Variable feedback is obtained by making one arm of the output voltage divider the plate resistance of a triode, V_3. If the grid of V_3 is controlled by a negative bias which increases with the signal amplitude, volume expansion is obtained. Provision for varying the grid bias is not shown. The author shows that with type EF50 tubes for V_1 and V_2 the amplifier gain varies from 3675 to 3270, without feedback. With feedback the gain drops to 570 and 52, giving an expansion ratio of 11:1, or 20.8 db. If the V_3 grid bias is made to go positive with signal increase, then volume compression is obtained.

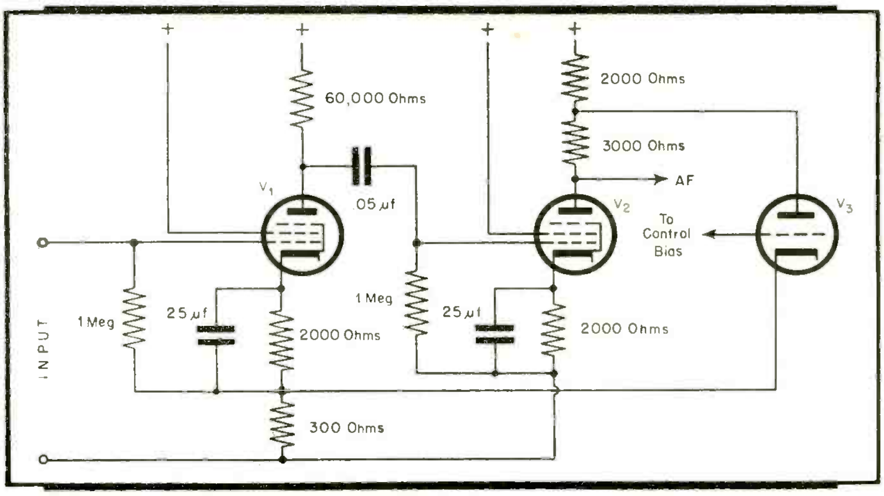

Figure 8

ANTENNA ANALYZER

★ The long series of mathematical computations which have been necessary in solving the intricate problems involving the location and arrangement of radio towers are replaced by a new electronic device called the Antennalyzer, Dr. George H. Brown of RCA Laboratories announced recently at a meeting of the Washington, D. C., Section of the Institute of Radio Engineers.

Field tests and calculations, which formerly required weeks to perform, are now done in a matter of minutes by

FIVE TOWERS

$$F = KI_A \cdot \sqrt{\begin{aligned}&\Big\{1 + M_B \cos\left(\alpha_B + \tfrac{2\pi d_B}{\lambda}\cos[\phi-\theta_B]\right) + M_C \cos\left(\alpha_C + \tfrac{2\pi d_C}{\lambda}\cos[\phi-\theta_C]\right) + M_D \cos\left(\alpha_D + \tfrac{2\pi d_D}{\lambda}\cos[\phi-\theta_D]\right) + M_E \cos\left(\alpha_E + \tfrac{2\pi d_E}{\lambda}\cos[\phi-\theta_E]\right)\Big\}^2 \\ &+ \Big\{M_B \sin\left(\alpha_B + \tfrac{2\pi d_B}{\lambda}\cos[\phi-\theta_B]\right) + M_C \sin\left(\alpha_C + \tfrac{2\pi d_C}{\lambda}\cos[\phi-\theta_C]\right) + M_D \sin\left(\alpha_D + \tfrac{2\pi d_D}{\lambda}\cos[\phi-\theta_D]\right) + M_E \sin\left(\alpha_E + \tfrac{2\pi d_E}{\lambda}\cos[\phi-\theta_E]\right)\Big\}^2\end{aligned}}$$

Figure 9

which adds and subtracts angles, multiplies, looks up trigonometric functions, adds numbers, squares them and finally takes the square root of the whole to produce the desired answer, which the engineers must have to locate accurately tion pattern equation for a five-tower antenna is shown in *Fig. 9*.

The Antennalyzer, shown in *Figs. 10* and *11*, consists of 52 electron tubes. The associated circuits may be adjusted to duplicate all characteristics of a projected antenna. In operation, the controls of the machine are regulated until a pattern of light on a cathode-ray tube

[*see on page* 58]

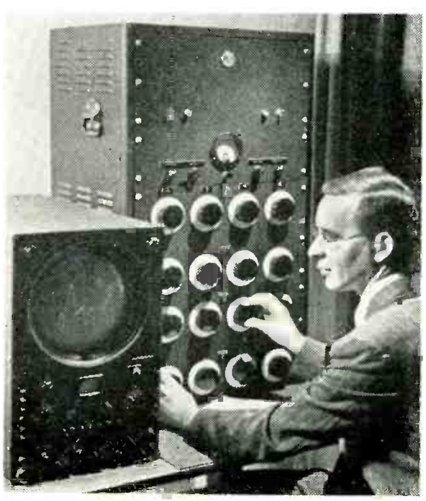

Figure 10

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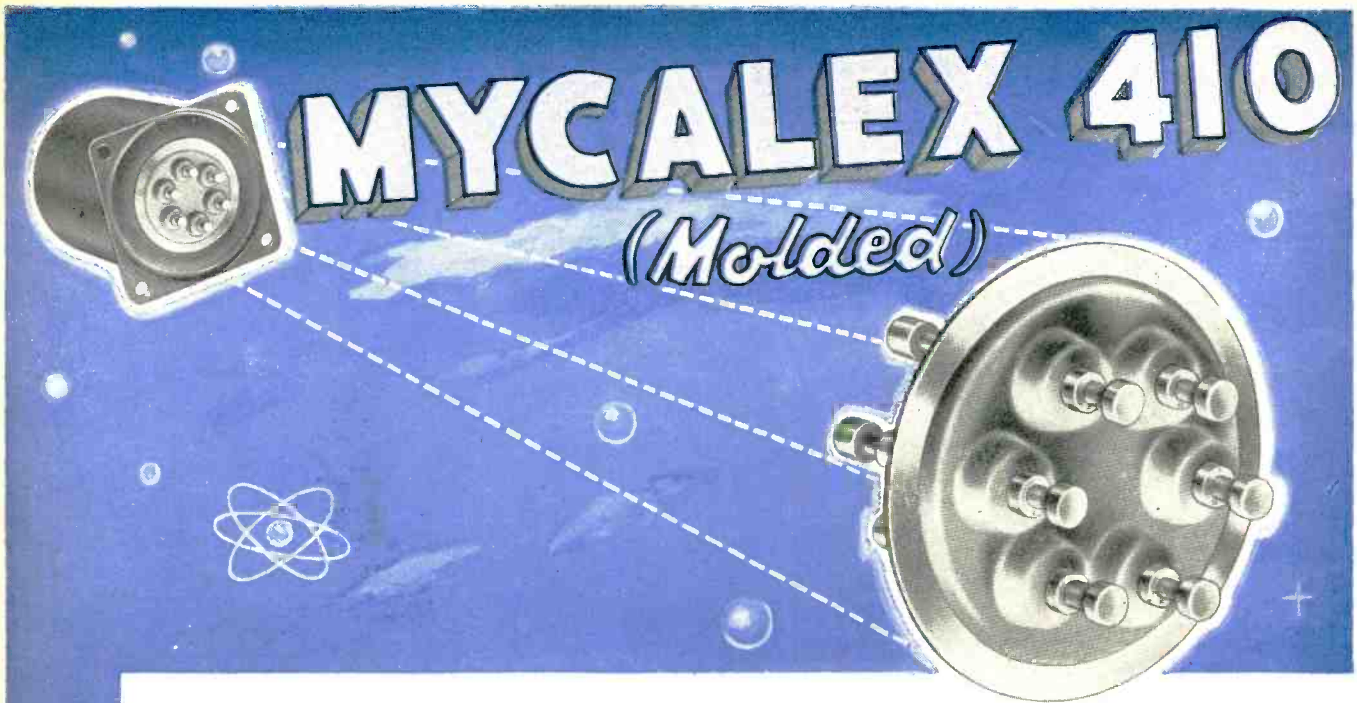

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4 - Place in cold sodium chloride at 0°C for 1 hour
5 - Leave overnight in salt water at room temperature 20°C
6 - Meg test - infinity test

This test was repeated three times. At the end of the test the unit was tested for leakage and showed a small amount. This amount was within the limitations imposed by the Army Signal Corps. After the assemblies had dried for about 15 minutes they indicated no leakage. We consider these terminals to be extremely satisfactory for hermetic sealing purposes.

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Yours very truly,

S. W. Levy

S. W. Levy
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The design, construction, and operating characteristics of a new type of magnetic pickup with many desirable features

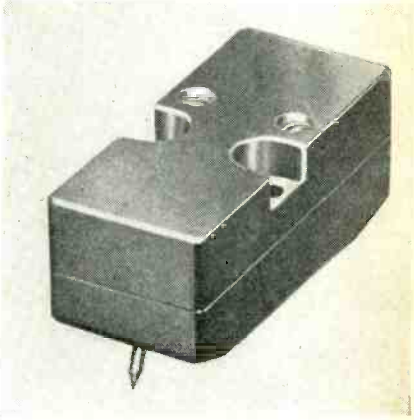


Fig. 5. 6,000 cycle cutoff magnetic pickup

Ever since the electric phonograph pickup replaced the acoustic sound box about twenty years ago, engineers have been searching for the ideal lateral electric pickup. That such a pickup has not yet been produced is well known to those in the art, but each year brings us a little closer to the realization of the ideal. This article describes the latest advanced step in that direction.

In the light of present communication engineering standards it is possible to outline a set of somewhat idealized characteristics toward which the engineer may direct his development. These may be roughly divided into two general categories, electrical and physical.

Requirements

The electrical performance requirements of an ideal pickup should be as follows.

1. The frequency response should be such that, with available commercial pressings, the electrical output is uniform over the entire range of recorded frequencies.
2. Amplitude distortion should be lower than that present in the record of any of the associated equipment.
3. Intermodulation as a result of tracking complex tones should be absent.
4. Signal-to-noise ratio should be great enough so that hiss and scratch due to normal record surface characteristics is negligible with respect to lateral response.
5. The output should be sufficient to allow full volume reproduction with ordinary amplifiers and without a great deal of shielding.
6. Its electrical characteristics should be such that it may be conveniently adapted to conventional circuits without the use of complex networks or special tubes.
7. If the pickup is of the magnetic type, its susceptibility to hum pickup should be so low as to cause no interference with signal reproduction.

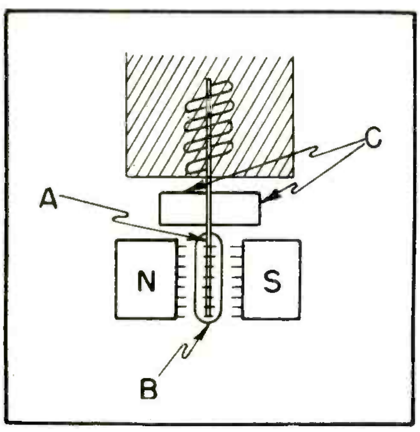


Fig. 1. Schematic view of pickup generating system

Desirable physical characteristics are as follows:

1. Size and weight should be small enough to allow complete freedom to the designer of the tone arm in the determination of mass, pivoting, counterweighting, etc.
2. It should be provided with a simple mounting system with conventional fastenings for convenient replacement.
3. The mechanical impedance of the moving system should be low enough to permit positive tracking of fully modulated grooves with less than twenty-five grams of stylus pressure.
4. The needle talk should be low enough to be negligible with respect to the acoustical output of the speaker.
5. It should contain no materials that deteriorate rapidly.
6. It should be mechanically stable so that its initial factory assembly adjustment will represent its permanent operational characteristics.

In addition to the foregoing desirable electrical and physical properties, the pickup design should lend itself to large-quantity production to make it commercially sound. Some pickups have been produced in the past with characteristics approaching those listed here, but they have always been laboratory devices that could not be made available to a large number of users at reasonable prices.

Pickup Types

Commercially practical pickups in the past have fallen into two general classes, magnetic and crystal. Magnetic pickups have generally been of the conventional balanced armature type, usually large, heavy and cumbersome. Some moving coil magnetic pickups have been produced, but these have generally fallen into the class of high-priced laboratory or professional units and consequently have never reached the volume consumer market. During the past ten years, the Rochelle-salt piezo-electric pickup has almost entirely replaced the older conventional magnetic pickup for two principal reasons; low cost, and relatively high output. The disadvantages of the crystal pickup as commonly used are well known.

The lateral pickup described here combines the best features of the magnetic and crystal pickups as generally accepted in the past. It is a development of Donald J. Baker, of Los Angeles.

The moving system in this pickup consists of a thin vibrating reed of high-permeability magnetic material rigidly supported at one end and with a stylus attached to the free end. *Fig. 1* is a schematic view of the generating system employed. The vibrating reed (*A*), is solidly supported in the shaded area. A soft iron stylus shank, (*B*), is split and mounted at the free end. *Fig. 2,* which is a side elevation, shows the manner in which the stylus shank is bent so that its end projects downward through the pickup case. A demountable tip is cemented into a recess drilled into the end of the shank, (*B*). A small horseshoe magnet is mounted to produce a substantially uniform yield between the pole pieces (*N*) and (*S*). With the suspension shown and without any damping, the frequency characteristic of the moving system is as shown in *Fig. 3.* Note that the resonance peak is only 12 db in amplitude and is not particularly sharp, due to the low "Q" of the reed suspension. By introducing damping, the curve is modified as shown in *Fig. 4.* In quantity production, this characteristic curve may be maintained with a tolerance of ± 2 db from the norm. The damping material is in the form of two small blocks, indicated at (*C*) in *Fig. 1.* These damping blocks are cemented into position and in assembly are compressed just enough to insure contact at both ends. These are not used as centering adjustments, this practice having so often proved troublesome in previous magnetic pickup designs.

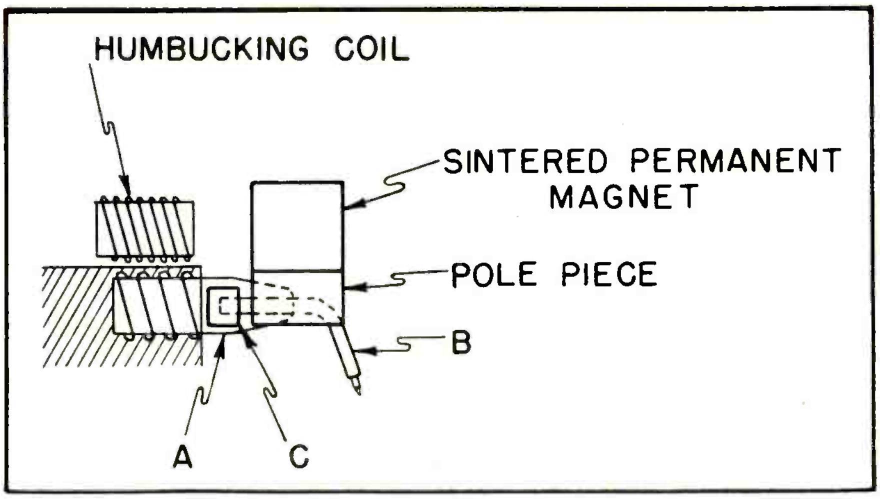


Fig. 2. Pickup side elevation, showing how stylus shank is bent

Compromises in Design

In all developments toward an ideal design, compromises must be made from time to time. In the design described here it became necessary to sacrifice either some of the highly desirable behavior characteristics of the reed arrangement in favor of high voltage output, or vice versa. Since all the flux transmitted to the stationary coil from the concentrated magnetic field must pass through the thin springy reed, it is evident that the maximum flux through the coil and consequent voltage output will go down as the cross section of the reed is reduced. Without this consideration it would be possible to design an ideal moving system, without any frequency peaks and with low enough mechanical impedance to permit tracking with five grams or less, resulting, incidentally, in almost infinite record life. However, because a large percentage of pickup applications are in record-changer mechanisms where the side thrust necessary to actuate the changer tripping device demands a minimum of one ounce of vertical stylus pressure, it was decided to take advantage of this fact and design the moving system for optimum performance at stylus pressures between 25 and 30 grams. This

[*see page* 62]

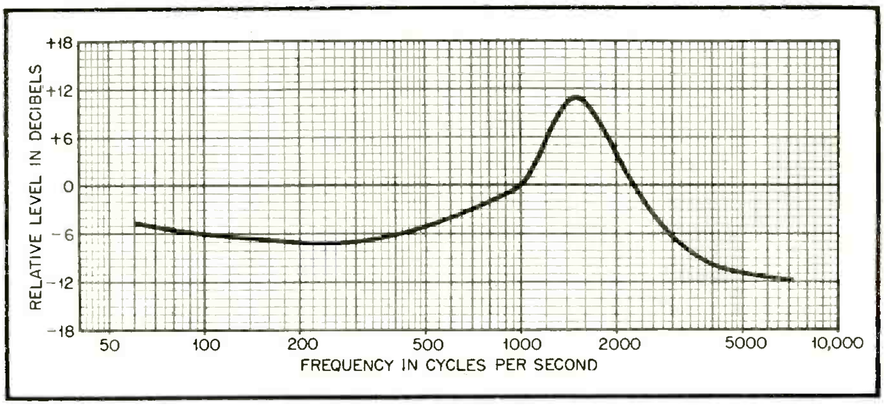


Fig. 3. Frequency characteristic of suspension shown in Figs. 1 and 2 without damping

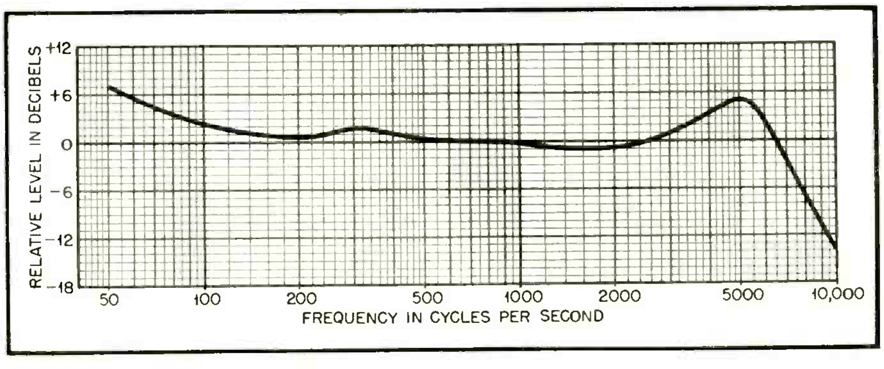


Fig. 4. Frequency response of pickup with damping applied

Irregularities In RADIO TRANSMISSION

OLIVER P. FERRELL

PART 1

Presenting some new concepts on the causes of radio interference

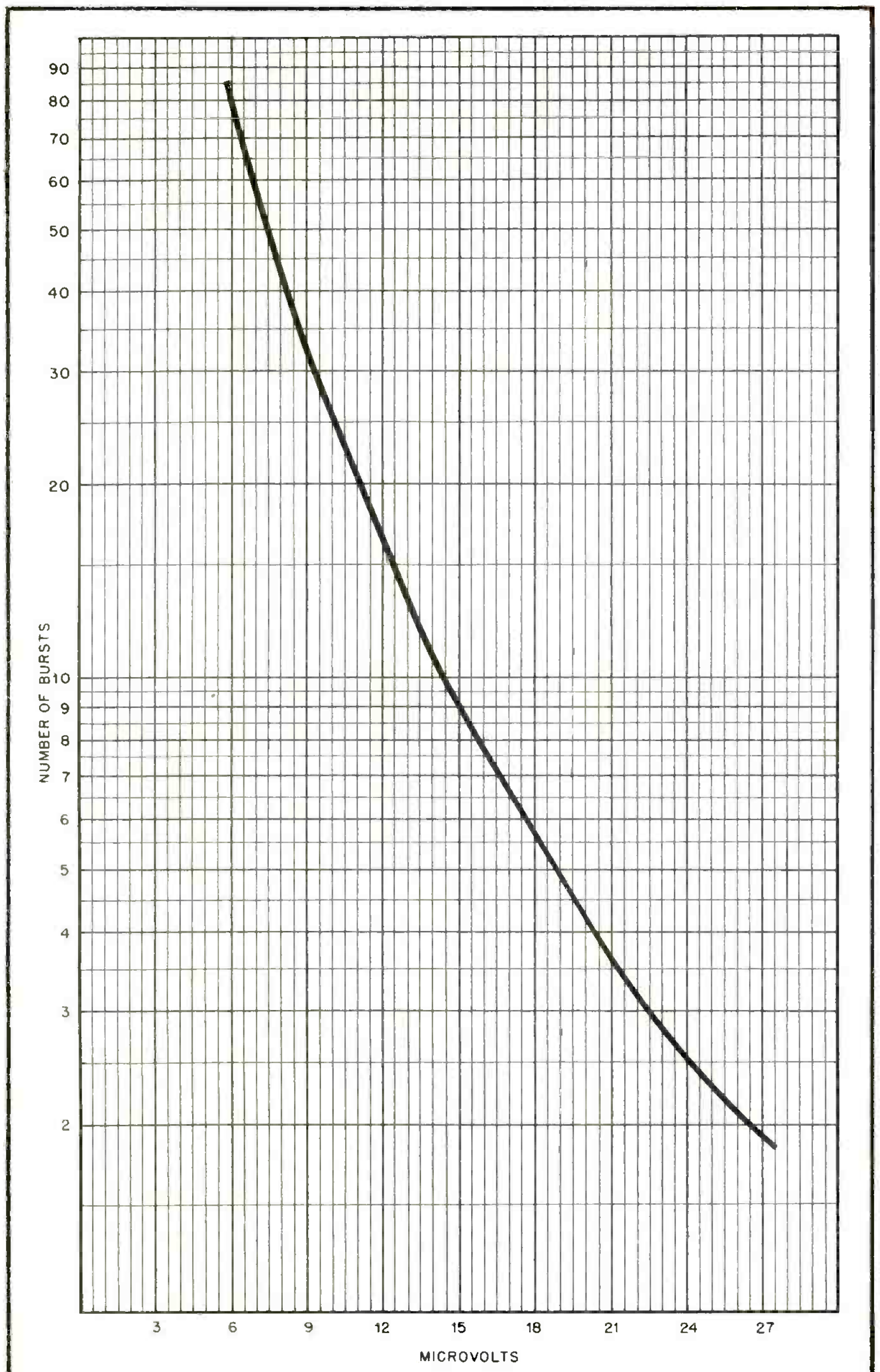


Fig. 1. Mean short-time amplitude distribution of "bursts"

RADIO ENGINEERS HAVE now found that war-time, too was unrelenting in adding to the apparently always mounting number of radio transmission vagaries. The miscreant "burst" in the FM services, "anomalous propagation" in radar long-range searching, an expanded lunar photoelectric effect on the AM broadcast band, the forecast of hundreds of hours of interference from sporadic E on the V.H.F., and wheezing-whistling meteors, all appear to be trying to compound a headache for the designer of a good AM-FM receiver.

What are these new irregularities? Where do they come from? Why has the radio listening public not been troubled before? Just what effects will all this have on reception with our post-war receivers?

Beginning with this installment, these questions and many more will be answered and weighed in their evident disturbance factor for the radio engineer. A thorough history and bibliography of each phenomenon has been prepared for those who wish to investigate the effects further, whereas an analysis of the possible future effects is included in the words of international radio physicists.

Bursts and Meteors

Following the F.C.C. hearing in 1940 on allocation of FM and non-commercial broadcasting on frequencies above 30 mc, some difficulties were anticipated with a "new" propagation phenomenon termed "bursts". These "bursts", from descriptions provided by the F.C.C. and others, consisted of a strong, steep-sided, short-duration signal received 200 to 700 miles from the transmitter. By short-duration it was construed to mean less than 5 seconds, whereas signal strengths of 50 microvolts per meter were not uncommon.

The immediate history of the "bursts" at that time appeared confusing. Contrary to information later disseminated by the F.C.C., radio amateurs had for a number of years previously intercepted "bursts" of a few words or snatches of sentences and call letters while casually tuning the 5 or 10-meter bands. The origin of these intermittent signals was naturally perplexing to the amateur who was limited in his attempts to investigate a short-duration phenomenon. Beverage, Peterson and Hansell[1] had reported "bursts" over a path length of 238 miles. This was in 1931 during their 42.0 mc experiments on the application of very-high frequencies to communication problems. The author had apparently made the first postulation of the origin of "bursts" in 1941[2] when ascribing short-duration, erratic FM signals to meteors.

Meteors as a factor in radio transmission had been suggested from time to time and had previously been correlated with "bursts" or "scattering" on the shortwave bands below 15 mc. "Scattering" had been subjected to an intense investigation by Taylor and Young,[3] Hoag and Andrews,[4] and Quack and Mogel[5] from 1928 to 1930. They reported multiple, short-duration echoes from nearby transmitters, intercepted within the inner boundaries of the skip zone.

Evidence that low frequency "bursts" were really low-level ionosphere reflections was provided by R. A. Watson-Watt[6] who mentions short-lived patches of intense ionization at the 83 km "D" region. These occurred mostly at night and remained for about 3 to 6 seconds with sufficient intensity to reflect waves in the 20 meter amateur band. Also during 1937 another British radio physicist, T. L. Eckersley, was investigating momentary ionosphere echoes, which coming from above the E layer, had puzzled experimenters for a number of years. Eckersley[7] concurred with Appleton[8] that "bursts" or short-duration echoes must depend upon an intense cosmic agency, possibly: (1) long range ultra-violet radiation accompanying bright chromospheric eruptions on the nearby stars, or (2) high velocity particles distributed isotropically in space or emanating from other stars in our galaxy, or (3) small meteorites.

This was a classic departure. The possibilities of meteoric ionization in large quantities having effects upon radio transmission had been oft-times considered. Nagaoka[9] pointed out that meteoric bombardment would tend to create an atmospheric commotion in the E region. The incandescent particles swept from the meteor body would form nuclei for collecting free ions. Nagaoka pictured erratic variations in the refractive index and irregular diffusion in the E layer causing most of the observed radio signal fading. Skellett[11] repudiated this and proposed noticeable increases in the overall density of the E region. Maris[10] had shown that as a meteor sped through the upper atmosphere it would actually dissipate sufficient energy in 1.5 seconds to vaporize 56 molecules of iron from the solid state to a gas at a temperature of 3000°K. or do about 1.12×10^{10} ergs of work. Using this data, Skellett[12] calculated meteors would produce limited area ion densities of 10^6 per cc., or sufficient to reflect 9.0 mc at vertical incidence. Schafer and Goodall[13]; Mitra, Syam and Ghosh,[14] and Bhar[15] proved this contention correct in observing overall increased E layer densities coincident with Leonid showers.

In a 1938 letter to *Nature*, Skellett[16] furthered the proposal that the Eckersley short-duration echoes were primarily due to small ionic clouds created individually by meteors. Pierce[17] meanwhile had been observing the field strengths of 10 mc signals at a distance of 30 km from the transmitter. In these records he found peculiar "bursts" of received energy of a few minutes duration when no ionospheric reflection could be obtained. When the F layer density was above the critical value for this frequency, occasional short periods of intense absorption greatly reduced the reflected signal. Both of these phenomena were subsequently attributed to small ionic clouds in the E region. Consistent with this hypothesis a correlation with meteors was established.

In New Delhi, India, an interesting Doppler effect in radio transmission was being observed, and also correlated with meteors. While monitoring the weak, unmodulated 7.0 mc carrier wave from a distance of 16 km, Chamanlal and Venkataraman[18] noted peculiar heterodyne whistles; whereas it is, of course, nothing unusual for heterodynes to be present in the sidebands of a broadcasting wave, these whistles varied according to the characteristics of a variable frequency beating against a fixed frequency. It was eventually realized that under the conditions of observation these resultant whistles could be explained by postulating that the variable frequency was the 7.0 mc carrier wave reflected from a rapidly moving surface. Subsequent measurements of the initial beat frequency gave values approaching 3 kilocycles per second, if:

$$\frac{c+v}{c-v} f_0 - f_0 = \frac{2v}{c} f_0 \text{ when } v << c.$$

$$v = \frac{f_d c}{2 f_0} = \frac{3000 \times 3 \times 10^{10}}{2 \times 7 \times 10^6} \text{ cms/sec}$$

$= 64$ km/sec (approx. 40 mi/sec)
where c is the velocity of the radio wave; v is the velocity of the reflecting surface moving towards the source; f_0 is the radiated frequency and f_d is the initial whistle frequency.

Velocities this high, relative to the observing station, could only be attributed to meteors in the upper atmosphere.

Although the whistling tones have been correlated with visual meteors, Khastgir[19] has mentioned the similarity to the "tweeks" and "swishes" observed in an audio-frequency amplifier connected directly to long antennas (one experimenter used an old telegraph line, 12 miles long). Khastgir has suggested a common origin; in the present case the atmospheric is supposed to be an electrical impulse produced in the ionosphere, its components being transmitted at different speeds by the dispersive action of the ionosphere.

Present Status of "Burst" Interference Factor

Two complete analyses of the effects of "bursts" and "scattering" in radio transmission have been recently published.

Eckersley[20] has discussed the effects of small ionic clouds on direction finding and long distance reception in short wave communications. While the effects of "bursts" may be predominant when the receiving station is within the skip zone around the transmitter, long distance primary radiation may completely swamp the "bursts" beyond the skip zone. Some lateral and vertical deviations are known to exist and may confuse the operator in the reliability of selective receiving antennas such as the M.U.S.A., which is designed to mitigate the factor of multiple echo distortion. In direction-finding work, the highest limit of accuracy will accordingly be limited by oblique reflections. However these probably do not exceed elementary mechanical errors in most systems.

For the scheduled hearings on the allocation of frequencies above 30,000 kc in September 1944, the Engineering Department of the F.C.C. installed throughout the country a number of FM receivers and recorders on the channel of WGTR (42,300 kc). Nine months after the installation was completed, the records from Laurel, Md. (337 miles distant) and Allegan, Mich. (720 miles distant) were analyzed. This comprehensive breakdown definitely indicated the interference factor to be very small. Further tests at Laurel, using the "bursts" as the interfering signal and a local FM signal generator as the desired signal, proved that a 1 to 1 ratio is sufficient to prevent any objectionable interference.

The mean short-time amplitude distribution of the "bursts" is presented in *Fig. 1*. This was accumulated for six typical morning hours over both the Laurel and Allegan paths. The curve permits a reasonably accurate estimation of the number of "bursts" which will exceed any desired level. With a rate of 80 "bursts" per hour exceeding 6

[*see page* 61]

Dry-Contact Rectifiers For Radio Applications

GEOFFREY HERBERT

Operating characteristics data of dry contact rectifiers

Long before the development of the vacuum tube diode as a rectifier for alternating electrical currents, the unilateral conducting properties of certain natural mineral crystals and coated selenium cells were discovered. Due to the random arrangement of the crystals in natural ores, the point at which rectification could occur had to be found by trial and error. This was accomplished in the crystal detector of early radio receivers by an adjustable wire, called a cat's-whisker. This process had to be repeated very frequently because of mechanical disturbances and burn-outs due to excessive current flowing through the junction between whisker and crystal. The minerals used in these rectifiers were mostly galena, a natural lead sulphide, and zincite, an oxide of zinc. These minerals are classified electrically as semi-conductors. The title of crystal rectifier is misleading because recent investigations appear to prove that the means of rectification is the same as for the better-known selenium and copper oxide rectifiers. In later designs of the crystal rectifier, the natural minerals have been replaced with metal alloys whose surfaces have been chemically prepared to duplicate the results found in nature.

Selenium Rectifiers

The ability of a specially prepared selenium cell to rectify current was announced by C. T. Fritts in the *American Journal of Science* in 1883. Due to the state of development of electrical knowledge, this discovery faded into oblivion. It was re-discovered and introduced on a commercial scale in Germany in 1927. The study of the construction of the selenium rectifier will demonstrate the basic principles upon which all forms of dry-contact rectifiers operate.

Construction

The phenomenon of rectification occurs at the interface between the semiconductor selenium and the treated surface of the selenium. Because selenium is very soft and has a high specific resistance, only a thin layer of selenium is applied on one side of a nickel-plated steel or aluminum disc which serves as a mechanical carrier and as a low resistance conductor of current to the rear side of the selenium layer. Then, by a series of controlled heat treatments, a crystalline surface is formed on the selenium. This crystalline surface acts as the barrier layer to the electron flow from the selenium. In order to make a firm and complete electrical contact on the other side of this barrier layer, a metal alloy of low melting-point is sprayed onto the prepared barrier surface. To prevent the sprayed counter-electrode from shorting to the carrier plate, masking rings stop-off the metal spray a short distance inside the borders of the selenium layer. In *Fig. 1* is a representation of the layers in a selenium rectifier plate.

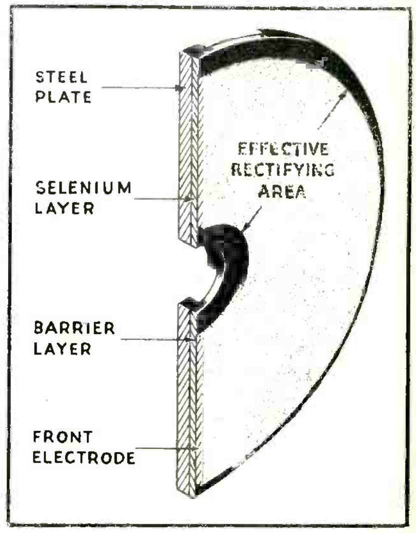


Fig. 1. Representation of the layers in a selenium rectifier plate

Each built-up plate is a complete half-wave rectifier. As it comes from the coating processes, it is known as an unformed plate. Subsequent forming by several successively applied voltage treatments, improves the already existing rectifying properties. The individual plates are assembled on an insulated bolt which supports them and provides the pressure for low resistance electrical contact between adjacent plates and terminals. The number of plates and the bus-bar wiring between them are determined by the required circuit and voltages. The current required determines the area of the plate. The plate not only acts as the rectifier element

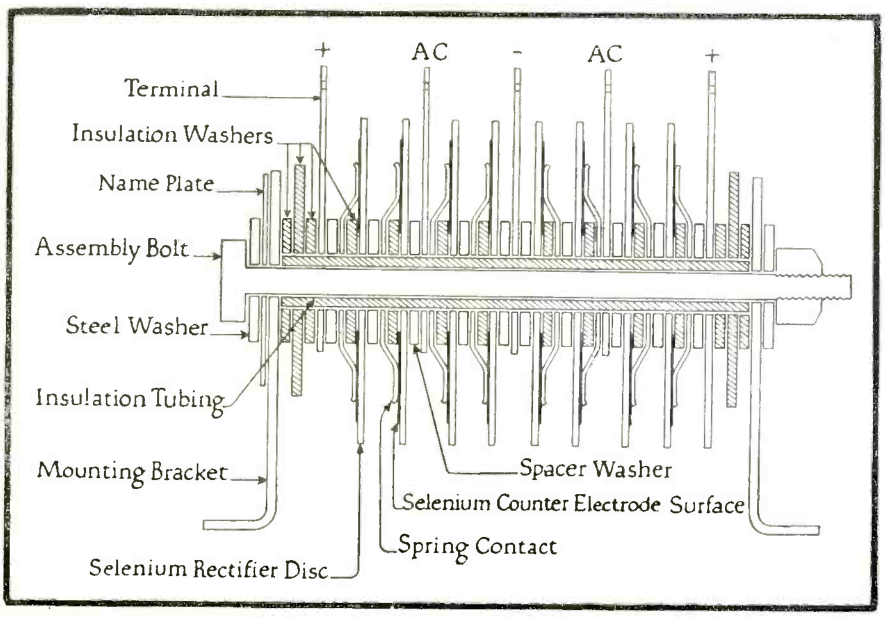


Fig. 2. Typical assembly of selenium rectifier

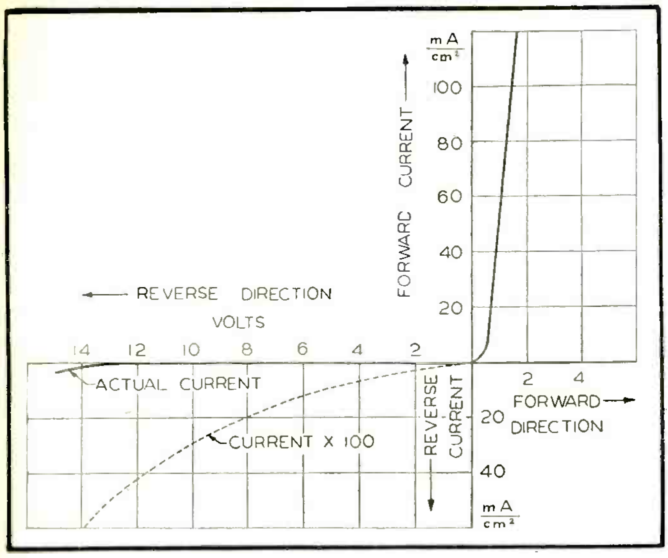


Fig. 3. D-c voltage-current characteristic for selenium rectifier plate. Reverse characteristic shown to 2 scales

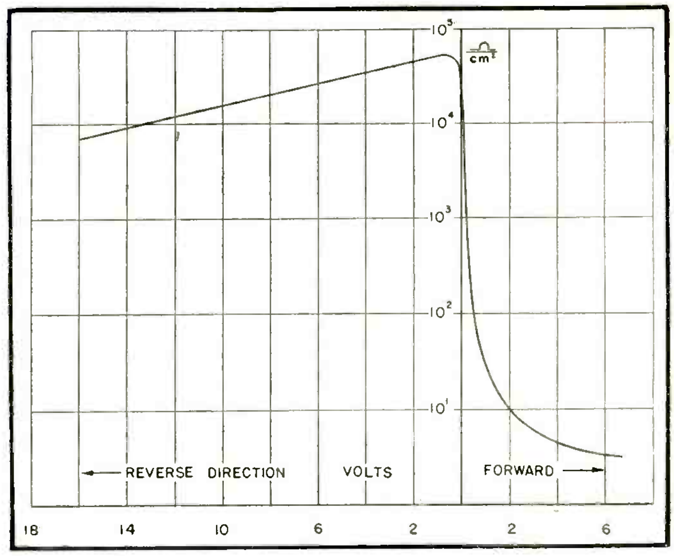


Fig. 4. Typical static resistance-voltage curve of selenium rectifier plate having an effective surface area of 1 sq. cm.

but also as a radiating fin for the heat generated by the passage of current through the selenium and barrier layers. The washers which make contact between the counter-electrode of one plate and the carrier disc of the adjacent plate, also space the plates apart. Increasing the amount of space between plates slightly raises the maximum load rating of the plates. Occasionally, it may prove more economical to clamp a large radiating fin against each plate than to use larger plates for a heavier load. In *Fig. 2* is shown a typical assembly of a selenium rectifier.

Theory

The generally accepted explanation for the rectifying action of dry contact rectifiers is based on the properties of semi-conductors and good conductors. It is believed that there are a great many more free electrons in a good conductor than in a semi-conductor. It is also presumed that the barrier or blocking layer is an extremely thin insulator. When a source of potential is applied across the rectifier disc, an electrical field with a steep potential gradient exists across the barrier layer. When the counter-electrode is connected to the negative side of the supply, the abundant free electrons are able to jump the insulating gap of the barrier layer. This is known as the forward current of a rectifier. When the selenium layer is connected to the positive side, the scarcity of free electrons causes the reverse current to be far smaller than the forward current. This explanation is not perfect but serves as a useful illustration of what appears to happen at the barrier layer.

Forming the Plate

The building of the individual rectifier plate created a peculiar resistor whose forward direction resistance is apparently much less than its resistance in the reverse direction. The ratio of reverse current or leakage to forward current is a measure of its effectiveness as a rectifier and is known as the ratio of rectification. The unformed plate, after being coated, possesses a useful ratio of rectification but cannot be used in circuits where the reverse voltage per plate exceeds 5 volts because the resistance in the reverse direction drops too low. If used with reverse voltages in excess of five volts, the plate would be damaged by excessive reverse current and heating.

By "forming", the average plate can be made to operate on reverse voltages up to 18 v.a.c., r.m.s. The forming is done by applying a direct current voltage to the plate in the reverse direction for several hours. As the forming progresses, the voltage is raised from five volts until the rated maximum is reached. This is a long and expensive process. Small plates have been formed to withstand a reverse voltage as high as 50 v.a.c. The cost of time and current make this value impractical for but the smallest plates. There is a general trend towards higher reverse voltages and medium size plates are now available for use on circuits having a reverse voltage rating. This is desirable because it means fewer plates are required to handle the

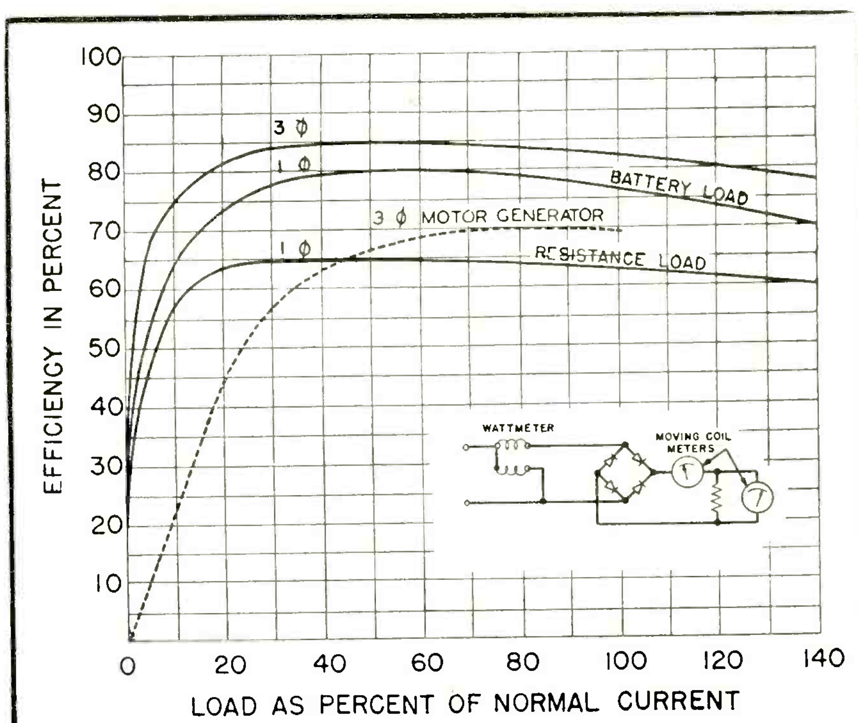


Fig. 5. Comparison of selenium rectifier efficiency at full load voltage with average typical efficiency of motor-generator set with exciters

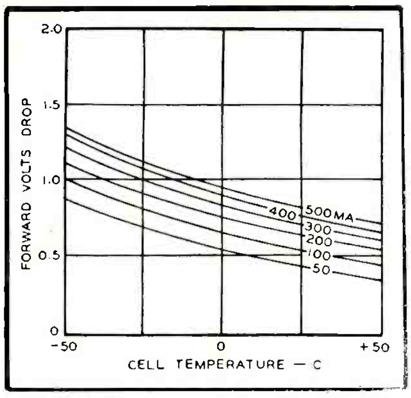
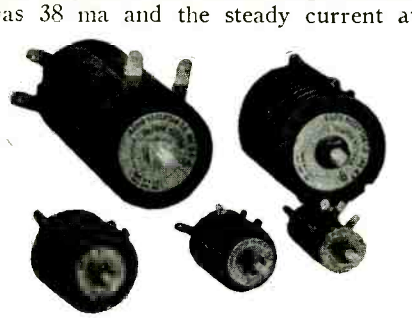


Fig. 6. Change in forward resistance vs. plate temperature

applied voltage. Where the applied input voltage is less than 18 v.a.c., there is no advantage. The forming operation seems to change the insulation value of the barrier layer.

Unfortunately, there is a tendency for a selenium rectifier plate to unform while idle. A comparison is often made between this unforming and the shelf-aging which an electrolytic capacitor experiences. The action of these two cases is not too dissimilar because both are due to the partial destruction of the insulation of the barrier layers. When the reverse voltage is applied, there is a momentary surge which diminishes to normal value within less than 5 seconds. Some plates exhibit greater stability of reverse or back resistance than others. By observing a group of plates for two or three months, it is possible to select those plates which show little reduction in reverse resistance. Plates chosen in this manner are referred to as stabilized plates.

A more serious cause of unforming is when a rectifier plate is subjected to direct current in the forward direction for several hours. This action deteriorates the barrier layer very quickly but will not permanently injure it. A typical rectifier plate which had been properly formed showed in initial surge current of 14 ma and a steady current of 6 ma when 25 v.d.c. reverse was applied. Then 150 ma was passed in the forward direction for four hours. At the end of the four hours, a reverse voltage of 25 v.d.c. was reapplied. The initial surge current was 38 ma and the steady current at



Selenium rectifier by Radio Receptor Co.

the end of fifteen minutes was 6 ma. For a relay or control circuit in which the rectifier is required to instantly block the reversal of current, this initial reverse current could not be tolerated. The unforming of the selenium plate can be avoided in this type of application by using unformed plates in the rectifier stack. The efficiency of unformed plates is lower than that of formed plates and a larger number would be required to block the same reverse voltage. The reverse resistance of an unformed plate would not drop sharply.

The forming of selenium plates has almost no effect on the forward resistance characteristic of the plate.

Current Characteristics

Since the dry-contact rectifier depends upon the difference in resistance encountered by the forward and reverse currents, the magnitude of these resistances will determine the performance. Neither the forward nor reverse resistance follows Ohm's Law for linearity. The resistance near zero voltage is the same maximum for either forward or reverse current. Increase of applied voltage from 0.2 volt to 1.0 volt in the forward direction causes the resistance to change in the order of 1000 to 1. At a-c voltages below 1 volt, the d-c output of a rectifier will be distorted badly. If the rectifier is used to supply rectified a.c. to a d-c instrument the meter should be chosen so that its value corresponding to full scale deflection is many times above this 1 volt level. Above 1.5 volts, the forward resistance is practically linear.

In *Fig. 3* is shown the d-c voltage-current characteristic for any selenium rectifier plate. The lower scale is of a different magnitude in order to show both directions of resistance on a small chart. In ordinary usage, the forward voltage across the plate is never as great as the reverse voltage because of the voltage drop across the load during the forward half-cycle. The non-linearity of the forward resistance below 1 volt is frequently used to secure a voltage-limiter effect on variable input signals. By increasing the number of plates in series the non-linear behavior can be extended to higher voltages. In *Fig. 4* is shown the companion resistance values to the voltage current characteristics.

Efficiency

The selenium rectifier exhibits an unusual constancy of efficiency over a range of from 20% to 150% of full load. This is due to the lowering of the internal resistance with increasing current flow in the forward direction.

In *Fig. 5* is shown a chart of typical volt-ampere efficiencies for various types of load. The inaccurately known current form factors of inductive or reactive

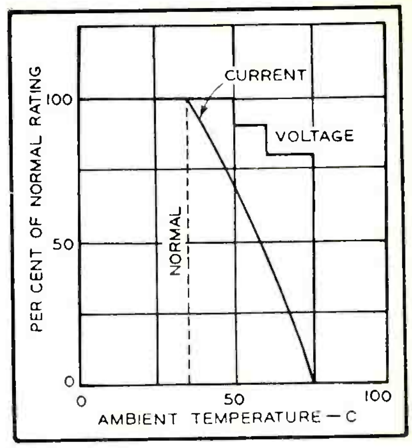


Fig. 7. Curve showing change in forward resistance with plate temperature

loads frequently cause erroneous estimates of output versus input voltages and corresponding errors in efficiency. The measure of efficiency from the ratio of output to input when both are measured with a wattmeter is about 85% at full load. This figure is independent of plate size because the per-plate current ratings are such that the same final plate temperature is reached by the rectifier in every case. This measurement is also independent of the type of load and rectifier circuit arrangement. In the d-c output of a rectifier there is an a-c component as well. If the load is battery charging, plating or similar chemical work where the a-c component is not employed, the output should be measured by a d-c voltmeter and d-c ammeter of the moving coil type.

Regulation

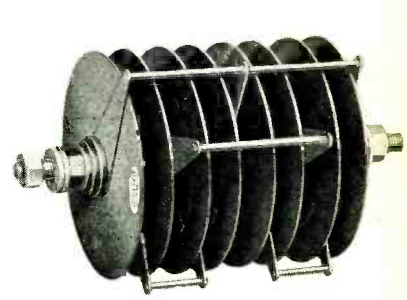
With a resistance load, the d-c output voltages at full load and no load, respectively, are about 77% and 85% of the r-m-s input voltage. The regulation from no load to full load is, therefore, of the order of 10%.

Power Factor

Because the dry-contact rectifier is a resistance device, it operates at unity power-factor at low power frequencies.

Temperature

The selenium-type rectifier has an inverse temperature coefficient which results in a decrease in forward resistance



Selenium rectifier by Benwood-Linze Co.

SIZES AND CURRENT CAPACITY OF SELENIUM RECTIFIER PLATES

Diameter Inches	Max. R. M. S. A. C. Volts reverse per plate	Maximum continuous D. C. amperes for one plate per arm at 35° C. ambient, inductive or resistive load						Maximum Continuous D. C. rating as valve at 35° C. ambient		Maximum No. of plates per stack †
		*Single Phase			Three Phase			Amperes	Blocking Voltage	
		Half Wave	Bridge	Center Tap	Half Wave	Bridge	Center Tap			
3/4	18	.040	.075	.075	.100	.110	.130	.06	15	36
1	18	.075	.150	.150	.200	.225	.270	.12	15	36
1	18	.11	.22	.22	.29	.33	.4	.17	15	28
1 3/8	18	.15	.30	.30	.40	.45	.55	.23	15	36
1 3/8	18	.23	.45	.45	.6	.67	.82	.34	15	28
1 3/4	18	.30	.60	.60	.80	.90	1.1	.45	15	40
1 3/4	18	.39	.78	.78	1.0	1.1	1.4	.58	15	28
2 5/8	18	.58	1.1	1.1	1.5	1.7	2.1	.87	15	28
2 5/8	18	.60	1.2	1.2	1.6	1.8	2.2	.90	15	40
2 5/8	18	.78	1.6	1.6	2.1	2.3	2.8	1.2	15	28
3 3/8	18	.90	1.8	1.8	2.4	2.7	3.3	1.4	15	28
4 3/8	18	1.1	2.2	2.2	2.9	3.3	4.0	1.7	15	28
3 3/8	16	1.2	2.4	2.4	3.2	3.6	4.5	1.8	12	40
3 3/8	16	1.5	3.1	3.1	4.1	4.6	5.8	2.4	12	28
4 3/8	16	1.8	3.5	3.5	4.6	5.2	6.5	2.7	12	28
4 3/8	16	1.9	3.8	3.8	5.0	5.6	7.0	2.9	12	24
6" sq.	16	2.7	5.4	5.4	7.2	8.1	10.0	4.1	12	28
4 3/8	14	2.0	4.0	4.0	5.3	6.0	7.5	3.1	12	40
4 3/8	14	2.6	5.2	5.2	6.9	7.8	9.7	4.0	12	28
6" sq.	14	3.7	7.4	7.4	9.8	11.1	13.3	5.7	12	28
8" sq.	14	5.0	10.0	10.0	13.0	15.0	18.0	7.5	12	28

*NOTE—These ratings do not apply to battery charging or condenser loads.
†When the rectifier stack is subject to vibration the maximum number of plates per stack is 16 for all types.

Fig. 8. Typical chart of normal load ratings for standard selenium rectifier plates

with an increase in temperature. The variation in reverse resistance is very slight and has little effect on the output. It has a positive temperature coefficient up to about 60 degrees C. and then swings to a negative coefficient above 60 degrees C. In *Fig. 6* is shown the change in forward resistance with plate temperature. Where very accurate output voltage is required, it may be advisable to make provisions for adjusting the input voltage. Where selenium rectifiers are to be used outdoors in sub-zero temperatures, the voltage drop in output should be very carefully considered.

The maximum operating temperature of a selenium plate for continuous operation should not exceed 75 degrees C. An operating temperature of 85 degrees C. can be withstood for several hours with safety. The standard 100% load ratings for rectifier plates are based on an ambient temperature of 35 degrees C. and a steady operating temperature of about 75 degrees C. This assumes a temperature rise of approximately 40 degrees C. at 100% normal load.

Where operation in a higher ambient temperature is required, the load rating must be modified by the factor shown in *Fig. 7* in order to maintain the final

[*See page* 60]

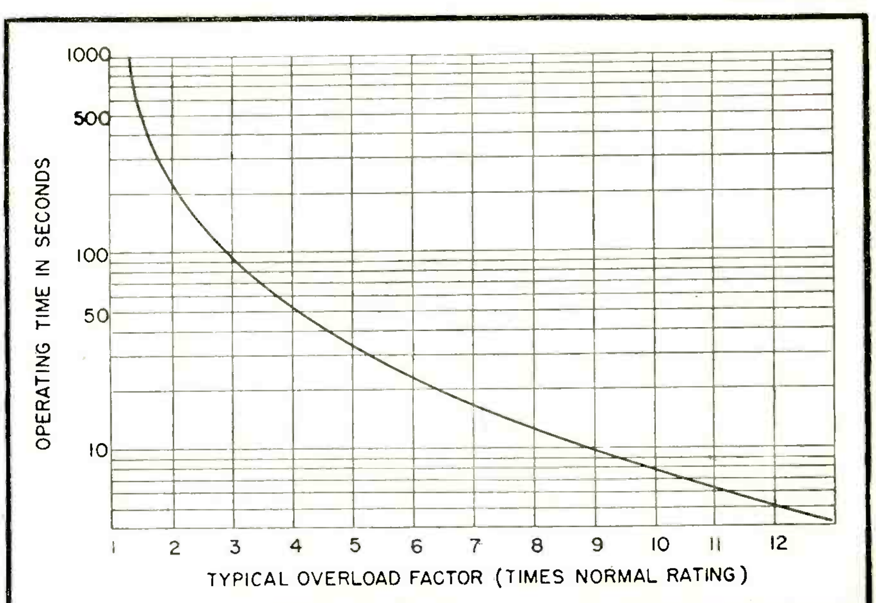


Fig. 9. Typical overload capacity curve

Radio Insulating Materials

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Glass-bonded mica; its properties and design criteria

PART 4

PREVIOUS DISCUSSIONS in radio insulating materials have indicated that there is no perfect insulator. During this discussion we investigate another material which serves admirably under certain conditions—glass-bonded mica, known also by several trade names.

Mica of the proper grade is recognized as one of the best forms of electrical insulation. However, its lack of certain physical properties prohibits use in applications where rigidity and delamination are factors. Glass, when properly prepared, can have a low electrical loss, high voltage breakdown strength, and low moisture absorption, which properties parallel mica's properties. The wedding of these two superior insulating materials is a glass-bonded mica.

We shall see, as we investigate this material, that certain properties lacking in each of the two basic materials appear when the two are mixed. Bear in mind that the new material is for the most part a mixture and not a new chemical compound.

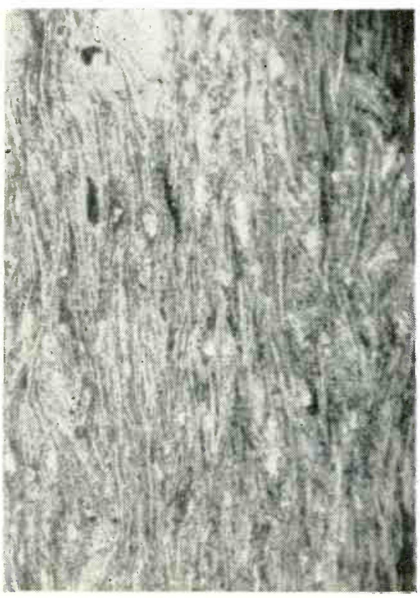


Fig. 1. Photomicrograph of compression-molded glass-bonded mica with light rays perpendicular to direction of pressure
(Courtesy of Mycalex Corp. of America)

Preparation of the Raw Material

Mica is chemically a silica salt of some metal, such as aluminum or magnesium. Two grades are mined that represent the desirable and common electrical grades: muscovite or phlogopite. These two forms of mica differ in that the muscovite, the commoner of the two, has a lower disintegration point, but it has higher electrical strength and insulation resistance. Muscovite is more commonly used, as the disintegration point of mica is not an important factor in this mixture.

It is incumbent upon the glass, however, that it melt at a sufficiently low point to prevent destruction of the mica structure. Should such a destructive action take place, the mica would fuse with the glass creating a borosilicate compound. The glass employed is either a borate or borosilicate form with or without lead.

The lead salt is sometimes used to allow better flow of the material and to better the electrical properties. Most of America's production today includes a leaded glass. Lead as a component of glass is not dangerous to the user; it is rendered inactive in the firing operations.

A unique combination of glass and mica—with a nearly even mixture of each—constitutes the raw material for the glass-bonded mica. The glass is prepared as a finely powdered frit, the mica as a finely ground powder. This material is pelleted, similar to the preforms of the plastics, and heated above the melting point of the glass. When in a molten, or near-molten state, the material is compressed and solidifies under the heat and pressure.

Compression Molding

Curing time, a factor in plastic molding where detailed chemical reactions set in, is not a factor in the preparation of this material. Instead, solidification time is the factor as solidification of the material is proportional to the thickness and contour of the piece.

The resulting composition is a hard dense material, that is brittle in thin sections, although not as brittle as its component glass. Part of the increased strength comes from the quasi-stratification of the mica particles. Because mica is basically a material that exists in a plate-like grain structure, during the molding operation the mica flows so as to present a plate-like form directly perpendicular to the forming pressure.

Fig. 1 is a photomicrograph of glass-bonded mica with the light perpendicular to the forming pressure. A laminate-like form may easily be observed. This gives the material greater flexural strength, although lower compressive strength, than most of the other ceramics. It should be noted that very few other ceramic materials present a laminate structure.

The properties of the material are indicated in Table 1. These data are figures based on published data of the American companies making the glass-bonded mica insulation. Data are presented in Table 1 only for compression

Fig. 2. Photomicrograph of transfer-molded glass-bonded mica with light rays parallel to the flat surface
(Courtesy of Mycalex Corp. of America)

molded sheet or rod stock. Similar properties are to be expected for any compression molded product of unique design using this material.

Great stress has been laid so far on the compression molded form. Perhaps it would be well at this point to differentiate between compression and transfer molding, as it is practiced in the glass-bonded mica industry.

Molding Operations

Compression molding includes certain fundamental operations: pelleting of the material, heating, forming, annealing, and removal of the "skin". Although individual operations vary, these operations are the essential ones.

After the material is mixed to the correct proportion of glass and mica, the material is pelleted by "cold pressing" to the desired shape. During this operation there is only partial stratification of the mica, since the glass is still in frit or unmelted form. After the material is cold pressed, it is heated to some temperature between 1000°F. and 1500°F. so that the glass becomes softened. It is then transferred to the press where pressure is applied directly to the plastic sheet; at the same time heat is applied so that proper material flow can be maintained.

After solidification in the mold, the material is removed from the press and the "skin" ground off. The skin on the material is a porous layer of improperly set-up material. This skin occurs because of surface chilling during the operations from the furnace to the press and because of contact with plattens that must be maintained at a lower temperature than the softened glass-bonded mica.

Proper molding operation also includes a very slow cooling-off period. If this cooling-off period is correctly timed at the proper heat, the material is free of stresses. If material is under-annealed, it will have inherent stresses and may crack or split under machining operations.

Transfer Molding

Transfer molding, which we mentioned previously, differs from compression molding only in one manner: the molding operation itself. The operations of preforming, heating, and stress-relieving are similar. However, upon removal from the cooling chamber, the material is free from skin. The absence of skin is due to the lack of cooling in the material's moving from the furnace to the mold. Transfer molding includes a technique where the softened material is placed in a well and pressure is applied to the pellet. As pressure is applied the material squeezes into runners that feed into cavities the shape of the desired piece. Since only plastic material flows into the cavities through the canals or runners, the material's surface (including the porous skin) is maintained in the unused well.

Of the two forms of molding, transfer molding gives a smoother, harder surface and lends itself to mass production where the cost of molds can be easily amortized; compression molded parts usually require the subsequent operation of grinding off the skin. Compression molded parts are cheaper for there is no material waste in the "wells" and because the tooling is necessarily less complicated. Where the mold cost can be easily amortized, transfer molding offers the better product.

Other Forms

At present, compression molding and transfer molding represent the only two techniques of forming the glass-bonded mica. Compare the properties of transfer-molded material shown in Table 2 with the properties of the compression-molded material in Table 1: note also the absence of a grain structure as shown in *Fig. 2*. The light is again parallel to the flat surface.

Extrusion molding has not been successful to date because the material must solidify under heat and pressure. Casting the product is not a desirable advance because the non-uniformity of the material would probably cause deleterious electrical effects.

The resultant mixture has some desirable properties from the radio designer's point-of-view. Ceramic in nature, the material does not carbonize under an electric arc and withstands higher temperatures than most of the organic plastic forms. Quoted figures show no deformation under moderate loads to temperatures in the order of 700°F.

Because the glass and the mica are each excellent from the point of moisture

TABLE 1

PROPERTIES OF COMPRESSION-MOLDED GLASS-BONDED MICA

POWER FACTOR, 1 mc	0.0018 to .001
DIELECTRIC CONSTANT, 1 mc	6.6 to 8.3
LOSS FACTOR, 1 mc	0.013
(Measured after 48 hours immersion in distilled water in accordance with procedures of JAN-I-10)	
DIELECTRIC STRENGTH, volts per mil (1/4" thick)	340 to 500
VOLUME RESISTIVITY, ohm-cm	5×10^{15} to 1×10^{16}
SURFACE RESISTANCE, megohms	300,000
(After 96 hours at 85° F. and 85 % relative humidity with one inch electrode spacing)	
ARC RESISTANCE, ASTM seconds	260 to 325
TENSILE STRENGTH, lbs. per sq. in	5,000 to 7,000
COMPRESSIVE STRENGTH, lbs. per sq. in.	22,000 to 35,000
TRANSVERSE STRENGTH, lbs. per sq. in	15,000 to 20,000
IMPACT STRENGTH -- Charpy -- 1/4 in. x 1/4 in. specimen	0.098 to 1.16 ft.-lbs.
HARDNESS, Brinnell	40 to 50
THERMAL CONDUCTIVITY, BTU/sq. ft / hr / °F /in	3.5 to 4.0
DENSITY, lbs. per cu. in.	0.10
SPECIFIC GRAVITY	3.0
WATER ABSORPTION, 48 hours	Less than 0.1%
MAXIMUM SAFE OPERATING TEMPERATURE	400°C.
COEFFICIENT OF LINEAR EXPANSION, °/C.	7.5×10^{-6} to 110×10^{-6}

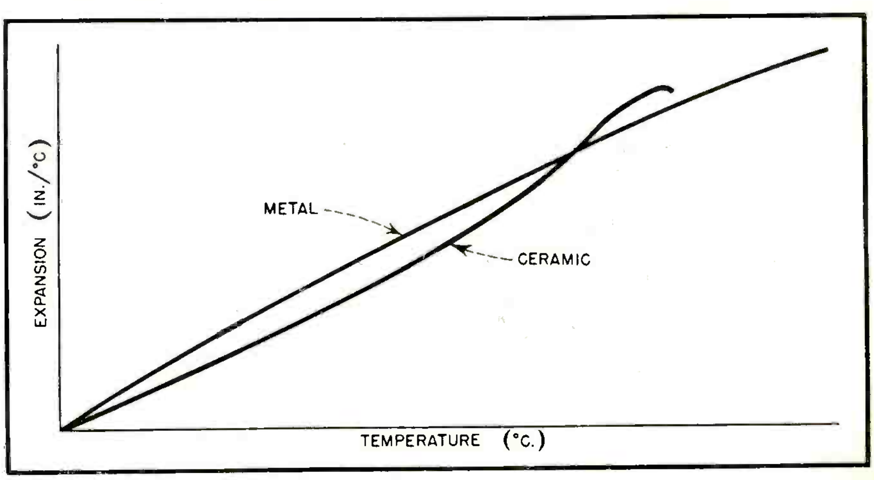


Fig. 3. Temperature-expansion chart of a typical metal-ceramic seal. Note the non-linearity of the ceramic material's expansion

TABLE 2

PROPERTIES OF TRANSFER-MOLDED GLASS-BONDED MICA

POWER FACTOR, 1 mc, dry	0.0015 to 0025
DIELECTRIC CONSTANT, 1 mc	7.5 to 8.5
VOLUME RESISTIVITY, ohm-cm	6.0×10^{17}
DIELECTRIC STRENGTH, volts per mil (1/4" thick)	325 to 400
ARC RESISTANCE, ASTM seconds	250 to 325
TENSILE STRENGTH, lbs. per sq. in.	6,000
COMPRESSIVE STRENGTH, lbs. per sq. in.	20,000
TRANSVERSE STRENGTH, lbs. per sq. in.	8,000 to 13,000
MODULUS OF ELASTICITY, lbs. per sq. in.	8×10^{6}
HARDNESS, Brinell	150
DENSITY, lbs. per cu. in.	0.140
SPECIFIC GRAVITY	3.8
WATER ABSORPTION, 48 hours	Less than 0.1%
MAXIMUM SAFE OPERATING TEMPERATURE	400°C.

pickup and because of the high forming temperatures, moisture absorption after 48 hours is less than 0.1% under American Standard Society for Testing Materials' moisture absorption (immersion) tests. In addition to its moisture resistance, glass-bonded mica is impervious to oils and to the common organic solvents. It will not resist acids or alkalies except in extremely dilute solutions.

Another advantage of the glass-bonded mica—although glass by the nature of its compositions and variations in the firing temperatures offers more possibilities along these lines—is the fact that the coefficient of expansion is low compared to organic plastics and may be varied to match the thermal expansion of some metals.

Metal Seals

Fig. 3 shows a theoretical curve of a metal and of a glass-bonded mica, with thermal expansion plotted against temperature. Note that under the worst conditions the materials may be far apart, but under the usual operating range, the materials may be considered the same. This example may be applied to glasses for the most part, although the magnitude of the examples will vary with the metal and the glass employed.

Metal inserts can be molded into the compression or transfer molded parts as long as proper design criteria are employed. Such criteria will be presented after electrical properties are discussed.

High arc resistance because of the absence of carbonizable material has been mentioned as one of the fundamental advantages. If we consider for the moment the reason why certain organic compounds have a low arc resistance, it will be readily apparent why glass-bonded mica and all other ceramics excel in this property.

Consider the phenolics which are low in arc resistance. Phenolics, chemically, are compounds of carbon, oxygen, and hydrogen. When heat is applied either as electrical or thermal energy, the carbon alone remains since the oxygen and hydrogen escape in the form of water vapor.

If the composition is altered to include nitrogen, as in the case of the melamines, the ability to form water is still present, but the end product after water evaporation is a carbon-nitrogen compound. Since the carbon atoms are separated by the nitrogen atoms, the product does not arc or form a conducting path as readily as the phenolics.

Adding more nitrogen or other noncarbonizable substance causes higher arc resistances. Ceramics, representing a group of materials free from carbon, do not carbonize. Tracking in the case of ceramics results only from surface films of moisture or dirt.

Low Loss

Low moisture pickup has a direct correlation in this case with the electrical loss. The lower this moisture pickup, the lower the electrical loss; glass-bonded mica represents a material with a low moisture pickup and a low dielectric loss factor.

Dielectric constant of most grades remains the same over the radio frequency to the u-h-f band. Loss factor over the same range varies with a low point in the ten to thirty megacycle region. At power frequencies, however, there is a pronounced upswing of both the dielectric constant and power factor. This phenomenon is true of almost all ceramics; however, relatively higher loss factor at these frequencies plays little part as the frequency component is so low. *Fig. 4* illustrates this property.

Thermal shock resistance is often coupled with dielectric loss factor in the other ceramics. Thus, a pure steatite, which represents the purest ceramic of low loss qualities has particularly poor thermal shock qualities. Cordierite or zirconite, modified steatite forms, possess the ability to resist thermal shock, but are "lossier".

The same analogy does not necessarily hold for the glass-bonded micas. Ability to resist thermal shock is not coupled with the loss factor because several of the better (from the point of loss factor) glass-bonded micas successfully resist thermal shock; some of the poorer materials (by the same criteria) do not resist thermal shock.

It should be pointed out, however, that thermal shock resistance is a phenomenon based on the geometry of the insulator, the metal parts which may be bonded to it, and the constituent materials.

High dielectric strength and high insulation resistance follow from the materials employed.

Design for Fabrication

To consider some of the fundamental design criteria, permit the writer to again make several divisions of the subject: fabricated parts of ground sheets or rods of glass-bonded mica, compression-molded parts (where no finishing operations are performed), and transfer-molded parts.

Soft low-temperature glass and finely ground mica make glass-bonded mica

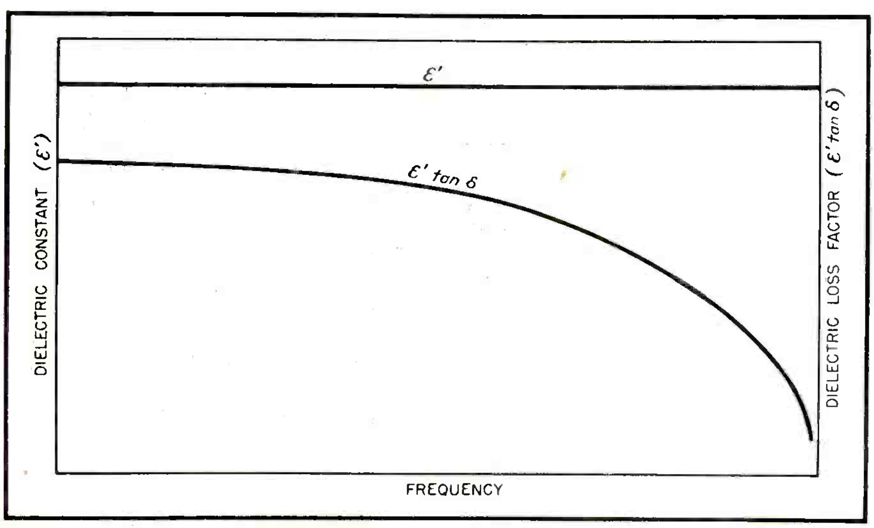


Fig. 4. Dielectric constant and loss factor of a typical glass-bonded mica

insulation machinable. The word "machinable" must be qualified—the material is machinable to the extent that cutting, drilling, tapping, flycutting, slotting, and grinding are the operations permitted.

It was mentioned that the material comes out of the annealing operation with a slight surface skin. This skin is customarily wet ground from the surface prior to shipment from the manufacturer's plant, allowing a smooth even surface.

Cutting may be performed using resinoid-bonded silicon carbide wheels at high speeds with a water coolant. Tolerances on such pieces, as cut, will vary with the thickness. General manufacturing specifications prefer the minimum tolerance on width, length, or thickness to be no less than ±1/64". Thickness may be maintained to ±.005" on thicknesses up to ½".

Drilling, tapping, slotting and the like should be completed with tungsten carbide tools at moderate speeds with a water coolant. Class 1 tolerances on screw threads are the industry accepted standard on externally or internally-threaded parts.

Fabrication Rules

Because the material cannot be punched or formed. all designs must take into consideration that the only operations permitted are drilling, grinding, cutting, flycutting, tapping, and slotting. With this in mind, the following design precautions were drawn up:

1. Square holes can be made only by hand filing. Avoid these where possible because they will add to the cost or make fabrication prohibitive. In most cases, square holes cannot be made at any cost.
2. Tapped holes in glass-bonded mica should be avoided where possible. A through hole in the insulation with a tapped hole in the supporting metal member will serve the same purpose in many cases. This design technique means that the thread is a closer fit and will not wear, as tapped holes in glass-bonded mica do.
3. Blind holes should be avoided. Bottoming of tapped holes should be avoided.
4. Externally-threaded parts should be avoided where strength is a requirement. Coil forms, however, may often be produced on a lathe if broad enough tolerances are allowed the manufacturer.
5. Concentricity requirements on through holes should not be included, except where imperative.
6. Irregular and curved shapes should be avoided except when these parts can be compression or transfer-molded. In other words, use irregular shapes only when mold costs can be amortized over a large quantity.
7. Hole spacing should be a minimum of ⅛" apart and also ⅛" in from the outside of the piece. Closer spacing of holes to each other or the outside of the piece may cause chipping.
8. Angle cuts into the piece should allow a generous radius. This, of course, will vary with the thickness of the part and the size of the angle cut. Minimum tolerance on angle cuts is ±1°. Round cuts into the side of a sheet should be avoided, although such a fabrication technique is possible.
9. Right angle corners are preferred to rounded edges.
10. Minimum thicknesses should be employed only where the strength is sufficient.

The above rules are summarized in Table 3 in the form of a chart of expected tolerances. Upon examination, the designer will note that the above rules are true in any material, but are important where any highly abrasive and dense material is employed.

TABLE 3

GLASS-BONDED MICA DESIGN TOLERANCES (FABRICATED PARTS)

TOLERANCE ON THICKNESS, LENGTH, OR WIDTH	±1/64"
TOLERANCE ON HOLE SPACINGS	±.007"
TOLERANCE ON HOLE SIZES	±.005" OR ±1% OF HOLE DIA, WHICHEVER IS GREATER
TOLERANCE ON ANGULAR DIMENSIONS	±1°
FLATNESS LIMITS	.0015"/INCH OF LENGTH
ROD DIAMETERS	±.005

BUSHINGS:

MAX LENGTH	O.D.	MIN WALL
1/4"	UP TO 3/8"	1/16
1"	UP TO 1/2"	1/8
1"	1/2" TO 3/4"	3/16
1"	3/4" TO 1"	1/4

(BASED ON JAN-I-7, JOINT ARMY-NAVY SPECIFICATION)

Design for Molding

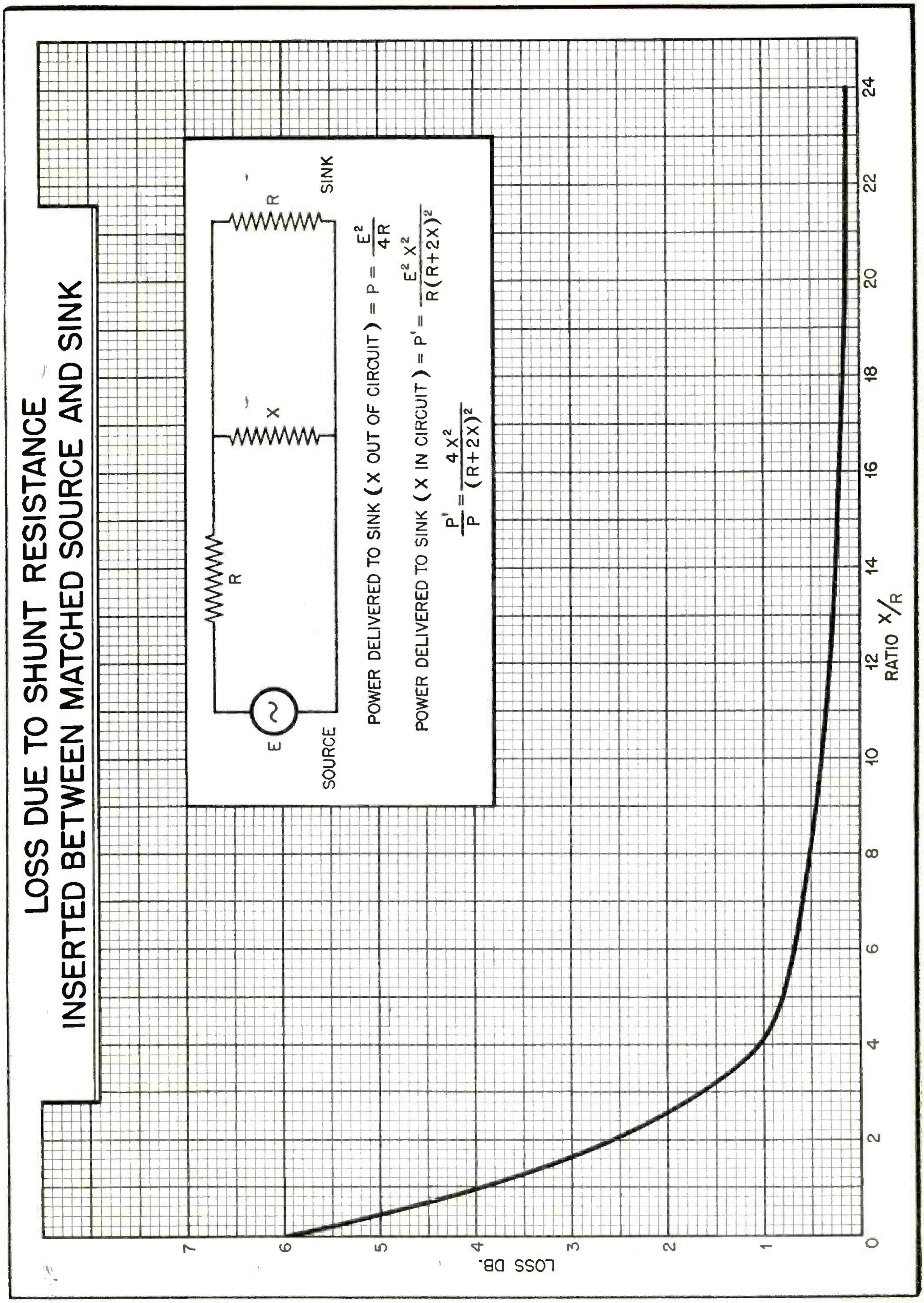
Certain other rules could be added; many exceptions apply to the above rules. The designer in the interest of reducing his job cost should try to make the job of the glass-bonded mica manufacturer easier since the ease of fabrication will reduce cost.

Compression molded parts follow some very basic rules. Transfer-molded parts follow some equally basic rules. The rules these two techniques have in common are as follows:

1. Threaded parts cannot be molded into the material, either externally or internally, with any permanent degree of satisfaction. In transfer-molded parts use high strength metal inserts anchored for internal threads; use metal jackets for external threads. Ordinarily, the external metal can be brass or any other metal. In compression-molded samples, avoid placing metal inserts—if possible—since the application of direct pressure may crush the metal part. If metal parts are used for threads, use high strength thick section metal for either internal or external threaded parts.
2. Gradual draws are preferred to sudden draws, particularly in compression molding. Transfer-molded parts lend themselves better to sharp draws since the material is injected into the cavity under pressure and heat; compression molding needs the direct application of pressure with a minimum of material flow.
3. Taper should be allowed on either compression or transfer molded parts. Transfer-molded parts require more taper to allow proper ejection of the part from the mold. Designers should allow approximately .010" taper per 1". Compression-molded parts may be designed to approximately .005" taper per 1".
4. Blind holes and small diameter holes (less than .100") should be avoided because of shearing action of the molten material.
5. Square holes, slots, close hole spacing tolerances, and irregular shapes are feasible providing the above precautions are observed. Again, holes should be spaced 1/16" away from any edge for proper strength. Hole spacing tolerances, however, may be maintained to ±.002" in either type of molding; hole spacing tolerances in fabricated parts are approximately ±.007".

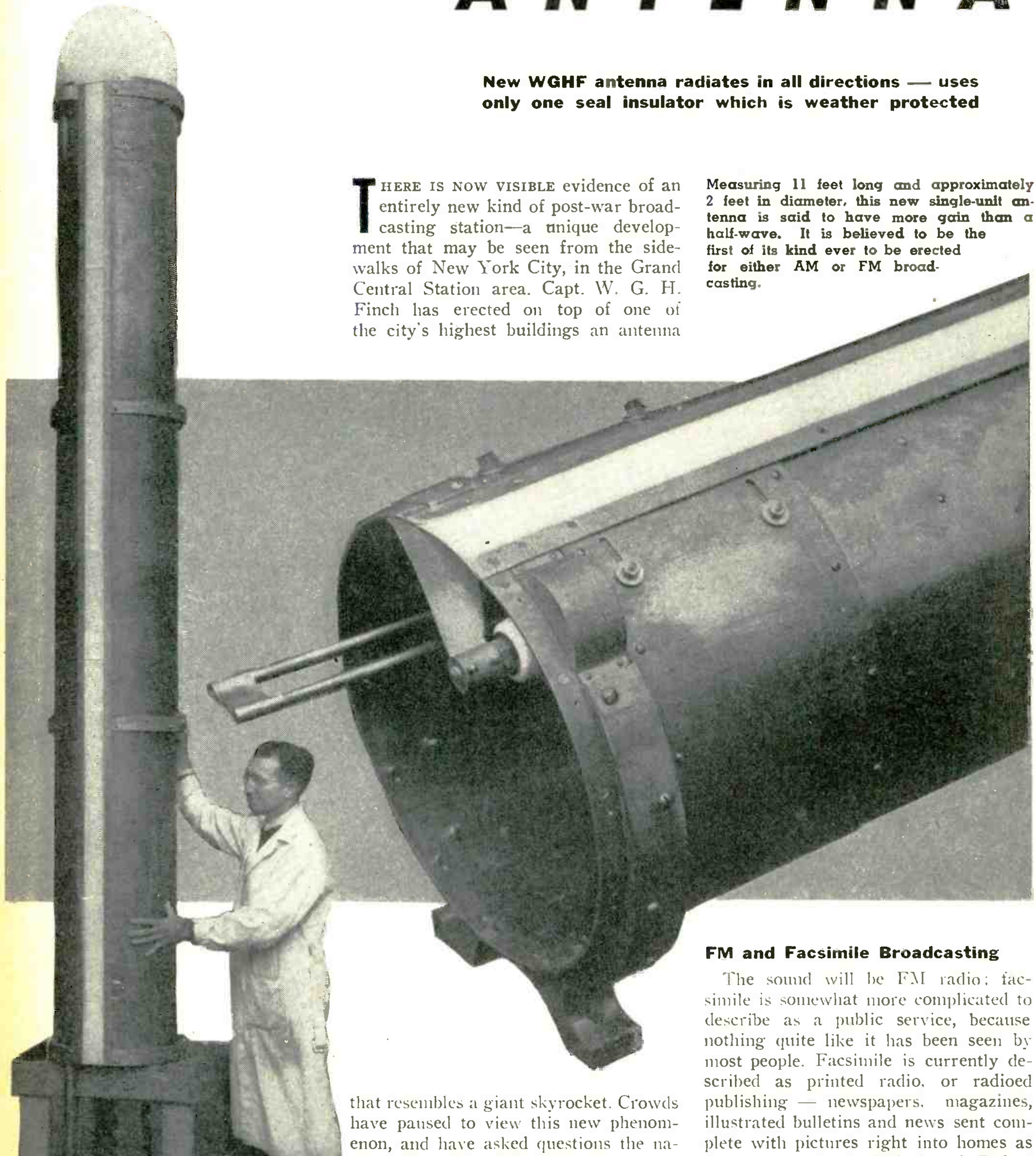
[see page 59]

LOSS DUE TO SHUNT RESISTANCE INSERTED BETWEEN MATCHED SOURCE AND SINK



FM-FAX "SKYROCKET" ANTENNA

New WGHF antenna radiates in all directions — uses only one seal insulator which is weather protected



Measuring 11 feet long and approximately 2 feet in diameter, this new single-unit antenna is said to have more gain than a half-wave. It is believed to be the first of its kind ever to be erected for either AM or FM broadcasting.

THERE IS NOW VISIBLE evidence of an entirely new kind of post-war broadcasting station—a unique development that may be seen from the sidewalks of New York City, in the Grand Central Station area. Capt. W. G. H. Finch has erected on top of one of the city's highest buildings an antenna that resembles a giant skyrocket. Crowds have paused to view this new phenomenon, and have asked questions the nature of which run the gamut from developments of the atomic bomb to projected trips to the moon. Actually, the antenna is simply part of the apparatus that has been built for static-free broadcasting of sound and facsimile.

FM and Facsimile Broadcasting

The sound will be FM radio; facsimile is somewhat more complicated to describe as a public service, because nothing quite like it has been seen by most people. Facsimile is currently described as printed radio, or radioed publishing — newspapers, magazines, illustrated bulletins and news sent complete with pictures right into homes as distant as radio itself is heard. Before the war, facsimile was broadcast on AM far across the ocean. As newer FM reaches only to the horizon, or what is known as line-of-sight transmission, the

[*see page* 58]

RADIO DESIGN WORKSHEET

NO. 43 — NOTES ON THE RECEPTION OF VERTICALLY POLARIZED ELECTROMAGNETIC WAVES; SOME NOTES ON CIRCUIT SHIELDING

NOTES ON THE RECEPTION OF VERTICALLY POLARIZED ELECTROMAGNETIC WAVES

Fig. 1 illustrates the mutual directions of wave propagation, the electric field thereof, and the magnetic field of a vertically polarized wave. In order to avoid confusion, it should be recognized that the electric field and the magnetic field are in reality aspects of the same thing. We can therefore consider the action of

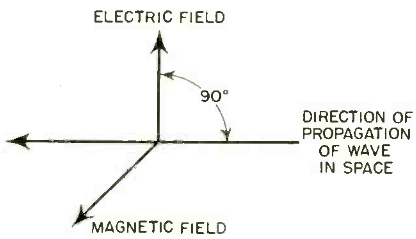


Figure 1

either field on a receiving antenna, but not both acting simultaneously. We can consider either the electric field charging the antenna or the lines of force of the magnetic field cutting across the antenna conductor. In *Fig. 1* let us consider the electromagnetic wave to be traveling over a flat and perfectly conducting surface. This presupposes no loss in the surface over which the wave is traveling. Sea water approaches this sort of surface except of course that it is not flat. The direction of travel of the wave, the electric field, and the magnetic field are mutually at right angles.

If the wave of *Fig. 1* impinges on a vertical antenna which is parallel to the direction of the electric field, a maximum voltage will be induced in it. If it impinges on a horizontal antenna which is perpendicular to the electric field, no voltage is induced in the antenna. If it impinges on an antenna that is partly vertical and partly horizontal, then voltage will be induced in the vertical projection only.

The ideal case just cited of course seldom exists in practice. The wave may

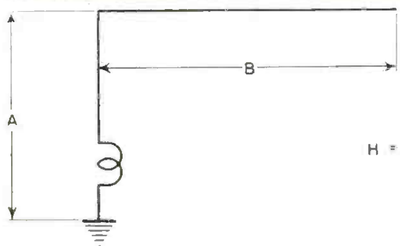


Figure 2

be vertically polarized when it is radiated from the transmitting antenna but there is loss in the surface of the earth and steel buildings, power lines, telephone lines, and other conducting surfaces that may appreciably alter the direction of propagation. This together with re-radiation from conducting surfaces causes actual antennas to respond somewhat differently than the ideal case. The same results would have been ob-

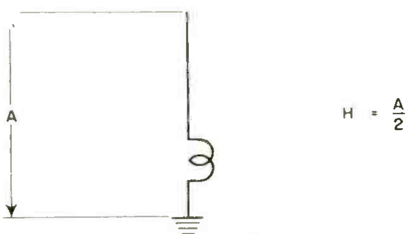


Figure 3

tained if we had considered the magnetic field instead of the electric field.

When the vertically polarized wave travels over poorly conducting earth, frequently, appreciable power dissipation in the earth will result that will cause the wave to take a forward tilt. It is this forward tilt that causes the Beverage wave antenna to function. This wave antenna is a long, low, horizontal wire (usually one or two wavelengths long), strung like a telephone line and its pick-up per unit length is proportional to the angle of tilt of the electric field from the vertical. Due to the lower velocity of propagation of the antenna compared to its velocity of propagation in space, the voltage built up in the horizontal member may be considerable. As a matter of fact optimum conditions in the wave antenna are usually considered to be a velocity of .7 to .8, that of free space for an antenna one wavelength long. The wave antenna is terminated at each end in its characteristic impedance. This type of antenna has been most successful where ground conditions are poor, such as the sandy soil of Long Island.

The voltage induced in the receiving antenna is proportional to the effective height of the antenna and to the field strength in its immediate antenna. Assuming ideal conditions the field would be uniform and the higher the antenna reaches into it the more voltage induced. Frequently in actual conditions the field strength is not uniform from the ground up and more voltage is induced in some parts of the antenna than in others. A common means of defining the effective height of an antenna is that it is the voltage induced in the antenna by a uniform field of one microvolt per meter.

Fig. 2 illustrates a vertical antenna and the formula generally used to determine its effective height. The length *A* is in meters. If a perfectly flat top is added to the vertical antenna of *Fig. 2*, as shown in *Fig. 3*, then the effective

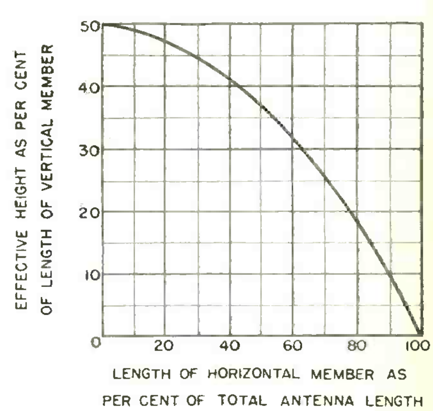


Figure 4

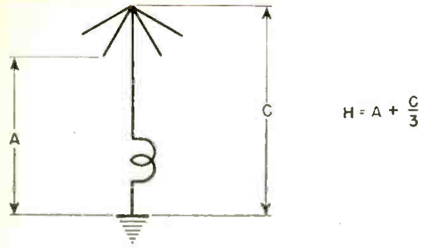


Figure 5

height is unchanged. However, the capacitance of the flat top lowers the impedance of the antenna and for that reason sometimes makes it more desirable. *Fig. 4* shows the effective height for the relative percentage of length of vertical and horizontal wire. Another type of top loading may also be used. This is illustrated in *Fig. 5* and is called the umbrella antenna. Here the loading structure not only reduces the antenna impedance but also contributes to the effective height.

SOME NOTES ON CIRCUIT SHIELDING

Perhaps a perfect magnetic shield may never be realized but adequate magnetic and electrostatic shielding to meet a specific circuit condition can be and is realized. Low frequency magnetic shielding usually depends on inserting a path of low magnetic reluctance between the element to be shielded and the source of magnetic flux. This path may be either a piece of high permeability or a thick shield of low permeability magnetic material or both. A similar result may be accomplished by inserting a high conductivity conductor between source and object to be shielded. Eddy currents set up in the shield oppose the interfering magnetic field, reducing the resultant effect on the shielded element. It is now pretty generally realized that the fundamental problem of shielding becomes easier as the frequency increases.

In the early days of radio the belief was generally held that metal in any form was objectionable in or near radio frequency circuit elements. As a result, chassis, etc.. were of insulating material rather than metal, some of which resulted in far greater losses than would have resulted had the base metals been used instead. To reduce coupling between air core r-f coils, these axes were disposed to be mutually at right angles. This, of course. limited the designer to three coils in any one circuit. Then came the arrangement of r-f coils at the so-called sacred angle. The sacred angle was a function of coil geometry and averaged about 37° with the horizontal for the standard three inch coil then in use. *See Fig. 6.*

As indicated above a metal sheet of high electrical conductivity placed in a magnetic field will have induced in it, voltages which will in turn set up circulating currents. These circulating currents will then set up a magnetic field that will be in phase opposition to the originating magnetic field. Such a shunt operates in a manner similar to a short-circuited turn. Nearly all designers are familiar with the great reduction in inductance of any coil due to a short-circuited turn. Shorted turns

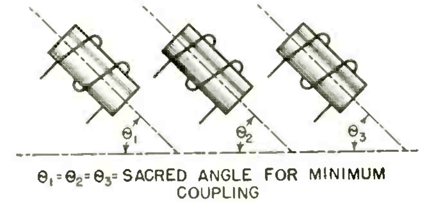


Figure 6

have been used for shielding too. The current induced in the shield or shorted turns will never be quite sufficient to completely neutralize the magnetic field which induced it. However, it may be sufficient to substantially reduce it. If the impedance of the ring is zero, then the induced current would be of such value that the original magnetic field would be completely neutralized. As the impedance of the ring is reduced then the effecting resultant field is reduced more and more until as a limit it can be reduced to a value smaller than any assignable quantity. *Fig. 8* shows the type of shield commonly used in r-f circuits.

The action described in connection with the shorted turn takes place in coil shields. Consequently for low frequencies the shield must be very thick since this current will be more or less

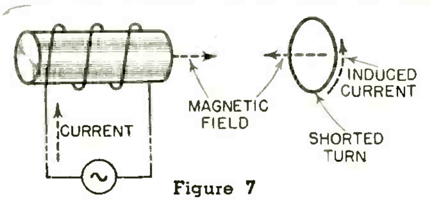


Figure 7

evenly distributed throughout the interior of the shield. At higher frequencies the current tends to crowd to the outside surface of the shield. Therefore since the inside of the shield carries no current, it serves no useful purpose and may be eliminated, thus thinning the shield. The higher the frequency, the thinner the shield may be. Actually all that need be done in most cases at radio frequencies is to distort the magnetic field so that its value w...

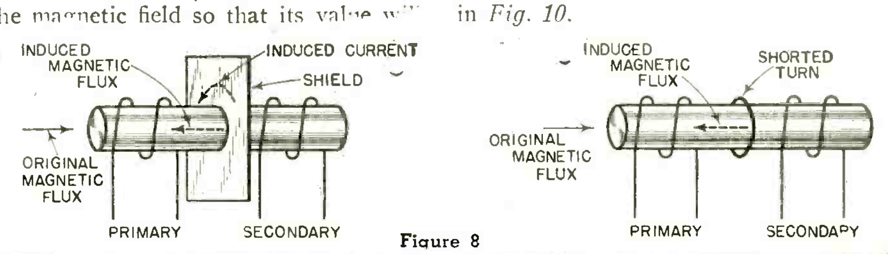


Figure 8

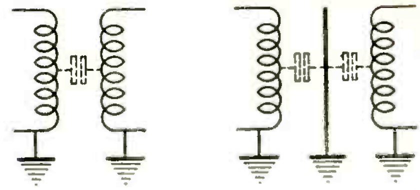


Figure 9

be sufficiently low at the point to be shielded. This may sometimes be accomplished by a single partition or at worst by a double partition. High frequency shields may be steel plated with some highly conductive metal such as copper, silver, etc. Corrosion will in some instances decrease the effectiveness of the shield if it has higher resistance than the shield, because the currents induced in it will tend to crowd to the corroded or oxidized outer portions of the shield. Silver oxide has about the same conductivity as metallic silver and is therefore as good a shield. To prevent this situation, shields may be sprayed with water dip lacquer to prevent the oxidation of the surface.

Electrostatic shields are inserted between a source of voltage and another member to reduce the natural capacity existing between these elements. When

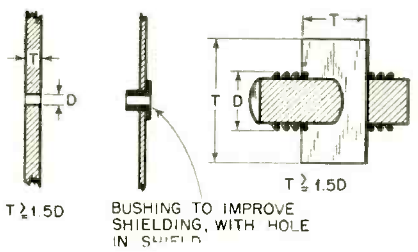


Figure 10

a metallic shield is placed between two coils, the intercoil capacity is broken and shunted to ground so that energy cannot be transferred from one coil to another by electrostatic means. This is illustrated in *Fig. 9*. When the shield has approximately the same dimensions as the elements to be shielded, end results may reduce the effectiveness of the electrostatic shield. These are carried by spurious capacitances around the edges of the shield. For this reason it is common practice to proportion electrostatic shields so they are much larger than the elements they are intended to shield. This usually amounts to about 1.5 turns the dimension of the shielded elements. This is illustrated in *Fig. 10*.

This Month

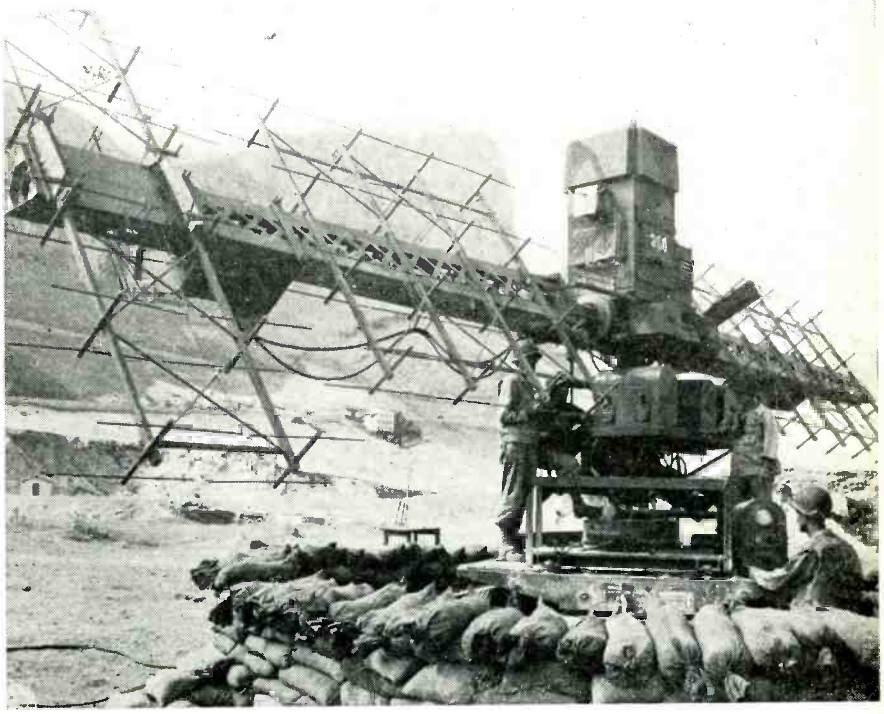
EXPERIMENTAL STATION POLICY

In acting upon a number of applications for experimental television stations on some of the channels now allocated for commercial television stations and for FM developmental stations in the old FM band between 42-50 megacycles and in the new FM band between 88-108 megacycles, the Commission recently reemphasized its rule that such applicants must make a satisfactory showing of a meritorious program of research and experimentation.

The Commission stated that it was fully aware of the fact that there exists a need for developmental work regarding the higher frequency channels for commercial television broadcast stations, and that there exists a need for FM developmental work on the frequencies between 88-108 megacycles to which this broadcast service is assigned, but that it would not grant applications in either of these fields unless the applicant presented a genuine program of research, and clearly showed that an experimental station was necessary for carrying forward the research.

The Commission announced that it will examine carefully the representations made by each such applicant as to whether it in fact proposes an experimental and developmental station, or whether its proposal is more properly the subject of an application for a commercial television or FM station.

In denying applications which included requests for experimentation for the purpose of conducting site surveys or field intensity measurements, the Commission pointed out that such work required radiations for only short periods which did not justify a long term station license, and that a 30-day or less authorization to operate a station which can be applied for under Section 1.365 of the Commission's Rules should be adequate for such purposes.



SCR-268 RADAR

Here against the rugged background of Southern Italy, a radar silently probes the sky for errant units of the Luftwaffe. Known to the War Department as an "early warning" radar, this equipment helped us to blunt the violence of the enemy's air attack at the very peak of its power early in the war.

(U. S. Signal Corps Photograph)

BRITISH FIRM DEVELOPS NEW TELEVISION SYSTEM

A new system of television transmission which makes use of the principle of radar "pulses" was announced recently by a British firm (Pye, Ltd.).

The new system embodies the transmission of sound by pulses similar to the small bursts of radio waves or "pulses", lasting but a few millionths of a second, which are used in radar. It enables a home vision receiver to receive both vision and sound, and makes it possible for a televised program to be effected by a single transmitting unit.

The use of the new system would considerably reduce the cost of television, both for the broadcasting station and for the home public, since stations incorporating the new dual-purpose transmitter will be less costly to erect, while the new combined sound-vision receiver will be far less costly to manufacture. Again, the transmitting station would be able to effect a major reduction in equipment, as well as to cut down running costs. For the home user, the elimination of the sound receiver would mean a valuable saving on tubes and other components.

When the television transmitter is in operation, there are short intervals of time during which no signal is being broadcast. These intervals occur during the time that the spot which traces the picture is returning to its starting point preparatory to making another line, and each represents rather one-tenth of the total transmission time. Each of these idle periods lasts for ten-millionths of a second, and there are just over ten thousand of them during each second. It would now be possible to use the television transmitter during these idle periods to transmit the sound program. This would be done by taking a "sound snapshot" of the sound part of the program whenever the transmitter is not transmitting the vision part of the program. Using television of the present definition, 10,125 of these "sound snapshots" are transmitted per second. This pulse would be separated from the vision program in the television receiver and the variation of its width would be made to operate a loudspeaker.

The new system embodies many other improvements:

(1) It would eliminate the possibility of interference in the television receiver between sound and vision.

(2) An efficient television receiving aerial would be far simpler to make.

(3) Less frequency space would be needed for each television transmitter, because it would no longer be necessary to provide separate frequencies for vision and sound transmitters.

(4) Picture would be held steady, even during severe fading of signals. This is because the system can incorporate automatic gain control.

(5) It would give a clear reception for television sound programs to localities distant from the transmitting station, because there will be less noise and interference.

Jack Beebe

★ Simultaneously with the announcements which have recently appeared in regard to "S-N-C" transformers comes the news that Jack Beebe will have charge of the manufacturing and distributing of this widely diversified line.

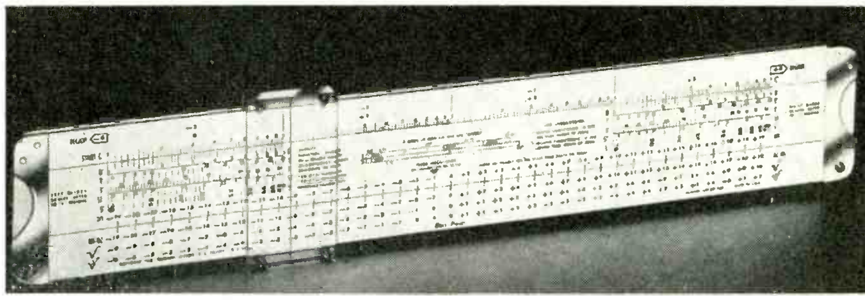
Mr. Beebe is well known for both his technical and sales knowledge of transformers as he was for many years connected with both the manufacturing and sales divisions of Thordarson Electric Manufacturing Company, until quite recently holding the post of General Sales Manager of this organization.

Since resigning from Thordarson, Mr. Beebe has joined the transformer division of the Swain Nelson Company of Glenview, Illinois, an eighty-nine year old organization actively engaged in manufacturing for a number of fields concerned primarily

[see page 54]

New Products

DECI. POINT SLIDE RULE



Several important new features are now being incorporated into the Deci. Point Slide Rule which is stated to be the first one to place the decimal point at the end of long and intricate computations. It will, in fact, determine the precise location of the decimal point in involved expressions with results up to 19 places.

Now, this rule is being manufactured of light-weight Dowmetal which makes possible a number of advantages. Dowmetal permits superior accuracy as it is not affected by climatic conditions of heat, cold or moisture. There is no perceptible warping, swelling or other distortion. Dowmetal, moreover, can be machined to extremely close tolerances. This permits the use of self-centering "optical groove" — a type of tongue and groove construction favored in optical instruments because it prevents side play and binding.

Mathematical, rather than mechanical advances, are what really make Deci. Point such an outstanding improvement over ordinary slide rules. These advantages, moreover, are not reserved for advanced or professional users only. Deci. Point's highly simplified arrangement of scales so greatly facilitates computation that even persons of limited mathematical knowledge can evaluate and point off problems containing cube root, square root, logarithmic and trigonometric factors. In these and all other slide rule operations, the Deci. Point user enjoys five advantages over users of ordinary rules:

1. Places the decimal point mechanically up to 19 digits or zeros.
2. Same setting of hairline for result also gives readings for cube and square roots, and logarithm of result.
3. Gives 30-inch scale accuracy for cube root.
4. Gives 20-inch scale accuracy for square root.
5. Simplified slide rule calculations so that relatively complicated expressions can be evaluated and pointed off by users with a limited mathematical background.

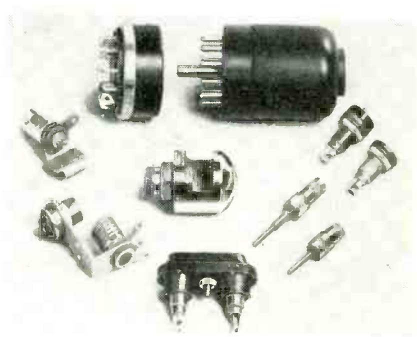
With each Deci. Point Slide Rule, the manufacturer provides a manual which covers all phases of slide rule operation as well as Decimal Point Location.

The Deci. Point Slide Rule is 12⅛ inches long and 2 inches wide. Manufactured by Pickett & Eckel, 53 W. Jackson Blvd., Chicago 4, Illinois.

NEW JOHNSON PRODUCTS

The E. F. Johnson Company, Waseca, Minnesota, announces that it has acquired all the tools, inventory and manufacturing rights for the cable connectors, pilot and dial light assemblies, tip plugs and tip jacks, which were formerly Mallory-Yaxley products. These items have been added to the Johnson line of variable condensers, tube sockets, insulators, inductors, plugs and jacks and in the future will be manufactured and sold solely by Johnson.

The seven and twelve wire cable connectors are polarized and contacts are clearly marked for convenience. These connectors are available with several types of mountings for both the receptacle and pin



plugs, providing the most efficient means of making and separating multiple connections quickly and easily for radio, electronic and other electrical equipment.

Pilot lights can be supplied with a variety of jewel colors and jewels may be purchased separately for replacement.

Dial lights are supplied as shell assemblies and with slip-on brackets to facilitate speed and ease in installation and bulb replacement.

Fitting well into the Johnson line of plugs and jacks are the former Mallory tip plugs, tip jacks and twin tip jacks. Tip plugs are of the solderless type and supplied in a long and short length. Tip jacks are available with either metal or bakelite type heads and both are available with round and hexagon heads.

The twin tip jacks are molded bakelite in two types, shorting and non-shorting.

NEW G-R INSTRUMENTS

Two new instruments for monitoring and testing broadcast transmitters are announced by the General Radio Company, the Type 1931-A Amplitude-Modulation Monitor and Type 1932-A Distortion and Noise Meter.

Type 1931-A Monitor

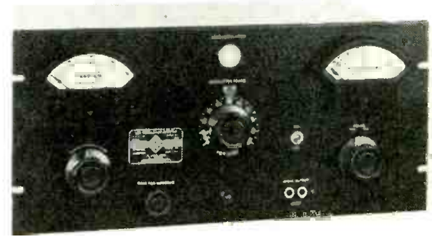
The Type 1931-A Amplitude-Modulation Monitor measures percentage modulation on either positive or negative peaks and gives a continuous indication of modulation peaks in excess of a predetermined percentage set by means of a dial. It can also be used for program-level monitoring and for measured transmitter audio-frequency response. Two audio output

circuits are provided, one at 600 ohms for audible program monitoring, and the other a high-impedance circuit that gives a faithful reproduction of the audio envelope for distortion and noise measurements. The linear rectifier is designed for use at a low power level, so that the problem of coupling to the transmitter is greatly simplified. The required r-f power input is only 0.5 watt, far less than that necessary to operate pre-war modulation monitors.

Range: 0 to 110% on positive peaks
0 to 100% on negative peaks
Carrier Frequency Range: 0.5 to 60 mc
Dimensions: Panel, 19 × 8¾ inches
Depth behind panel, 10 inches
Net Weight: 31 pounds

Type 1932-A Meter

The Type 1932-A Distortion and Noise Meter is a direct-reading instrument for measuring distortion, noise, and hum in audio-frequency systems. When used for



measurements on broadcast transmitters, the distortion meter operates from the high-impedance output circuit of the Type 1931-A modulation monitor. A continuous frequency range of 50 to 15,000 cycles, fundamental, is covered by a single dial and push-button multiplier. Distortion and noise components up to 45,000 cycles are included in the measurement. The direct-reading distortion meter provides full-

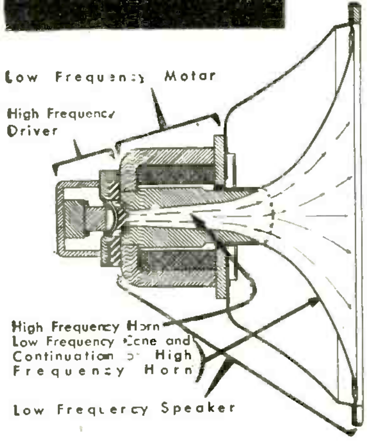
TYPE H

WITH *Compression-type* HIGH-FREQUENCY SPEAKER

The first of a new series of JENSEN Coaxial Speakers, combining in one coaxial assembly a horn-type high-frequency speaker with a cone-type low-frequency unit. By unique design, the cone of the low-frequency unit forms a part of the high-frequency horn, thereby dispensing with a separate horn. An integral two-channel network gives the desired crossover characteristics. Thus this new Coaxial Speaker provides the quality of reproduction so essential and desirable for radio receivers and phonographs for home entertainment, particularly for FM reception and high quality phonograph recordings.

The distribution characteristics of the Type H Coaxial are excellent and, when installed in a suitable enclosure such as a Bass Reflex cabinet, its performance covers the entire frequency range useful in home reproduction.*

Type H Coaxial, illustrated here with field coil low-frequency speaker and ALNICO 5 high-frequency unit, is designed for manufacturers. Other models for more general use, incorporating ALNICO 5 design in both high-frequency and low-frequency units, will shortly be announced.



TYPE H SPECIFICATIONS

Power rating 25 watts maximum, in speech and music systems. Input impedance 16 ohms. Field 14-20 watts. List price approximately $100.00.

*See No. 3 JENSEN Monograph: "Frequency Range in Music Reproduction," for discussion of useful frequency ranges.

Other Coaxials Now Available!

These Type J Coaxials, improved over prewar design, offer low-cost Coaxial performance in home radio receiver and phonograph entertainment.

JAP-60 (15-inch) with HF Control Switch. List price **$79.45**
JHP-52 (15-inch) with HF Control Switch. List price **$56.15**
JCP-40 (12-inch) HF Level Control extra. List price **$33.45**

Jensen
SPEAKERS WITH
ALNICO 5

JENSEN RADIO MANUFACTURING COMPANY • 6619 S. LARAMIE AVE. • CHICAGO 38, ILLINOIS
IN CANADA—COPPER WIRE PRODUCTS, LTD. • 137 OXFORD STREET, GUELPH, ONTARIO

Specialists in Design and Manufacture of Fine Acoustic Equipment scale ranges of 0.3%, 1%, 3%, 10%, and 30%.

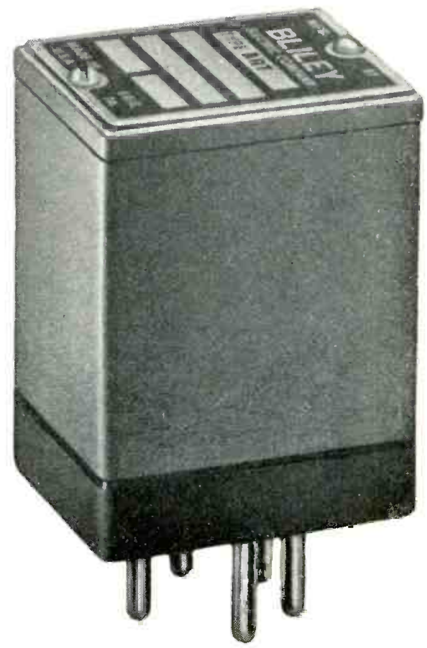
Both instruments are available in standard black-crackle finish. Other finishes can be supplied.

Distrtion Range: 0.3%, 1%, 3%, 10%, 30% full scale

Noise Range: To 80 db below 100% modulation or 80 db below zero VU

VHF CRYSTAL

A new crystal unit for VHF services has been announced by Bliley Electric Company, Erie, Pennsylvania. This new unit, type ART, is a ruggedly built, temperature controlled crystal assembly designed for such services as police and radio communications where frequency stability must be maintained for temperatures ranging from 55°C to plus 75°C.



A built-in heater operating on 6.3 volts at 1 ampere provides temperature control within ± 2°C. This permits an over-all frequency tolerance of ± .005% or better including variations due to temperature change as well as tolerances required for crystal production.

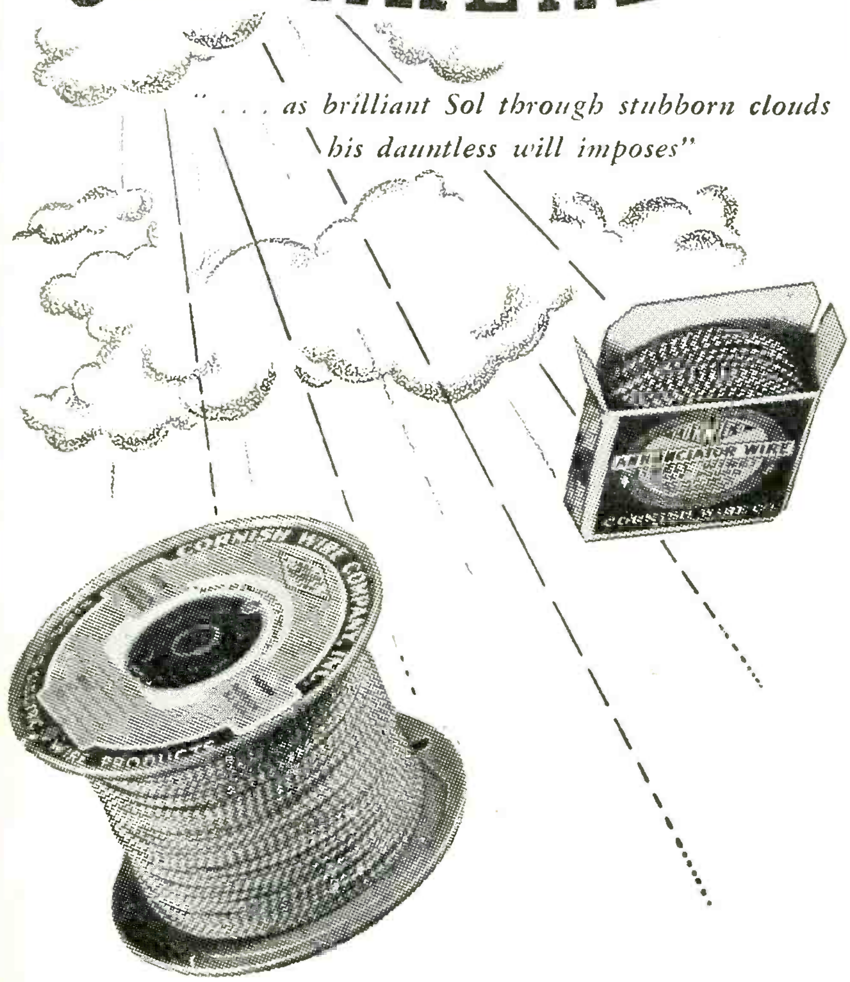
Type ART Bliley crystal unit is available for any frequency between 3500 kc and 11,000 kc. The suggested oscillator design illustrates efficient frequency multiplication.

REMOTE ANTENNA AMMETER

Operating on a new principle without the usual thermocouples, a new electronic remote antenna ammeter has been de-

JOB AHEAD

". . . as brilliant Sol through stubborn clouds his dauntless will imposes"



RECONVERSION to national peacetime economy is on the march . . . perhaps not as swift as you and we would like it. Vast displacements, inevitable as we "shift our gears", must be absorbed and neutralized . . . in short, there's a JOB ahead.

Each day supplies of famous CORWICO Wire, so important in the war and so important now, will be made available for civilian use.

Patience! We've moved mountains before . . . .

CORWICO

cornish WIRE COMPANY, INC.

15 Park Row, New York City, New York

"Made by Engineers for Engineers"

We recommend these *Gammatrons* for the new amateur bands

In answer to many requests for our recommendations as to the Gammatrons which will give peak performance on the bands released to amateurs on November 15, we have been commenting as follows:

HK-24 and HK-24G "These triodes fill the bill for operation up to and including the 205 megacycle band. Your mechanical arrangement will largely determine your choice. We give the nod to the 24-G for top performance at 205."

HK-54 "Excellent up to 148 megacycles. Just the thing for the chap who wants 300 to 350 watts output from a pair on 28 megs—plate modulated."

HK-254 "If you want to put out a half kilowatt on 54 megacycles, use this big brother of the HK-54 in pushpull. Ratings decrease above this frequency to approximately 280 watts input to one tube at 200 mc."

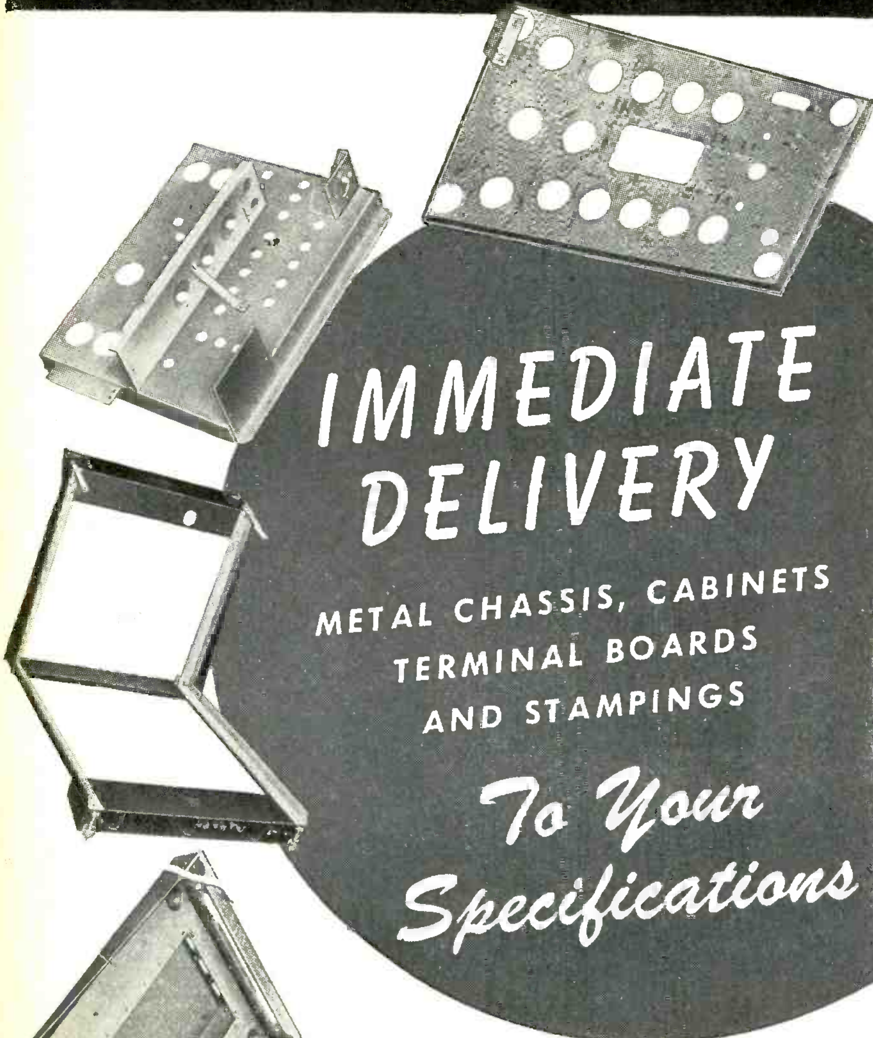
HK-257B "Don't overlook this beam pentode for your bandswitching job. It requires practically no driving power. A couple of receiving tubes, such as 6V6's, will take you in a hurry from a 3.5 mc. crystal to 28 megs where pushpull 257-Bs will give you up to 400 watts out."

HK-454 "This is the tube for the man who wants a full kilowatt output on 28 megacycles. It's also excellent on 54 megs."

Additional data on Gammatron tubes appears in "The Radio Amateur's Handbook" and in "The Radio Handbook." Data sheets on individual types will be sent on request, and our engineering department will gladly provide special information or advice on your particular applications. You can now obtain Gammatrons at stores handling amateur components.

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA
Export Agents: M. Simon & Son
25 Warren Street, New York City, U. S. A.

FIRST AWARD . . . . JUNE 23, 1944 — FIRST RENEWAL WITH STAR . . . DEC. 16, 1944 — SECOND RENEWAL WITH STAR . . . MAY 26, 1945



A complete, expertly-manned tool and die shop enables Insuline to give almost immediate delivery on anything a manufacturer might require... from a lug to a gigantic transmitting cabinet...in quantities and to specifications.

The rest of the Insuline plant is equally well equipped to serve the nation's manufacturers. Batteries of high-production machinery are available to turn out such items as chassis, metal boxes, cabinets, terminal boards, and special stampings of all kinds.

Moreover Insuline can produce the item you require from beginning to end, all within the walls of the Insuline plant.

If you have a production problem, an Insuline Engineer will be glad to discuss it with you. If you prefer, send your specifications and we will send an accurate estimate by return mail.

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INSULINE BUILDING • LONG ISLAND CITY, N. Y.
QUALITY PRODUCTS SINCE 1921

veloped by the Andrew Company, Chicago 19. The remotely-located d-c microammeter is actuated by a current transformer feeding a diode-rectifier tube located at the antenna.

Since the regular thermocouple antenna ammeters can be disconnected most of the time, the station using this new Andrew unit is spared the frequent cost of meter replacement. Likewise, station shutdowns due to thermocouple failure in lightning storms are eliminated.

For additional details, write the manufacturer for Bulletin 28A.

FEDERAL ANNOUNCES NEW FM BROADCAST EQUIPMENT

A comprehensive line of FM Broadcast Transmitters and Antennas, with outputs ranging from 250 watts to 50 kilowatts, incorporating new techniques, circuits and tubes, has been announced by Federal Telephone and Radio Corporation, Newark, N. J., manufacturing associate of International Telephone and Telegraph Corporation.

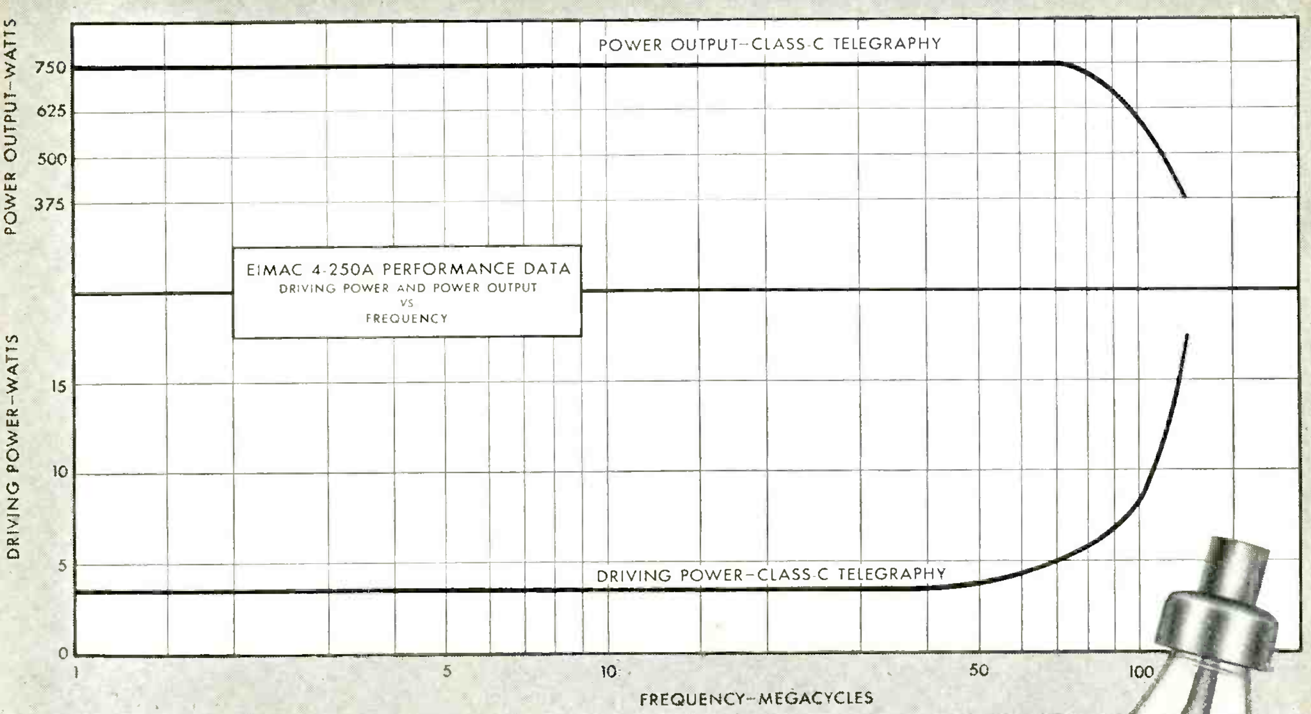
The new transmitters are of the highly practical multi-unit design, permitting the broadcasting station to increase its output when desirable, by adding the power amplifier units necessary to provide it.

The basic unit of Federal's new FM Broadcast Transmitters is the exciter which generates the initial radio frequency power, in itself, a complete 250 watt transmitter. In this unit are included the frequency modulation system, center frequency stabilization system, and the radio frequency multiplier and output stages. The 250-watt output of the exciter unit is stepped up to 1, 3, 10, or 50 kilowatts by a Power Amplifier Unit or series of such units.

Federal's new FM Broadcast Antenna arrays are fed by standard coaxial lines, combining high power gains with noncritical tuning, and consist of from 1 to 12 or more loops, each embodying two or more half-wave elements. The arrays are factory-tuned for easy installation.

A high degree of center frequency stability, all-important in FM broadcasting, is obtained in the Federal FM Transmitters by a phase discriminator in the basic unit which locks the center frequency accurately to the crystal oscillator frequency, making the frequency stability of the transmitter equal to the stability of the crystal employed. High fidelity audio frequency re-

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT



NEW EIMAC 4-250A TETRODE

Heading a parade of sensational new tubes now in production, the Eimac 4-250A Tetrode—introduced several months ago—is already in great demand. It may pay to check these performance characteristics against your own requirements.

As can be seen by the chart above, the new Eimac 4-250A Tetrode will deliver 750 watts output at frequencies up to 70 Mc. with a driving power of only 5 watts. At frequencies up to 40 Mc. an output of 750 watts may be obtained with a driving power of 3.5 watts.

The grid-plate capacitance of 0.12 μμfd. is extremely low, allowing operation at high frequencies without neutralization. Use of Eimac "X" process control grid reduces both primary and secondary emission which provides utmost stability.

You are invited to supplement the information given here with a technical bulletin on Eimac 4-250A Power Tetrode. It contains an elaboration of the tube's characteristics and constant current curves. Send your name and address and a copy will go to you by return mail.

The Lid's Coming Off... *Watch your favorite trade journals for announcements of other new Eimac tubes to be released this year.*

CAUTION! Check serial numbers on Eimac tubes before you buy. Be sure you're getting newest types. Look for latest serial numbers.

FOLLOW THE LEADERS TO

Eimac TUBES

EITEL-McCULLOUGH, INC., 1086 San Mateo Avenue, San Bruno, Calif.
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U. S. A.

TYPE 4-250A—POWER TETRODE

ELECTRICAL CHARACTERISTICS

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Plate Dissipation (Maximum)	250 watts
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.12 μμfd.
Input	12.7 μμfd.
Output	4.5 μμfd.
Transconductance (i_B = 80 ma., E_B = 3000 v., E_{C2} = 500 v.)	4000 μmhos

J086

MEANS MAXIMUM PERFORMANCE AT AN ECONOMICAL PRICE . . .

THERE is more to STANCOR design than theory and paper engineering. Behind-the-scenes operations reveal unremitting *fact-finding*—nothing is taken for granted. For the STANCOR engineer is as persistent as he is practical, demanding—and receiving—high standards of performance.

Engineering design implies more than mere conversion of the customer's electrical requirements to manufacturing specifications. At STANCOR it includes the employment, to the greatest advantage, of selected materials to achieve optimum performance—all with the constant practical thought—more *useful* watts per dollar.

Competent laboratory and sales engineering facilities are available NOW to meet your most exacting transformer specifications.

IN TRANSFORMERS STANCOR Gives More

STANCOR

STANDARD TRANSFORMER CORPORATION
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sponse, low harmonic distortion and low hum level are obtained by the application of negative feedback from the last power stage of the exciter to the audio amplifier.

FREQUENCY CONTROLLED SWITCH

The Stevens-Arnold Switches are frequency controlled tuned relays and therefore particularly well suited for remote control applications with either wire or radio as the carrier medium.

In the radio application, the switches are sufficiently sensitive so that when made on special order they can be controlled from either a crystal detector or vacuum tube type receiver. Response time is only a small fraction of a second.

Each switch is adjusted at the factory to accept a selected band of frequencies in the range of 20 to 800 cycles per second and to reject all others. In other words,

one switch might be controlled by the band from 50 to 60 cycles, another by the band from 65 to 75 cycles, another by the band from 80 to 95 cycles, and so on up.

Frequency selection and rejection is obtained by using the well-known vibrating reed principle with hermetic sealing and other design features which make the switches maintenance free.

Ratings of one to ten amperes, 115 volts a.c are available. The size shown in the illustration is the two ampere, 115 volt rating, and measures 3″ × 4″ × 5″.

For further information, write the Stevens-Arnold Co., 22 Elkins St., So. Boston, Mass.

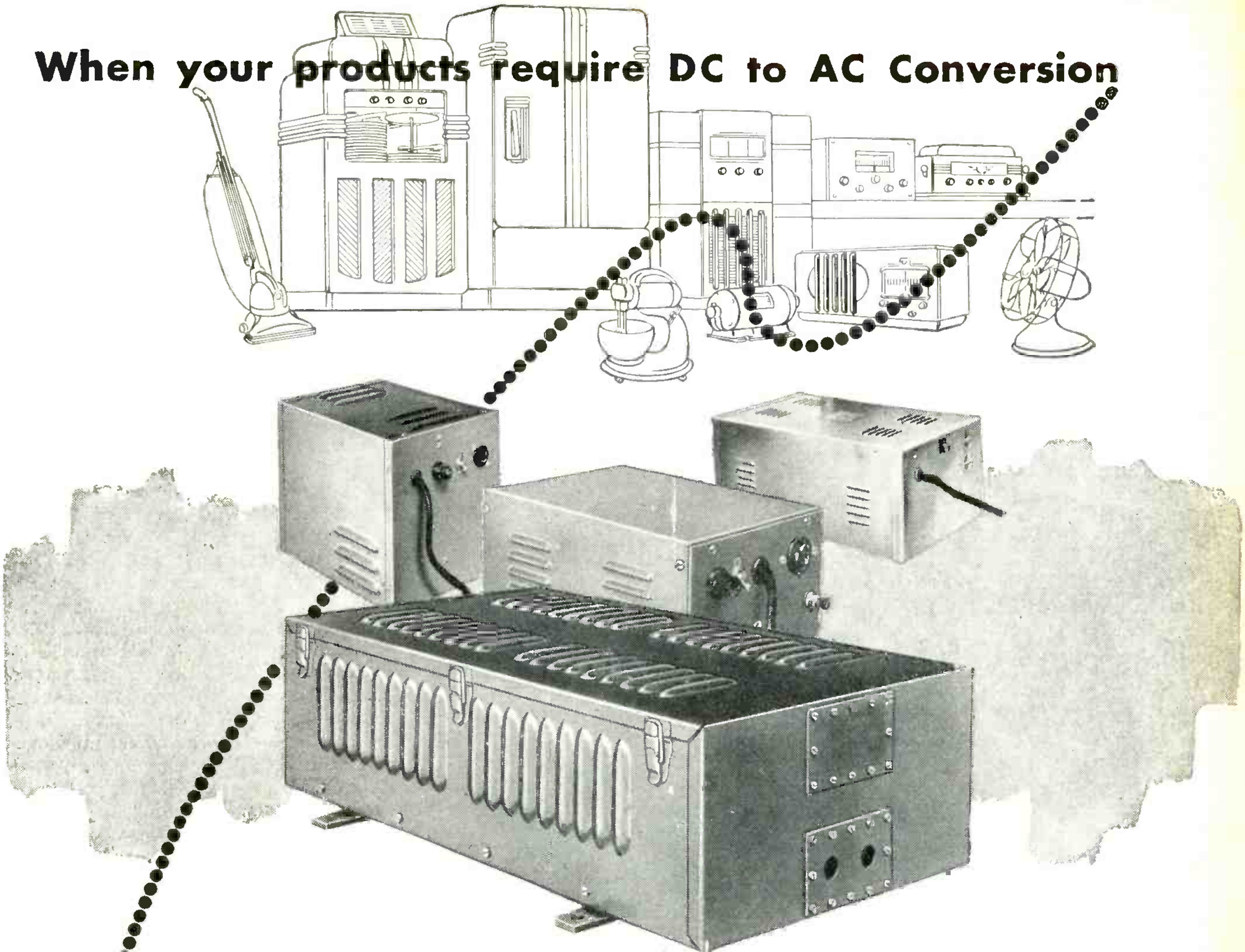
NEW DIAL LAMP

The Westinghouse Lamp Division, Bloomfield, N. J., has developed a fluorescent lamp producing ultraviolet rays which make the dial markings of home radio or television receivers appear in uniformly-glowing colors.

Although the "black light" lamp was designed chiefly to improve dial lighting and for radio set beautification, it is expected to find wide practical favor in television where it will cause receiver control knobs and dials to fluoresce with easy visibility and minimum interference with the television image.

The tubular lamp itself is a simplified, miniature version of the fluorescent tube used to light homes, offices, industries and public places. But in place of the phosphors selected for the production of visible fluorescent light, special black light phosphors coat the inner surface of the radio panel lamp. It will be used with a special

When your products require DC to AC Conversion



...THERE IS AN E-L VIBRATOR INVERTER for *each* important *application*

★ *Greater efficiency* ★ *Increased capacity* ★ *Longer service* ★ *Lower cost...* In your manufacture of communications equipment, appliances, electric motors and all similar products, E-L is equipped to serve your *exact* requirements with *efficient* DC to AC conversion units.

SERVICE AND ECONOMY

For coin-operated equipment, public address systems, neon signs, and electric razor operation there is a standard E-L inverter with longer service and lower cost. These results come from the simplicity of the E-L Vibrator Inverter, with *only one* moving part, plus precision construction in every detail.

No routine maintenance is required, since there are no brushes, armatures or bearings to lubricate or care for.

The design of each E-L Vibrator Inverter is preceded by a study of product and application. Each E-L model fits an exact need and becomes a part of your pattern of quality manufacture.

FOR EACH DC-AC APPLICATION

In case of products with new or unusual requirements, E-L engineers are equipped and ready to design special power supplies. In every way E-L is set up to satisfy modern manufacturers and distributors of electrical and electronic products in *each important* DC-AC *application.*

MODELS ILLUSTRATED
(Typical of 26 E. L Models available to meet your requirements)

MOD. NO.	INPUT VOLTS DC	OUTPUT VOLTS AC	OUTPUT WATTS	LOAD P.F. (%)	DIMENSIONS (in.)	WT. (lbs.)	PRINCIPAL APPLICATIONS
302	6	115	75	80-100	9⅜x6⅜	15½	Radio Receivers, Appliances
507	12	115	150	80-100	10¾x7½x8¼	25	Radio Receivers, Transmitters, Appliances
146	32	115	350	80-100	16x10x8⅜	48	Receivers, Transmitters, Coin Phonographs
268	115	115	750	80-100	20⅛x11¾x7½	66	Motors, Communications, Equipment

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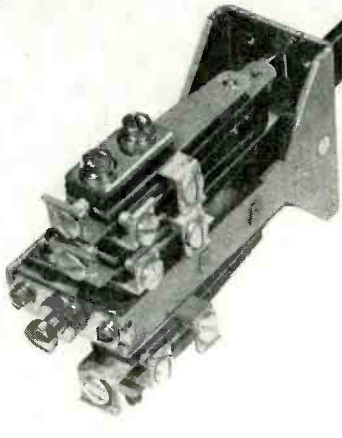
Electronic LABORATORIES, INC.
INDIANAPOLIS

DC-AC INVERTERS

VIBRATORS AND VIBRATOR POWER EQUIPMENT FOR LIGHTING, COMMUNICATIONS, ELECTRIC AND ELECTRONIC APPLICATIONS glass mask which blocks out stray visible light present even with black light phosphors but nevertheless permits the invisible black light to stream through.

HEAVY DUTY SWITCHES



Donald P. Mossman, Inc., 612 N. Michigan Ave., Chicago, Ill., has announced an optical special terminal arrangement for its Series 4100 and 4500 Heavy Duty Lever Switches, and its Series 6300 and 061T Heavy Duty Turn Switches.

The addition of the 41ET and 41ETM terminals does not change the operation of the switch in any manner, and the terminals correspond with the spring pile-ups. This new type terminal, however, is more effective for specific applications, because the switch may be installed and serviced more easily because of lugs, or loops at the end of the wire conductors. All soldering is eliminated.

The terminals are heavy, silver-plated brass with #6-32 binding head machine screws and a #6 plain washer. Up to #10 wire may be used.

The switch is particularly adapted to heavy loads or in installations which, of necessity, are not serviced for long periods of time.

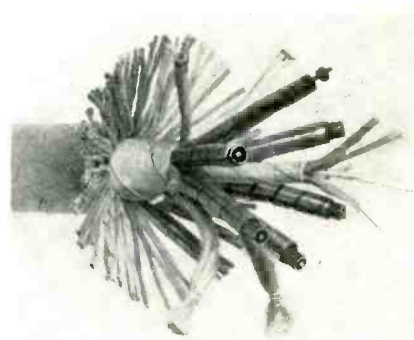
NEW C-R TUBE

A newly-developed cathode-ray tube is announced by the Allen B. Du Mont Labs., Inc., of Passaic, N. J., as the basis for low-priced television receivers now appearing on the market.

Called upon several months ago by television receiver manufacturers for a practical yet economical cathode-ray tube of adequate screen size, good definition and brilliance, Du Mont engineers came through with the new Type 7EP4. This 7" tube provides for a normal screen image of 5¾" by 4¼" high, which is adequate for entertaining a group of several lookers-in. If desired, the screen size can be increased to 6⅛" wide, with satisfactory results. The images are of high luminosity so that the room does not have to be darkened unless so desired for maximum concentration.

The 7EP4 tube fits into a cabinet of reasonable depth, being only 15½" long. The accelerating potential is only 2500 volts, therefore calling for a power supply that is relatively low in cost.

Already in quantity production in the Du Mont plant to meet the growing requirements of television receiver manufacturers, the new tube must be regarded as an outstanding contribution towards opening up a vast television market.



SECTION OF COAXIAL CABLE

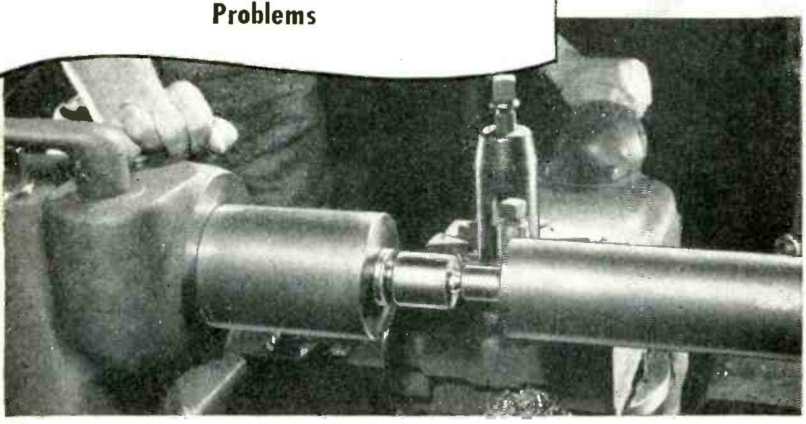
A view of one section of the coaxial cable which will be used to carry television programs by means of the long distance network between Washington and New York. These six copper tubes make it possible to transmit television images or hundreds of telephone conversations.
(American Tel. and Tel. Co. photo)

NEW STANCOR BROCHURE

Comprehensive is the word for the Standard Transformer Corporation's 88-page brochure, "Engineering a Transformer," planned to help the application engineer and the purchasing agent to co-

[see page 53]

Ingenious New
Technical Methods
To Help You with Your Reconversion Problems



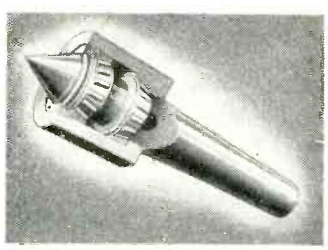
New Precision Built Roto Center Eliminates Chatter... Speeds Production!

Now You Can replace dead centers on lathe and grinder tailstocks, with this new Keene live Roto Center—to increase production—to eliminate all radial play and possibility of chatter! Low in cost, the Roto Center is a high capacity unit, featuring many innovations to speed and improve quality of work!

Matched roller bearings preloaded, are packed with high grade anti-friction grease at assembly. No attention is required for long periods. After assembly, runout is kept to absolute minimum—guaranteed less than .0002. Rear of center is tapped to receive standard hydraulic fitting. Chips, dust and cutting oil cannot reach bearings!

More and more peacetime "helps on the job" are returning to industry. One of these days, famous, flavorful Wrigley's Spearmint Gum will also be back to help you "on the job"—but only when we can assure Wrigley's Spearmint manufacture in *quantity* and *quality* for all. Today, we ask you to remember the famous Wrigley's Spearmint wrapper. Tomorrow, you may again enjoy Wrigley's Spearmint Gum quality and flavor while you are at work.

You can get complete information from Keene Electrical Machinery Co., 549 W. Washington Blvd. Chicago 6, Ill.



The Keene Roto Center

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Z-94

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You and your co-workers can now save up to half the regular cost of a RADIO subscription by using the Group Plan. The more men in a Group the more each saves, up to 50%.

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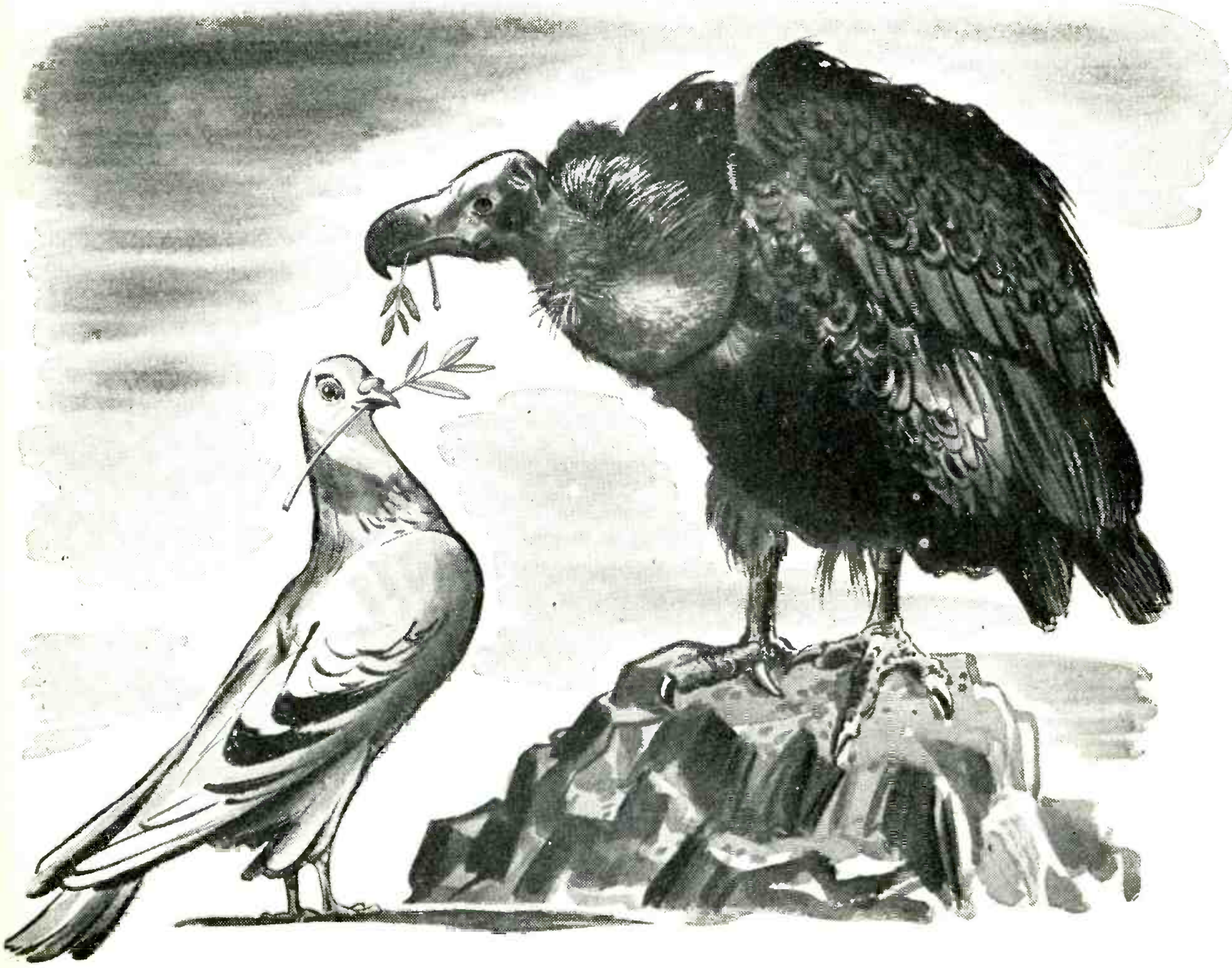


Which will be the bird of Peace?

IT has been several months now since the fighting stopped in Europe. But few men have seen the legendary dove that was to herald the end of the war.

Instead, too many of the people of France, of the Netherlands, of Belgium and Poland and Greece, have been more familiar with the vulture.

For how can peace be glorious to those still ravaged by disease and hunger, who lack fuel for their roofless homes, and blankets and medicines for their children?

We on this side of the ocean have a tremendous stake in whether peace returns to the cities and fields of Europe. If war is to be followed by despair and violence, by uprisings and anarchy, instead of by hope and rebuilding, we, and all other nations, must suffer.

That's why, when you support the Allied Relief Agencies through a part of your gift to the Community War Fund, you are doing more than expressing comradeship to our friends who suffered most from war's destruction.

You are helping the cause of peace in a way that may be more effective than all the treaties. For you are helping to restore faith in the decency of man. And without that faith neither our allies nor we can have much hope of a world of co-operation.

You buy a share in a better future for everybody when you give to your local Community War Fund, which, in turn, supports all the 21 agencies of the National War Fund.

Give all you can, won't you?

Give generously to

YOUR COMMUNITY WAR FUND

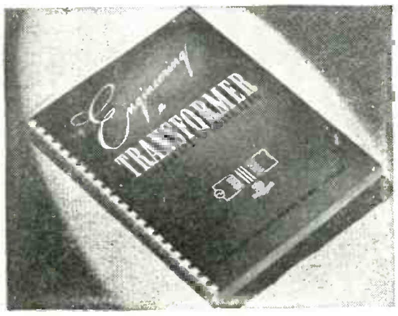
Representing the NATIONAL WAR FUND

NEW PRODUCTS

[from page 50]

ordinate transformer and reactor requirements.

Subjects covered include lamination size, grade, gauge and magnetic performance;



wire size, type and gauge; winding design; transformer-reactor physical and electrical aspects; electrical-mechanical considerations of core laminations; impregnation, assembling and casing; potting and sealing.

Those wishing to delve deeper into the theoretical and engineering principles of transformer construction and design will find a highly-informative 40-page technical section. Beginning with a historical discussion, subdivisions include definitions and nomenclature; transformer and reactor cores; core design; coils for small transformers and reactors; winding and lamination data charts; conductor and insulation selection; winding, lamination and coil data; power transformer design procedure and procedure chart; audio transformer frequency response test methods; reactor design; electrical and production testing.

Engineers and technicians will appreciate the clear-cut information of this section, invaluable in the approximation of transformer or reactor final design.

FREQUENCY RECORD

The Universal Microphone Co., Inglewood, Cal., is now distributing its D61 constant velocity frequency record for use in checking frequency response of phonograph pickups and recording components. Of new unbreakable material, it is said to be ideal for determining response of complete recording and reproducing systems.

The record is a twelve-inch lateral-recorded, high grade pressing for use on a 78 r.p.m. turntable. The D61 record is now available through radio parts distributors and Universal factory reps.

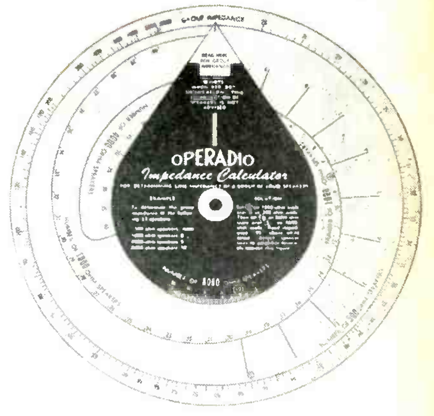
Technically: the frequency record covers the following ranges at constant velocity: 50 to 100 cps at plus 7 db; 200 to 500 cps at plus 14 db; 500 to 10,000 cps at plus 21 db; 1000 cps 2 db steps from plus 8 to plus 18 db; and 400 cps at plus 18 db.

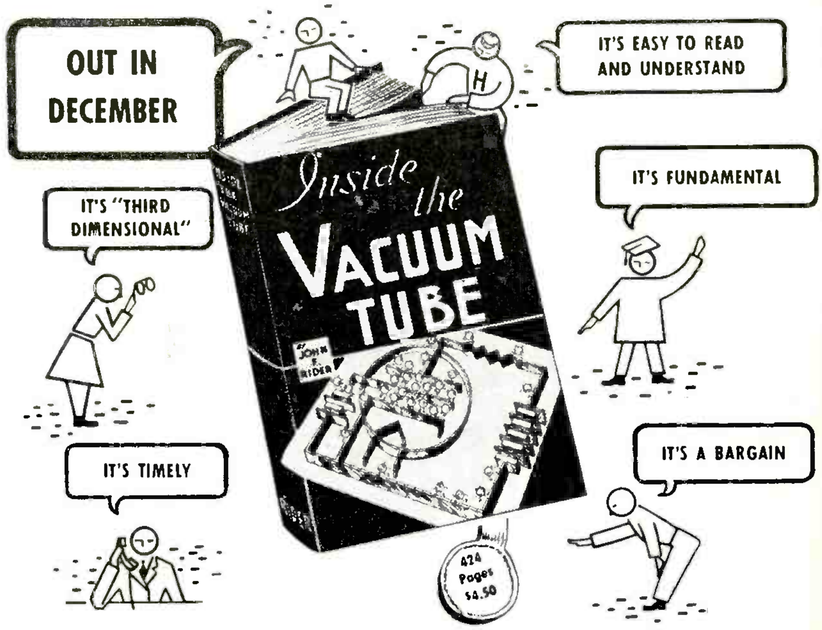
With such variety of frequencies from which to select, this record will meet the urgent demand of the phonograph service man as well as the laboratory engineer, say the manufacturers.

OPERADIO IMPEDANCE CALCULATOR

An Impedance Calculator, designed to quickly match loudspeaker lines to an amplifier for any sound system covering 500, 1000, 4000, 8000 or 16,000 ohm loudspeakers, has been developed by C.S.P. engineers of Operadio Manufacturing Co., St. Charles, Illinois.

Doing away with the sound man's impedance matching bugaboo of the "reciprocal of the sum of the reciprocals" the new device eliminates pencil computaitons and reference tables. It calculates the group impedance automatically by simply setting the various dials in accordance with the number and type of loud-speakers in any given system. The unique calculator represents an unusual innovation in time-saving devices for sound men, since nothing like it has been previously available.





Not just another book on the vacuum tube, this typical Rider Book offers a new approach and technique that makes its message easy to understand. Here is a solid, elementary concept of the theory and operation of the basic types of vacuum tubes.

After explaining the electron theory, the text presents a discussion on electrostatic fields. The reader's understanding of the distribution and behavior of the fields within a tube gives him a better picture of why amplification is accomplished within a tube.

Many diagrams and graphs are repeated to minimize the turning of pages in reading text and drawings. Anaglyphs give "three-dimensional" pictures of phenomena heretofore seen only in two dimensions; an aid in rapid understanding of the text.

Although an elementary book on a fundamental subject, therefore a goldmine for the student; developments in radio and the new fields of television and microwaves make it a must for the libraries of servicemen, amateurs and engineers.

Place your order today.

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On "Resonance & Alignment"	
On "Automatic Volume Control"	
On "D-C Voltage Distribution"	1.25 each

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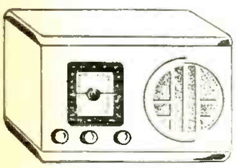
6 TUBE AC-DC KIT



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WRL MULTITESTER

All purpose tester. Money back guarantee.

$18.75

less leads

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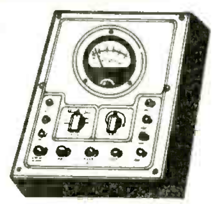
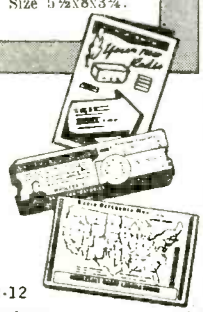


Handles AC DC Voltmeter, DC Milliammeter, high and low range Ohmmeter. 3" meter with sturdy D'Aronsval movement. Size 5½x8x3¼.



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☐ Send ______ 6-tube AC DC Kits and cabinets. Cost, $______
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Enclosed is $______; Balance C.O.D.

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I am ☐ an amateur; ☐ experimenter; ☐ service man.

We invite industrial inquiries for electronic equipment and devices of all kinds.

QUICK SERVICE FROM LEO
"same day" delivery service from the heart of the nation . . . on anything in radio. Order today.

Wholesale RADIO LABORATORIES

THIS MONTH

[*from page* 41]

with the supplying of equipment for radio, electronic and photographic purposes.

While the production of transformers by Swain Nelson Company has, until very recently, been almost wholly devoted to war work, the same as in the case of other manufacturers, S-N-C transformers are now obtainable for civilian use in limited quantities. Catalogs and literature will be available soon.

GRENBY ACQUIRES CARDWELL

A development of major interest to the electronic industry was recently announced by Carl A. Gray, President of The Grenby Mfg. Co., Plainville, Conn. and newly elected chairman of the Board of The Allen D. Cardwell Mfg. Corp. of Brooklyn.

According to Mr. Gray, The Grenby Mfg. Co., manufacturers of precision machine tools and electronic equipment ,has acquired full control of The Allen D. Cardwell Mfg. Corp., one of the pioneer manufacturers of radio parts and, during the war, developers of specialized electronic devices for the armed forces.

Mr. Gray also announced that Ralph H. Soby, Vice President and Director of The Grenby Mfg. Co. has been elected President of the Allen D. Cardwell Mfg. Corp., following the retirement of Mr. Cardwell; that Joseph K. Fabel, formerly Assistant District Manager, New York section of the Army-Navy Electronics Production Agency, will continue to serve as Vice President and Sales Manager of the Development and Engineering Division and that Ray L. Morehouse, who has been twenty-one years with the organization, continues as Sales Manager of the Commercial Products Division.

Mr. Soby, newly elected President, stated that the corporation will retain its long established "Cardwell" identity, and sustain its recognized conservative position in the industry and its sales policy of distribution through normal radio jobber channels. He emphasized, also, that there will be an immediate expansion of engineering activities coupled with a more aggressive sales policy to promote new products.

WESTINGHOUSE BEGINS RECEIVER PRODUCTION

First Westinghouse post-war home radio receivers—forerunners of the 3000-to-5000 sets per day which will come from production lines in the Home Radio Division's seven-and-one-half acre plant in Sunbury, Pa.—have been completed and shipments begun to approximately 10,000 retailers throughout the United States, Alaska and Hawaii.

Included in the new line are nine distinctive sets ranging from an ultra-modern six-tube six-by-six-by-nine-inch portable table model—reminiscent in size and price of the first home radio receiver built by Westinghouse in 1921—to an impressive 14-tube radio-phonograph combination set housed in a modified Chippendale console cabinet and equipped to receive standard broadcasts, foreign shortwave broadcasts and frequency modulation programs.

Prices, while not yet firmly established, are expected to range from about $25 to $350.

Although no television receivers are included in the first run, Division Manager Harold B. Donley said that these sets will be "ready for the market early next year". Meanwhile, both television and FM receivers made in the Sunbury Plant will be employed in flight tests of Stratovision—the new airborne system of television and FM transmission announced recently by Westinghouse and The Glenn L. Martin Company—scheduled to begin this fall, Mr. Donley said.

"Production will be stepped up as rapidly as possible until we attain our capacity of from 3000 to 5000 sets per day," Mr. Donley explained, "and there is good reason to believe we will have receivers in the hands of retailers in time for the Christmas trade. This, however, is a matter over which we do not have complete control since reconversion delays are hampering sub-contractors.

MAGUIRE BUYS RADIART

Purchase of the Radiart Corporation of Cleveland, a manufacturer of radio parts and accessories, by Maguire Industries, Inc., was announced recently by Russell Maguire, president of the latter.

All Radiart common and preferred stock has been purchased by the Maguire organization from Leslie K. Wildberg and William H. Lamar, and the corporation will be operated as a wholly owned subsidiary of Maguire Industries, Inc.

The Radiart Corporation was organized in 1928 and is an important maker of vibrators for automobile radio receivers and other radio receivers operated by batteries, and also of automobile antennas and power packs.

AIREON EQUIPMENT

Aireon Manufacturing Corporation is following up an earlier preview with an attractive, four-page brochure presenting illustrations, special features and electrical and mechanical specifications for its 50 Watt Ground Radio Station.

The 50 Watt Station, designed for small airports, airlines, and communication systems, is an RS-1 type, low power complete station, ready for installation.

Copies are available upon request to William Thom, Aireon Manufacturing Corporaiton, Kansas City, Kansas.

Thomas L. Pierce

★ Jensen Radio Mfg. Company of Chicago, designers and manufacturers of fine acoustic equipment, recently announced the appointment of Thomas L. Pierce, factory engineer, to the position of factory superintendent in charge of the manufacturing division.

Following service in World War I, Mr. Pierce began his radio career as draftsman for Western Electric Company, Chicago, later serving as service manager for a loudspeaker firm in New York and then with a radio jobber in Buffalo. After a year in business for himself, he joined the Jensen

Thomas L. Pierce

organization in 1929. During his sixteen years with the Jensen company, he has filled the positions of engineer, head of the department of manufacturing specifications and factory engineer.

His formal education was obtained at Heidelberg University, Ohio, and at Harvard and Purdue Universities. His home is in Riverside, a suburb of Chicago.

RADIO ENGINEERS ELECT NEW OFFICERS

The election of Dr. Frederick B. Llewellyn, of Summit, New Jersey, as President of the Institute of Radio Engineers for the year 1946, was announced recently by the Board of Directors of that society. He succeeds Dr. William L. Everitt, head of the Department of Electrical Engineering of the University of Illinois.

Dr. Llewellyn, a consulting engineer on the staff of Bell Telephone Laboratories, is an international authority on the design of vacuum tubes used for communication and electronic control purposes. His theoretical study of the subject resulted in his invention of the ultra-high-frequency oscillator tube which is fundamental to the development carried on during the war in radar and other communication devices. He is also known for his work on stabilized oscillating circuits used in radio and telephony. A graduate of Stevens Institute of Technology, his early work was in connection with the transatlantic telephone, and he was also one of the engineers who installed radio telephones aboard the steamship Leviathan, the first installation to be used in public service between ship and shore. In 1936 he received the Morris Liebman Memorial prize for his analysis of reactions within the vacuum tube.

As President of the Institute of Radio Engineers, he will direct a program of activity which has been enlarged by peacetime utilization of wartime developments in radio and electronics. This program has also been increased by the recent successful conclusion of a building fund providing for further expansion of the Institute's facilities.

Elected with Dr. Llewellyn, as Vice President, was E. M. Deloraine, President of the International Telecommunication Laboratories, New York, and well known

● You can build your own paper capacitor banks or combinations—whatever capacitances and voltage ratings you require—fitted into any space or container you prefer—by means of the Aerovox Type UC uncased paper sections. Or again, you can use these handy units as replacements in filter-block repair work.

These are non-inductively wound uncased paper sections, neatly shaped and wrapped in black varnished paper with ends sealed with pitch and provided with insulated wire leads 8" long. Available in 200 v. D. C. W. .1 to 1 mfd.; 400 v. .1 to 4 mfd.; 600 v. .25 to 4 mfd.; 1000 v. .5 to 2 mfd.

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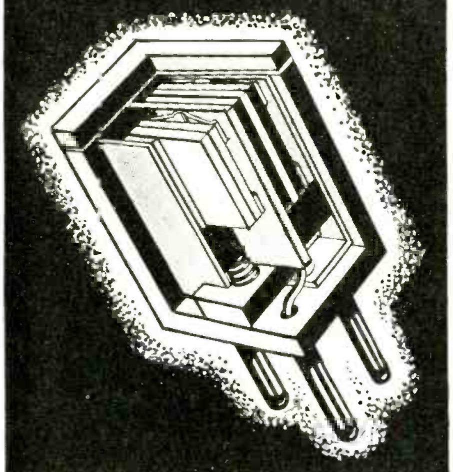

POLICE AND AIRCRAFT

A clamped type crystal which must pass Signal Corps and Coast Guard Class A specifications. Stays permanently at desired frequency - less than .01% drift over minus 30°C to plus 50°C temperature range. Shown at left is a dual unit for transmitting and receiving. Unusually stable and therefore ideal for Police cruisers, boats and aircraft. Available from 1000 to 10,000 KC.

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ORDERS FOR STANDARD TYPE CRYSTALS FOR AIRLINES, POLICE, AND OTHER EMERGENCY USES WILL BE FILLED WITHIN 24 HOURS FROM THE TIME THEY ARE RECEIVED

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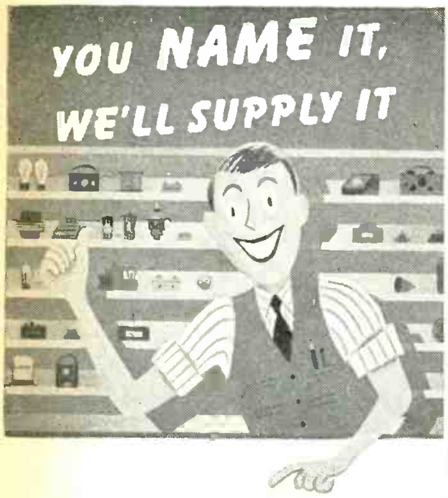

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Originators and Marketers of the Famous Lafayette Radio

Radio Wire Television Inc.

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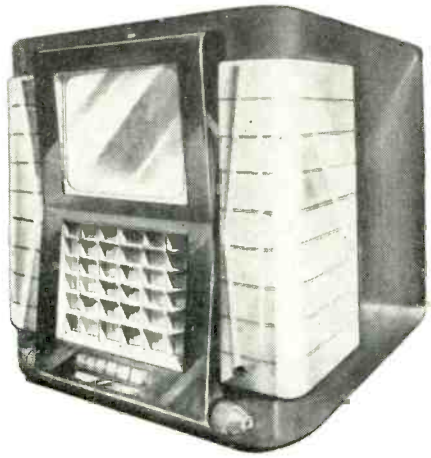
"No supplier anywhere has a bigger stock of Radio and Electronic equipment, Test equipment, Public Address equipment, Communications equipment. If your engineering problem requires special equipment, we'll make it. Write today, Dept. BL5.

in engineering circles in this country and in Europe. Three directors were also elected: Dr. Walter R. G. Baker, Vice President of General Electric Company, Syracuse, New York; Dr. Donald B. Sinclair, Assistant Chief Engineer of General Radio Company, Cambridge, Mass.; and Virgil M. Graham, Plant Manager of Sylvania Electric Products, Inc., Williamsport, Pa. Installation will take place in January at the annual meeting, which is to be held the first day of the Winter Technical Meeting at the Hotel Astor.



How a table model of the home television receiver of the future may look, according to one of Stromberg-Carlson's top-notch industrial designers. The model shown is an artist's conception straight from the designer's sketch-pad.

AIREON BUYS LEWIS ELECTRONICS

To further complement its postwar plans, Aireon Manufacturing Corporation, through its president and general manager, R. C. Walker, announced recently the acquisition of the Lewis Electronics, Inc., popularly known in the trade as "Lewis of Los Gatos".

Lewis, manufacturer of transmitting and industrial tubes, has been in business for many years.

FM REPORT

An Industry Meeting was called by Mr. George Adair, Chief Engineer of the Federal Communications Commission, on May 24, 1945, to discuss plans for monitoring operations of transmitters in the frequency range of 40-100 megacycles. During this meeting the Milwaukee Journal volunteered to operate simultaneously on 45.5 megacycles and 91 megacycles, and the Zenith Radio Corporation volunteered to establish a receiver location to monitor these transmissions. Since the result of this operation is quite startling, and since as far as we know we are the only company who has conducted tests of this kind, we felt that they should be brought to your attention.

The transmitters at Milwaukee were at the same site and the antennas were on the same tower. The receiving location at Deerfield, Illinois, an airline distance of 76 miles, was set up with conventional receivers and recording gear and with two dipole antennas at a height of 30 feet. The tests were run for the period of July 20 to September 21, 1945, at which time the Milwaukee Journal was forced to cease operations to allow reconversion of their equipment for program operation. The calibration of the receiver equipment and the results obtained were checked not only by our own technical people but in addition by a representative of the Federal Communications Commission, by Stuart L. Bailey of Jansky & Bailey, and by Major Edwin H. Armstrong.

Briefly, an analysis of the recordings indicates the following:

1. The signal obtained on 91 megacycles is less than theoretical predictions, and the signal on 45.5 megacycles is above theoretical predictions.
2. Using the Federal Communications Commission suggested method of analyzation, we find that the 45.5 megacycle signal averages three and one-half times the average signal on 91 megacycles.
3. Since these recordings are in microvolts per meter, and since the antenna length on 91 megacycles is one-half the antenna length on 45.5 megacycles, the actual signal in microvolts introduced at the receiver terminals is approximately seven times greater on 45.5 megacycles than on 91 megacycles.
4. This would mean that there is a power ratio difference of 49 to 1. In other words, if there were a transmitter operating on 10,000 watts on 45.5 megacycles, a transmitter on 91 megacycles to give the same input signal to the receiver would have to have a power of 500,000 watts.
5. We recognize that there is a noise factor which would influence these results to some extent, and that it is impractical to establish exactly what this factor may be. However, it has been estimated by our theoretical group and others that to provide equivalent service the transmitter on 91 megacycles would still have to have power between 100,000 and 200,000 watts as compared with 10,000 watts on 45.5 megacycles.
6. This situation is made worse by the decision of the Federal Communications Commission to reduce the power of transmitters when the change is made from the existing 42-50 megacycles to 88-108 megacycle band. As an example, the transmitters in Chicago which at the present time are either operating or were scheduled to operate on a power of 50 kilowatts have been assigned 12½ kilowatts for the new band. These figures are based on an antenna height of 600 feet.
7. An analysis of the recordings shows that on 91 megacycles the signal drops below a usable value sometime during three out of every four hours. In making the move to 100 megacycles the Federal Communications Commission gave as their reason long distance interference which they hoped to eliminate by this move. Industry testimony was that this interference existed for small fractions of 1% of the time. Technical witnesses for the Federal Communications Commission indicated that it might exist for a small percentage of the time. It is our opinion that the signal on 91 megacycles is *entirely absent for a much greater percentage of the time* than interference on 45.5 megacycles is present,

either on the industry testimony or on the Federal Communications Commission technical testimony.

It is our opinion, after observing these results that a frequency of 91 megacycles will not give satisfactory rural service, and that the frequency modulation system as planned for 100 megacycles would be satisfactory only for local service.

We feel that the Federal Communications Commission has been misled on this matter, because during its hearings, data was presented to them predicting theqretical field strengths approximately the same on the high frequencies as on low frequencies. Practical tests we have been running indicate that this theoretical data is not correct.

We felt that this information is of such importance that it should be given to industry at the earliest possible moment.

G. E. Gustafson,
Vice President in
Charge of Engineering,
Zenith Radio Corp.

Nelson P. Case

★ Nelson P. Case, well known in the radio industry and holder of approximately 30 patents on radio receiver circuits, has joined the Hallicrafters Company, Chicago, as chief engineer of its receiver division.

William J. Halligan, Hallicrafters president, who announced the appointment, said that Case's activities also will embrace work in connection with the firm's Echophone line of home radios.

Nelson P. Case

For the last two years Case had been director of engineering design and development for the Hamilton Radio Corp., New York City. Prior to that for thirteen years he was with the Hazeltine Electronics Corp., in various capacities. During later years with Hazeltine he was in charge of its New York license laboratory.

The new member of Hallicrafters staff was graduated in 1924 from Stanford University with an AB degree in physics, and in 1926 with an EE degree. He is a member of Phi Beta Kappa and Sigma XI.

Following his university days he became active in geophysical work, and in 1928 became assistant physicist in the Bureau of Standards in Washington, D. C. In the fall of 1929 he was named research physicist in the University of Michigan's

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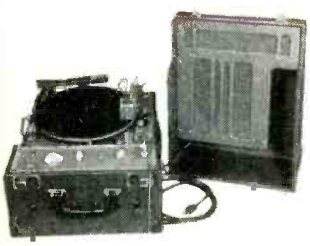

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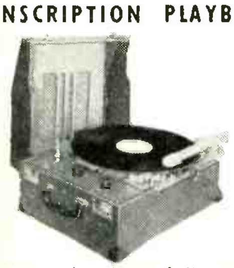

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Department of Engineering Research. He joined Hazeltine in 1930.

Case is vice-chairman of the committee on broadcast and short-wave home receivers of the Radio Manufacturers Association's engineering department. He is a member of the executive committee of the RMA engineering department's receiver section; a member of the RMA committee on television receivers, the RMA systems committee, and the committee on v-h-f receivers. He is a member of Panel 6—Television Panel—of RTPB, a senior member of the Institute of Radio Engineers.

CAMBURN EXPANDS

The Camburn Products Company, with offices and factory at 490 Broome Street, New York 13, N. Y., announces a huge expansion program.

One of the pioneers in the design and manufature of automobile antennas when auto radios were first introduced, Camburn Company. During the war went 100% into war manufacturing for the Federal Government, producing precision electronic equipment and special antennas for the various branches of the American fighting forces. The most popularly known antenna is the "Walkie-Talkie" antenna which the Camburn engineers helped develop.

The plans for the post-war period call for an ambitious move into other trade outlets, such as the radio industry. All products are definitely in the production stage and will be distributed through reputable sales representatives and radio jobbers in the United States. Besides streamline automobile antennas for the new cars, there will be complete lines of antennas for FM and Television home receivers and industrial electronic applicications and antennas for all types of marine installations.

TECHNICANA

[*from page* 23]

is identical with the desired pattern of transmission of the broadcast station. Final dial readings not only tell where to locate the towers, but give all electrical data needed to complete the most efficient antenna design.

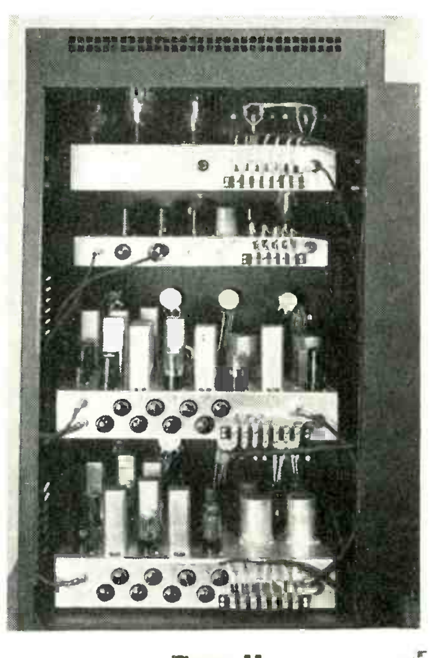


Figure 11

FM-FAX ANTENNA

[*from page* 38]

programs soon to be broadcast by the Finch station on 99.7 megacycles are expected to be limited in range to approximately 6,840 square miles. This covers a radius of 50 miles from the vicinity of the New York Public library. Other cities and territories will be served by other FM and facsimile stations.

Facsimile Operation

"In time," Capt. Finch said recently, "we confidently expect a great mass circulation for facsimile broadcasting. The printing-recording apparatus is well within the means of average families. The printer is simply attached to the present FM radio receiver; then, on receipt of a 'fax' signal, the roll of electro-dry sensitized paper in the printer begins to turn, and out comes the printed matter as fast as our station puts it on the air. Illustrated news, with details of market reports, pages of photos, cartoons, women's pages, columnists' contributions, book reviews, crossword puzzles, boxscores — everything that combined radio and printed matter can give will come by facsimile over WGHF."

Antenna Operation

The top part of 10 East 40th Street, where the antenna installation is located, is being converted into the studios and offices of the new radio station. The antenna has been specially designed by Dr. Andrew Alford, who is past-chairman of the Antenna Committee of the Institute of Radio Engineers. The tip of the mast is about 700 feet above sea level. Asked to describe the antenna and its operation in "words that any layman could readily understand", Dr. Alford said:

"High frequency of the new FM band together with horizontal polarization have made it possible to achieve something new in broadcasting: a single unit antenna that has gained over a half wave. This gain is obtained by using a bent metal sheet along which the wavelength is longer than the wavelength in space, so that the radiation comes from a long vertical column. This fact results in a concentration of radiation toward the horizon where it is desired. Less power is sent to the sky and into the area immediately adjacent to the station where the signal is always more than sufficient. The WGHF antenna radiates almost equally in all directions of the compass. The input of the antenna is relatively low so that the insulation is not subjected to high voltages. Only one seal insulator is used and this insulator is protected from the weather."

Although this installation was planned before Pearl Harbor, it wasn't until Capt. Finch returned from his duties as head of Radio Counter Measures; Research and Design of the Electronics Division of the Bureau of Ships, that construction of the new station was begun.

This new development in radio is being watched keenly as a progenitor of a vast service that may very well spread throughout the world—a service bearing profound influence upon the future of mankind.

INSULATING MATERIALS

[*from page* 36]

Compression vs. Transfer Molding

There are two points where the two types of molding require different design techniques. Compression molding will always have a thin layer of porous skin. If the piece is regularly shaped, the skin may be removed by grinding; if irregularly shaped, the skin cannot be removed. Remember that any skin does not have a fixed depth of penetration, so that exceptionally deep grinding is sometimes necessary to remove localized skin.

Skin will have little effect on parts where high heat is a condition, since the moisture cannot penetrate. For most applications, however, such a condition is unsatisfactory.

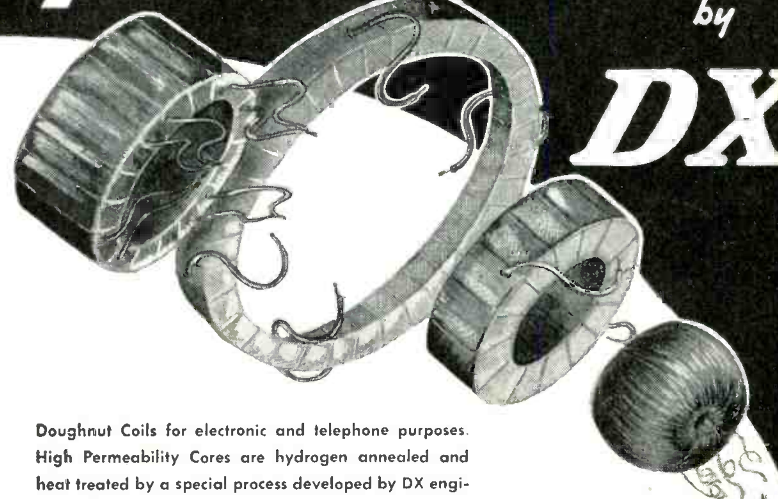
Transfer-molded parts will always have to be ground where the runners flow into the mold. This point of entry, commonly called the gate, is a small point on the surface of the material and occurs at the point where the mold closes. This technique is similar to that employed in the plastics industry.

The grinding of the gate will leave a very small mark on the surface of the part; otherwise, the part will present a smooth glazed surface. Since this gate is part of the necessary manufacturing operations, proper design will allow for minimum gate at the point where it will do least harm to the part.

Designers should decide where the mold can be opened, allow taper on both sides from that point, and design the part so that the gate causes the least design trouble. A smooth surface should be allowed at some point for proper ejection of the part from the mold.

Still another group of materials in the glass-bonded mica category exists. These materials are higher dielectric constant groups where titanium forms are introduced into the glass and mica mixture. Because we intend to pursue the titanium forms at a later point in these dis-

Toroids.. by DX



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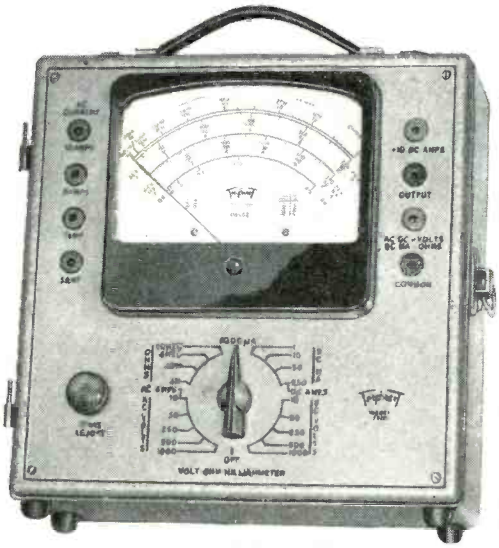

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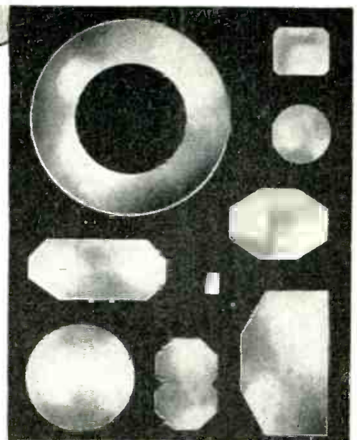

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cussions, only passing mention of this glass-bonded mica material is made.

Higher Dielectric Constants

Higher dielectric constant materials in compression molded sheets and rods have been made available to the industry with dielectric constants up to 20. Temperature-compensating materials with dielectric constants up to 80 and with temperature capacitance coefficients up to and above 1000 parts/million have been produced in transfer-molded forms.

The author would like to point out that certain portions of the techniques and the materials herein described are covered by patents. It is not the author's intention to describe any particular proprietary grade but to cover the field so that the radio designer can design properly with this material. It is clearly understood that specific proprietary brands may have properties that other glass-bonded micas may not possess.

It is suggested that the designer can do the best job by testing the material—whether it be glass-bonded mica or phenolic, etc. Since any manufacturer's statements are an approximation, testing under the designed conditions is often the best way of ascertaining a material's worth.

DRY-CONTACT RECTIFIERS

[from page 32]

plate temperature below the 75 degrees C. safe maximum.

The present limits on operating temperatures are the rapid aging which takes place at temperatures above 80 degrees C. and the melting of the sprayed-metal counter-electrode. New white-metal coatings are now available which have a higher melting point that will permit operation up to approximately 100 degrees C. continuously. This will eventually permit higher normal load ratings at 35 degrees C. after sufficient knowledge is obtained on aging at these higher temperatures.

Aging

The forward resistance of a rectifier gradually increased with use. This action is known as aging. It is assumed that it is due to a thickening of the barrier layer. The aging does not continue indefinitely. After about 10,000 hours of operation at an operating temperature of 65 degrees C., the forward resistance reaches a final constant value.

A typical set of output voltage values for a 3-phase bridge circuit rectifier with 115-volt rms, 60 cycle, input is:

Condition	Ambient Temperature 50°C.	—40°C.
NEW	138V	122V
AGED	130V	106V

High operating temperatures accelerate the process of aging. For accurate voltage output, it is desirable to have a variable voltage input to take care of the voltage drop due to aging.

Load Ratings

In *Fig. 8* is shown a typical chart of normal load ratings for standard selenium rectifier plates based on operation at an ambient temperature of 35 degrees C. in freely circulating air.

Overload and Intermittent Duty Ratings

Selenium rectifiers will withstand short time current overloads, provided the operating temperature does not exceed 75 degrees C. If sufficient time is allowed to lapse between overloads, higher overloads can be permitted. In *Fig. 9* is shown a typical overload capacity curve. This curve is based on half-hour off-periods. For shorter off-periods, it must be proportionately derated.

RADIO TRANSMISSION

[*from page* 28]

μv/m, a "burst" of over 25 μv/m may be expected every 35 minutes, or correspondingly a "burst" exceeding 15 μv/m every 6 minutes.

Examination of this typical period will also reveal the small signal strengths propagated by this short period phenomena.

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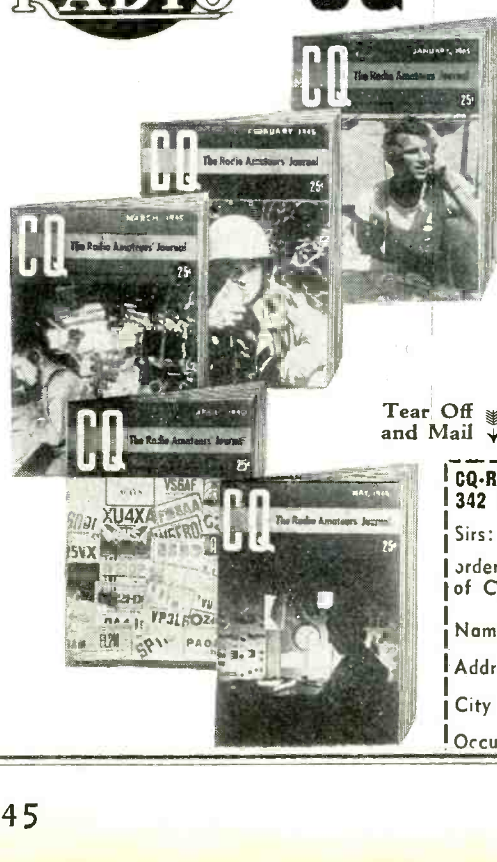

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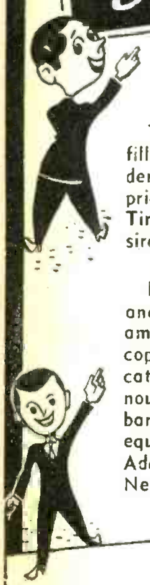

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NEW PICKUP

[from page 26]

resulted in a pickup coil which, when used with the maximum magnetic field permissible, will deliver to the external circuit about 2.5 millivolts at 1000 cycles. Because the maximum field with this design is determined by the magnetic characteristics of the thin section of reed, the permanent magnet itself may be very small. A further advantage gained by this relatively weak field is that centering of the reed is positive and permanent, eliminating one of the most troublesome of service failures common to most balanced armature designs.

Other Features

Due to the hinge effect of the solidly suspended reed, the moving system as viewed from the stylus end has substantially only one degree of freedom. In tracking laterally recorded grooves, the torsional reaction is entirely negligible. The same applies to vertical reaction. The mechanical impedance ratios for lateral versus these other two modes is so high as to make the only measurable response that due to the lateral displacement. In the absence of any other modes of vibration than the intended lateral motion, intermodulation is reduced to the point where it can be considered as negligible. Because the generator portion of the magnetic circuit is open at both ends, such a pickup would be susceptible to a-c fields produced by phonograph motors, power transformers, etc. However, the design lends itself to the ready adaptation of a simple hum-bucking system which, in the actual commercial design, has been carried out as shown schematically in *Fig. 2.* The hum-bucking coil is wound on a core similar in size and shape to the core of the generator coil and is located so close to it that only fields with an abnormally high gradient will induce any perceptible hum into the circuit. In actual practice it has been found that the pickup may be used with ordinary cheap turntable motors with no noticeable hum pickup.

The elimination of vertical response combined with the sharp high-frequency cutoff characteristic makes it possible to proportion the structure so that ordinary commercial pressings may be reproduced with very little surface noise without resorting to scratch filters.

Two general designs have been worked out, one intended for home phonograph use and the other for broadcast, transcription, and re-recording work. In the home phonograph version, the pickup has a rising characteristic to about 4,500 cycles and then drops off sharply

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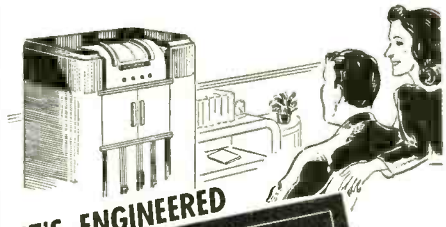

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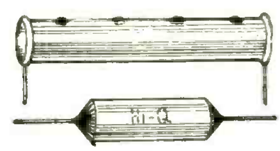

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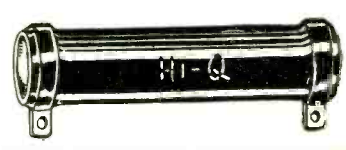

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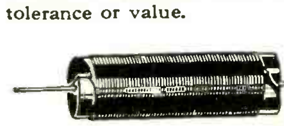

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after 6,000. This type of response seems most desirable where the maximum of brilliance is to be realized with the minimum of surface noise. In the professional design, the dimensions are such as to produce a curve of similar shape but with the rise occurring at 10,000 cycles and sharp cutoff occurring above 12,000.

Fig. 5 is a photograph of the 6,000-cycle cutoff model. Total weight of the cartridge is .65 ounce and it is mechanically interchangeable with crystal pickups in practically all tone arms. Standard two-hole mounting was selected as being the most generally acceptable method of mounting a pickup cartridge.

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For example, it resists body oils—won't get gummy. (*It resists most other chemicals, too; oils, greases, acids, alkalis.*) It's long aging—resists the action of air, ozone, sun, heat, cold. (*Ideal for radio connector cord, switchboards, etc.*) It's light in weight—made possible by thin coatings. (*That means more conductors per conduit in domestic, industrial, or utility wiring.*) It's smooth and comfortable. (*Easy to handle, easy to install.*) It has high flexlife. (*Use it anywhere that there's vibration or frequent flexing.*) Of course, all of these are in addition to excellent electrical properties that make possible power cable without protective sheathing; buried service entrance wire, and many other severe—or routine—forms of service.

The next time you order wire or cable be sure to specify insulation made from GEON. That way you'll be sure to get the best. For further information write Department WW-12, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

Geon
Polyvinyl Materials

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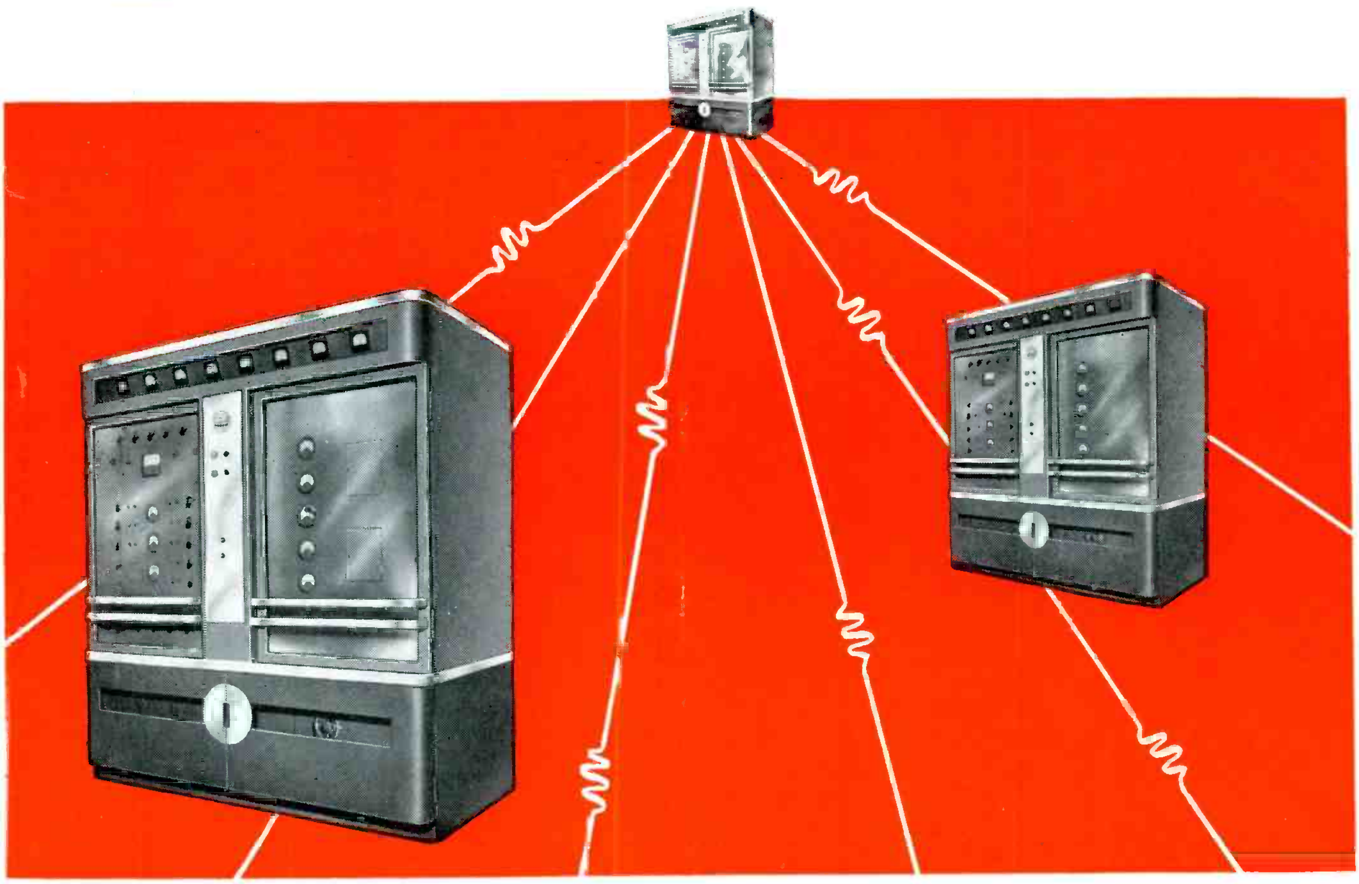
250 AND 1000 WATT FM BROADCAST TRANSMITTERS ARE *On The Way . . .*



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Here's why:

As specialists in the manufacture and development of communications equipment, receivers as well as transmitters, for Commercial, Marine and Emergency use, we have gained a thorough knowledge and understanding of *all* phases of the industry. This sound background has been greatly enhanced by the additional skill and "know-how" gained through war work, particularly in the development and production of vital Loran Radar Transmitters and other important communications units. Add to this improved production facilities and advanced precision methods of manufacture and you can readily understand why HAR-CAM FM Broadcast Transmitters will provide the last word in efficient, dependable and economical transmission.

Now is the time to get the complete story on these new HAR-CAM 250 and 1000 watt FM Broadcast TRANSMITTERS.

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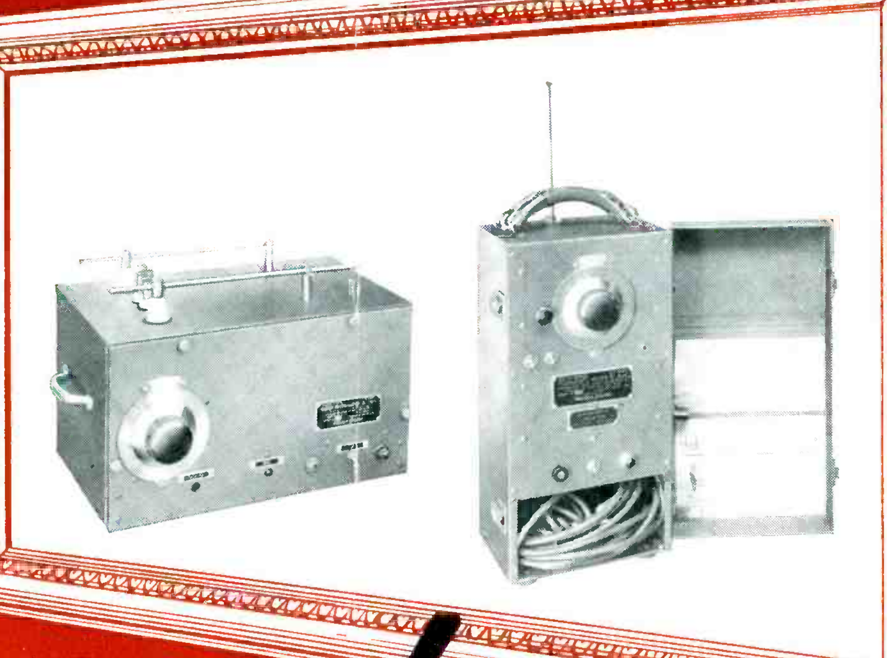

Scoop!

Left: Radio Modulator BC-423. High frequency signal generator operating from 195 to 205 mc., modulated at approximately 5000 cycles. Ruggedly built in steel case. Designed so that it can be re-adapted to many applications. Can be used as high frequency receiver, transceiver or frequency meter. Good for lab demonstrations requiring low power, ultra high frequency generator. Can be converted to 2½ or 1¼ meter receiver.

Right: Frequency Meter BC-438. Ultra-high frequency signal generator operating from 195 to 205 mc. with crystal calibration. Aluminum chassis in steel case. Removable nickel plated 19" telescopic antenna. Use as high frequency receiver or transmitter. Can be converted to cover any frequency range. Takes dry batteries for portable use. Precision tuning control make it ideal for "on the nose" ECO transmitter control unit.

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