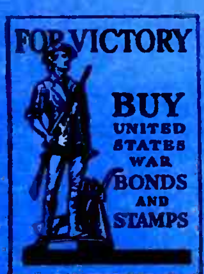
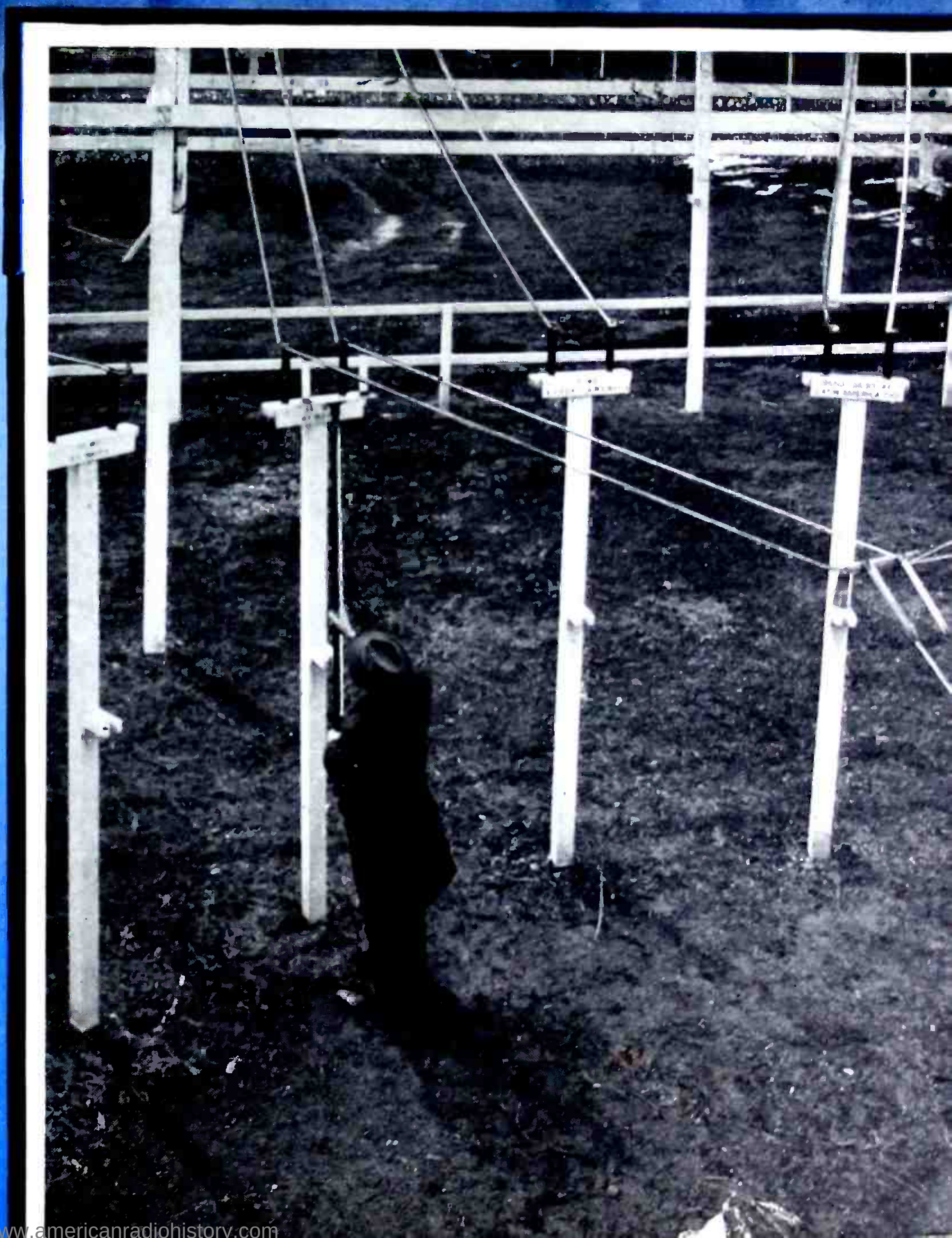
COMMUNICATIONS

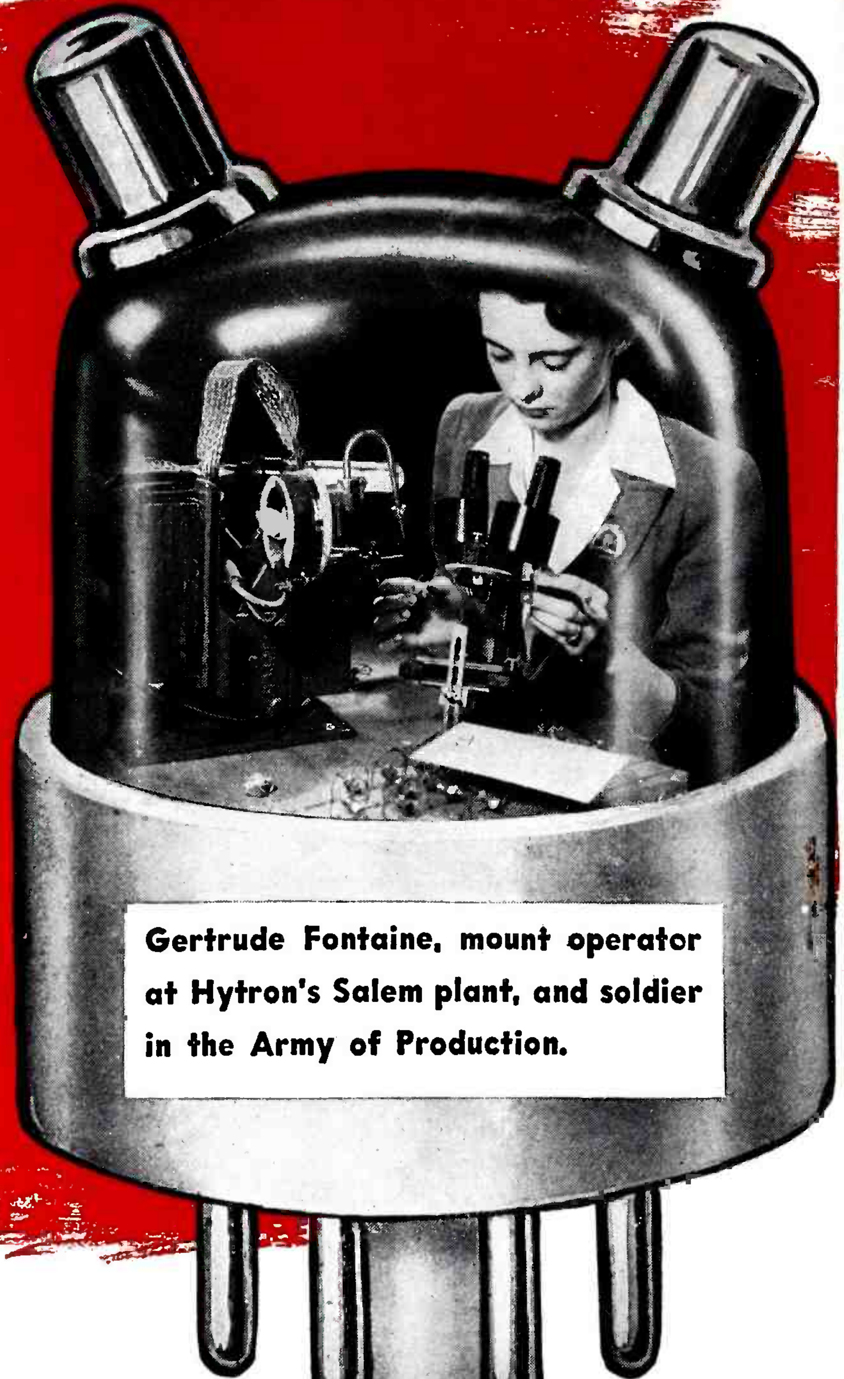
★ RADIO ENGINEERING
★ FIELD TESTS ABOVE 100 MC
★ NEGATIVE INDUCTANCE
★ U-H-F DESIGN TECHNIQUE
★ HIGH SPEED SOUND EFFECTS
★ TRANSIENTS IN COUPLING CIRCUITS
★ A STUDY OF IRON CORES
★ PRODUCTION AIDS
★ AIRCRAFT COMMUNICATIONS



JUNE
1943



with but a *Single* thought



Gertrude Fontaine, mount operator at Hytron's Salem plant, and soldier in the Army of Production.

Miss Fontaine concentrates her nimble fingers and keen young eyes (assisted by a microscope) upon spot-welding and assembling minute parts of a 954.

On another floor, a Hytron engineer is giving lavishly, night and day, of his long training and experience as he designs and develops a new War tube in record time. The driving force urging them — and all of us at Hytron — on to superhuman effort, stems from a single thought, a single purpose: to supply our courageous fighting men with tools to win. Hytron employees have but one goal — a mounting flood of top-quality tubes to serve as the "hearts" of electronic and radio equipment helping our boys to blast the way to speedy and permanent Victory.

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COMMUNICATIONS

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JUNE, 1943

VOLUME 23 NUMBER 6

We See...

THE CONGRESSIONAL INTEREST IN RADIO has become quite keen during the past months. With the White-Wheeler Bill (revising the present Communications Act), the Kilgore-Patman Bill (establishing an Office of Scientific and Technical Mobilization) and the Bankhead Bill (calling for the government's expenditure of close to $30,000,000 in advertising) to consider, Congress has a real job on its hands.

The Kilgore-Patman Bill seems to be arousing indignation in many quarters. The IRE recently took the stand, for instance, that the technical resources and particularly the radio facilities of the nation, are now operated very efficiently in the war effort, and accordingly do not require the suggested legislation. This proposed legislation, they say, would only result in confusion. A resolution expressing opposition to this bill was adopted by them recently, during a Board of Directors meeting.

Yes, radio has given Congress a few problems . . . problems that demand tense study.

TUBES CAN BE REPAIRED WITHOUT a preference rating, according to an interpretation of preference rating order P-133 and limitation order L-265, just released. According to the interpretation, any number of tubes can be repaired without the extension of a preference rating. However, a preference rating under P-133 cannot be extended for the purchase of a new tube, unless an operator has in his inventory less than one spare tube per socket.

CONGRATULATIONS TO ARTHUR VAN DYCK on his entering the Navy as a Lieutenant-Commander.

AS OUR CONTRIBUTION towards the conservation of paper, the trim size of COMMUNICATIONS was reduced in February. And now to further assist in paper conservation, lighter weight paper is being used, for both the covers and inside pages, effective with this issue.—L. W.

COVER ILLUSTRATION

The antenna switch bay of short-wave transmitters WGEA-WGEO.
(Photo by William A. Rittase)

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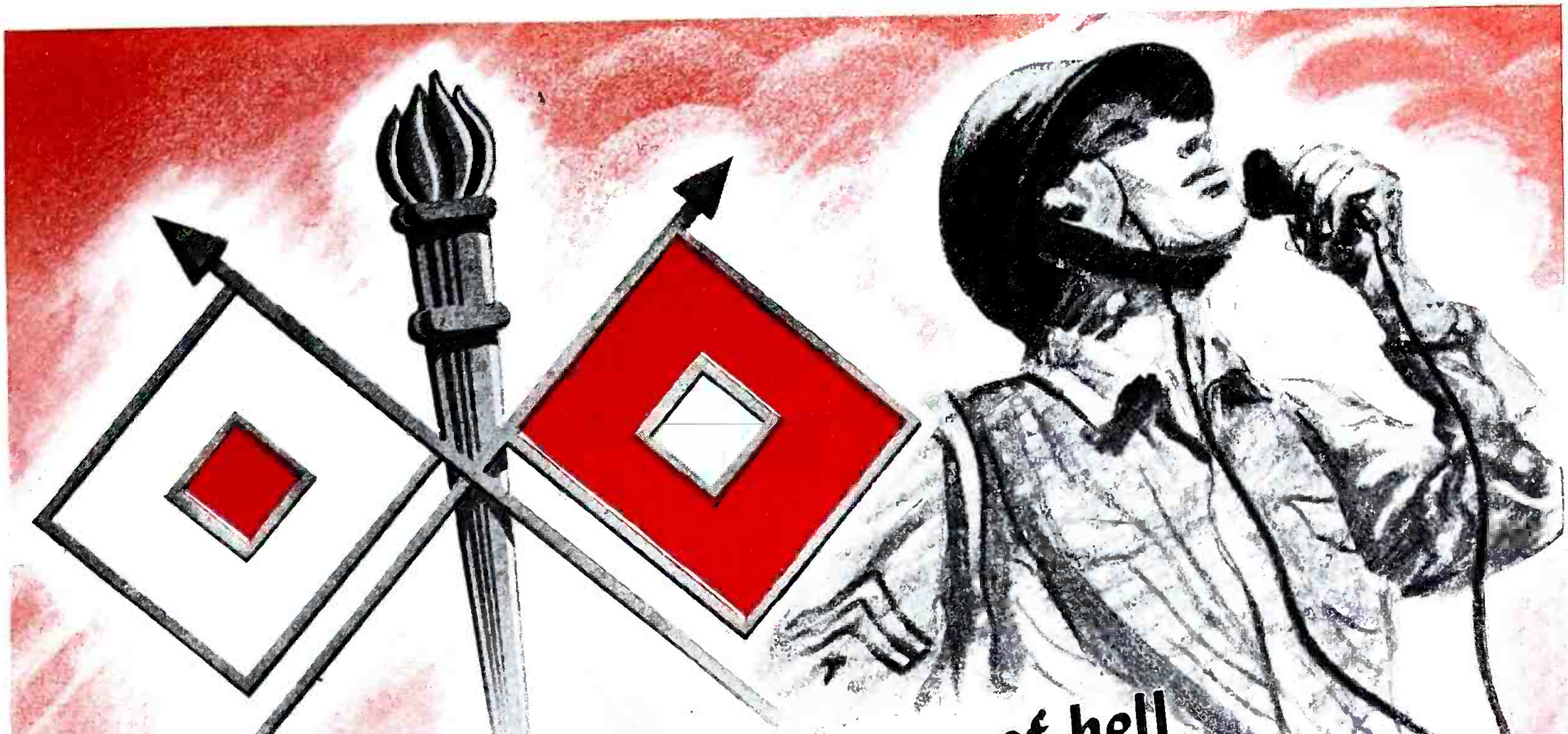
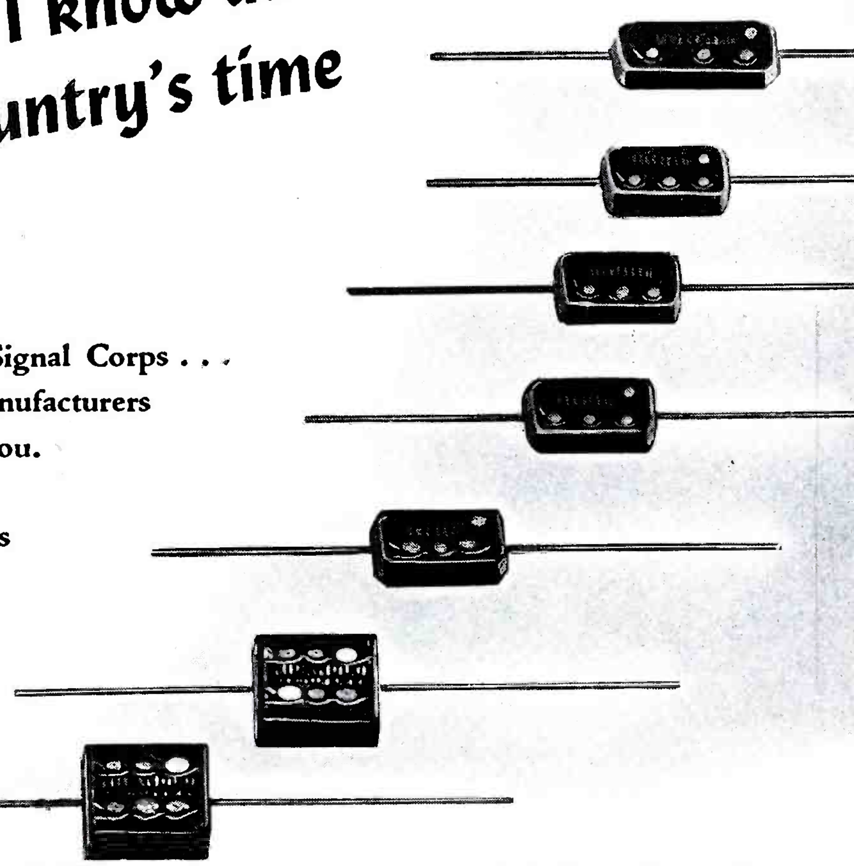


With miles of wire, through acres of hell
Glued to my phones, ducking shot and shell
I wish I were home, but I know damned well
I can't dream on the country's time



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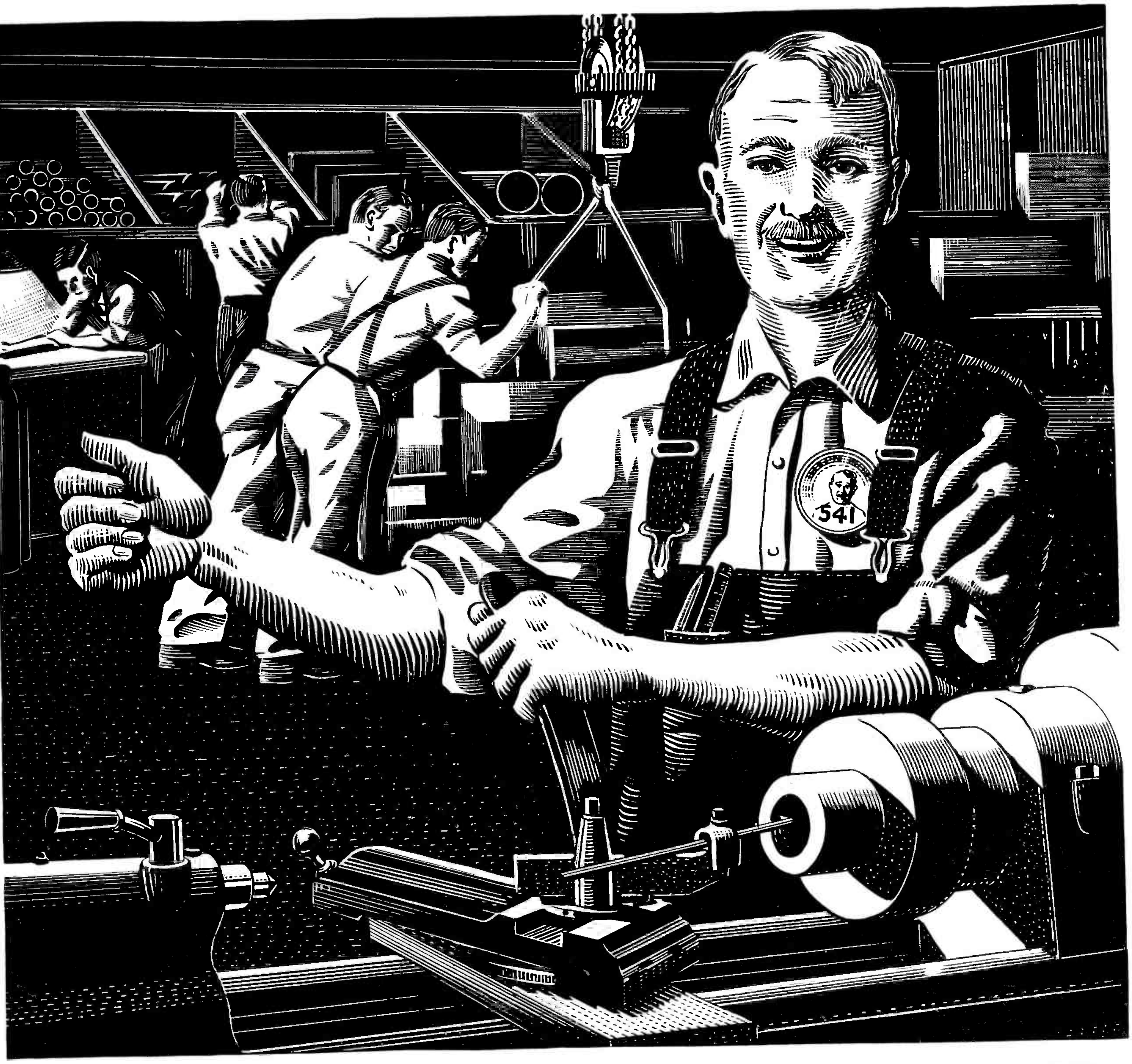
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High Altitude
OIL-FILLED CAPACITORS

Photo Courtesy of Bell Aircraft Corp., makers of the famous Airacobras.

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The revelations concerning RADAR and its part in the war came as no surprise to those whose job is to supply our fighting forces with modern electronic equipment. Since before Pearl Harbor these Americans have been working shoulder to shoulder with our armed forces in applying the power of electronics to the art of war. Out of this united effort have come fighting weapons never before known—on land, at sea or in the air. In this pioneering work it has been National Union's privilege to play a progressively increasing part. A greater National Union has been built to cope with vastly larger responsibilities. Today, National Union is ready to consult with and assist other manufacturers in the use of electronic tubes. Tomorrow, when peace comes—when the industrial usage of electronics gets the green light—engineers and production men will find at National Union unexcelled service and cooperation in perfecting new electronic applications for the production, testing and packaging of their products.

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THE SKILL *and* THE WILL
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Only one American in many thousands is privileged to wear the "E" pin, symbolic of high achievement on the production front. It symbolizes skill and determination above and beyond the high average standard set by American Industry. ▸ ▸ ▸ The men and women of Connecticut Telephone & Electric Division have been honored by the Army-Navy Production Award twice in a period of six months. This symbol of a job being well done in the cause of Victory is evidence, too, of what may be expected when the war is won. ▸ ▸ ▸ The manufacturer seeking cooperation in product engineering and improvement, the development of production control, or any problem involving the application of advanced electrical or electronic knowledge, is cordially invited to discuss the matter with our engineering staff.

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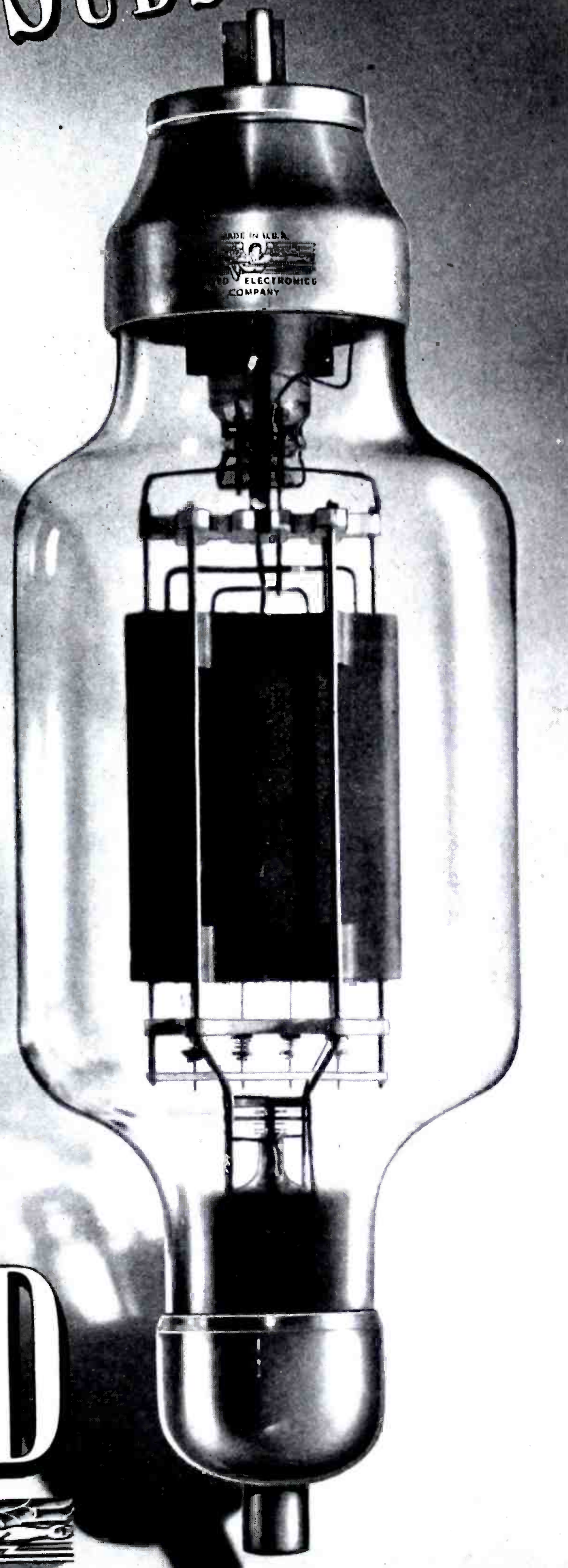

In the highly specialized field of electronics, the question "Who made the tubes?" will always be a matter of vital importance. Power tubes bearing the name "United" are products of original pioneers in the miracle known today as electronics. Step by step these seasoned engineers helped evolve the principles and advance the science of fabricating transmitting tubes which hold a superb record of performance. The early pioneers at United are *still actively pioneering!* The wealth of experience which they have been privileged to accumulate under the demands of war will be available to you when "United" electronic tubes are available again on a peace-time scale for radio and industrial applications.

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1. Enemy planes rise from distant airfields.

2. Radar sends out beam of ultra-high-frequency waves, reflected back to instruments which determine planes' location, speed, and direction.

3. Interceptor planes then surprise and destroy the advancing enemy.

The facts about RADAR

"The whole history of Radar has been an example of successful collaboration between Allies on an international scale."

THE NEW YORK TIMES, MAY 16

THIS amazing electronic invention that locates distant planes and ships despite darkness and fog is a great co-operative achievement of Science and Industry.

In this country and in the British Isles, over 2000 scientists and engineers, some working alone, some in the Army and the Navy, many in research laboratories of colleges and industrial firms, joined eagerly in the search for Radar knowledge.

Team-work that succeeded. Once this electronic device had been perfected, industry after industry rallied to the nation's call to manufacture Radar. General Electric is proud to have played a large part, with other manufacturers, in supplying to the Army and Navy this key weapon whose peacetime applications hold so high a promise.

As early as the Twenties, G-E engineers and scientists were developing the kind of high-frequency tubes, circuits and apparatus that make Radar possible. Thus long before Pearl Harbor, G.E. was able to build Radar equipment.

Post-war applications will be many. Radar will guard and guide the flight of great commercial transports. Planes will land blind. Transoceanic liners will slip safely into fog-bound harbors — all with Radar detection equipment.

In addition to Radar, General Electric is supplying to the Army, Navy, and Marines radio transmitters, antennae and receivers, carrier-current equipment, all kinds of electronic measurement equipment, and monitors. *Electronics Department, General Electric, Schenectady, N.Y.*

Tune in General Electric's WORLD TODAY and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over C.B.S. . . . On Sunday evening listen to the G-E Mazda Lamp program over N.B.C. network.

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G-E employees are now purchasing over $1,000,000 in War Bonds weekly

COMMUNICATIONS

LEWIS WINNER, Editor

* * JUNE, 1943 * *

100 MEGACYCLES AND BEYOND

For Relay Transmission

by W. L. WIDLAR

U-H-F Engineer, WGAR

AN optical, or line of sight, transmission path is the generally accepted requirement for the transmission of strong reliable signals in the region of 100 megacycles and beyond. In relay broadcasting, this requirement can not always be met. High quality program relays must often be made under very unfavorable conditions that at first seem prohibitive.

Relay Equipment at WGAR

WGAR has been successful in solving many of these problems in the design of their relay broadcast equipment. WEMV, the mobile unit, is equipped with a 100-watt f-m transmitter operating on 161.1 mc, and a horizontal directional antenna mounted on a short mast. Necessary auxiliary apparatus includes . . . speech input equipment, audio oscillator, frequency monitor, *VU* meter and two standard broadcast band automobile receivers.

F-M Receivers Used

A 161.1 mc f-m receiver is installed in a penthouse on the roof of a tall building beneath a 100-foot tower that supports a horizontal directional receiving antenna approximately 400 feet above the street level. This antenna can be revolved in either direction by remote control. An r-f transmission line connects the antenna to the receiver. A two-wire telephone line connects the output terminals of the receiver to the WGAR master control room in another building. The receiver and rotating antenna are unattended and are operated *blind* from the master control room by means of a current differential method. A schematic diagram of this remote control method is shown in Figure 2.

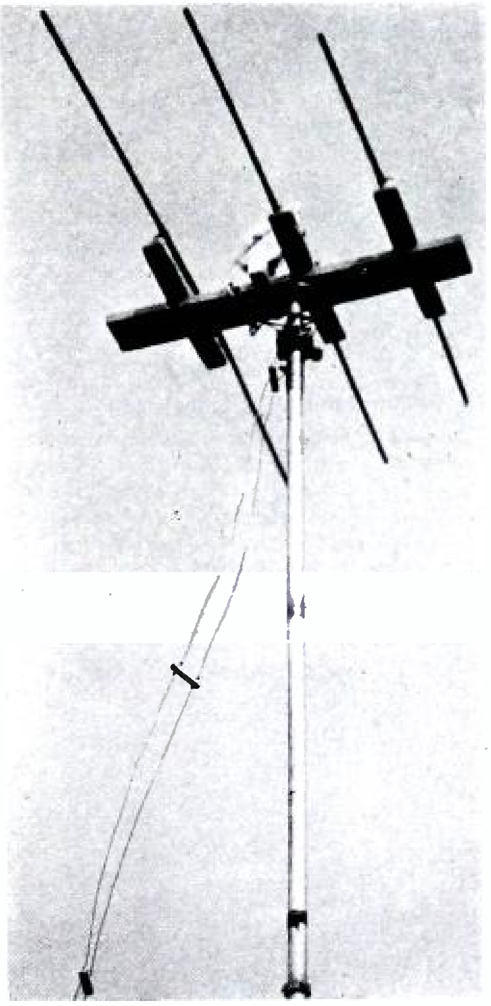


Figure 1
Three element horizontal directional 225.6 mc antenna used with *Griffin* inductive coupling, permitting continuous rotation.

Remote Control

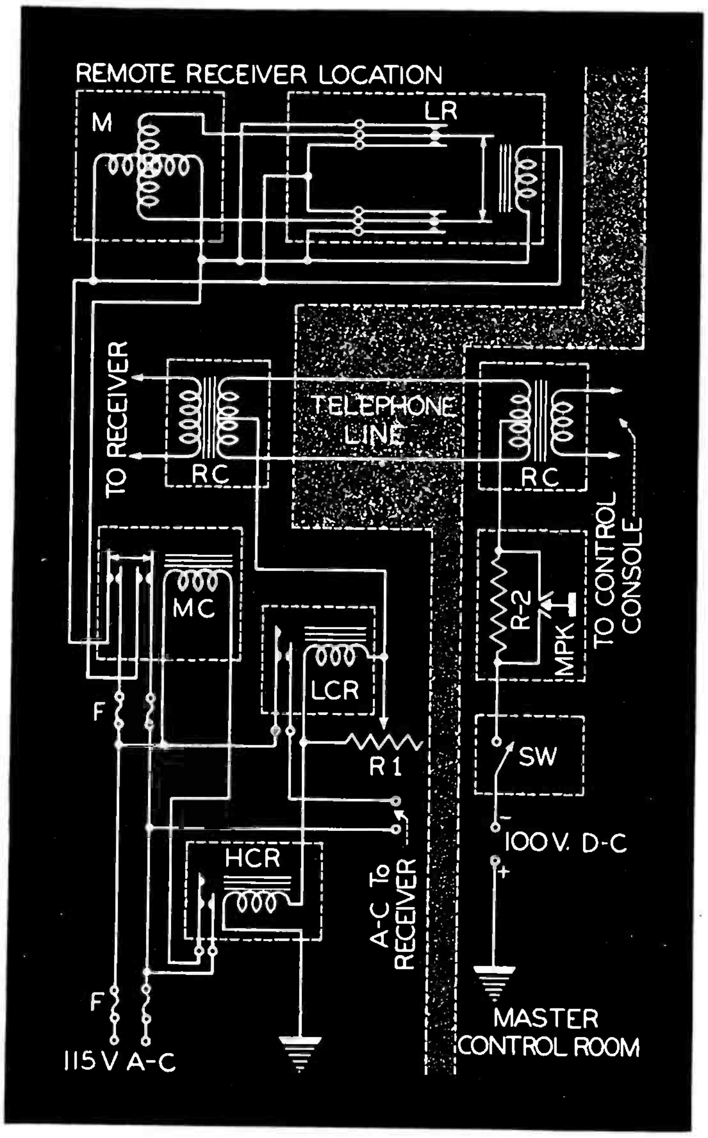
Remote control is obtained by the operation of a switch and push key. Power is applied to the receiver by completing the direct current center-tap circuit at *SW*. This causes the low current relay, LCR, to put the receiver in operation. The resistors *R1* and *R2* provide a means of adjusting the sensitivity of *LCR*. Operation of the manual push key, *MPK*, causes a higher current to flow through the circuit. This operates the high current relay, *HCR*, without affecting the function of *LCR*. The relay *HCR* operates the a-c motor contactor, *MC*, which applies power to the antenna driving motor *M* and latching relay, *LR*. The purpose of *LR* is to reverse the rotation of the motor each time power is applied.

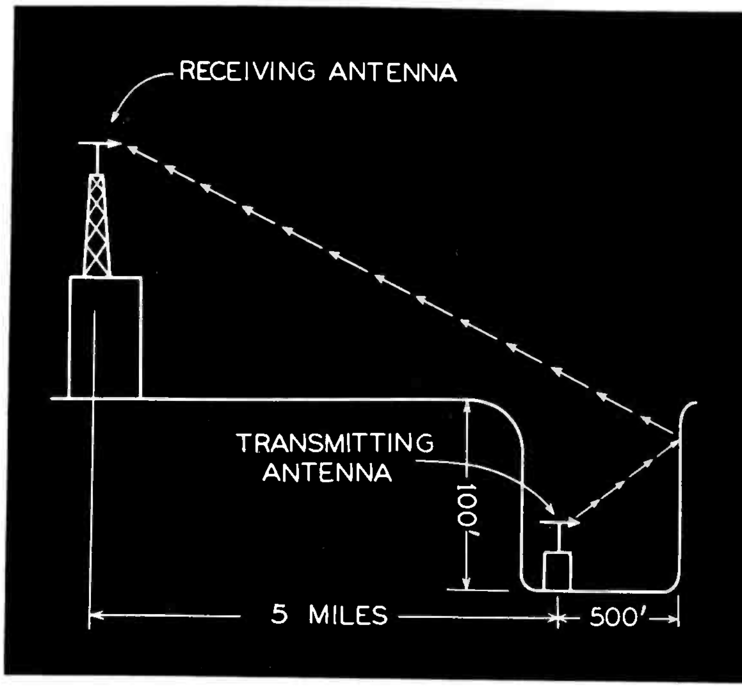
100-Watt Communications Transmitter

In addition to these facilities, the WGAR relay system includes WAAI, a 100-watt communications transmitter on 1,622 kc. This is connected to a 170-foot vertical antenna that is an element of the WGAR directional antenna array. With this antenna, WAAI serves a wide area. The communications transmitter is ordinarily connected to the master control room telephone panel by a five-mile telephone line.

Operation of Relay System

The use of the relay system is relatively simple. At a scheduled time the mobile unit transmits a test signal from location to the master control room, with the mobile unit antenna aimed at the receiver location. The master control engineer then orients the receiving antenna for maximum





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Figures 2 (left) and 3 (top)
At left, the remote control system used by WGAR permitting control of the horizontal directional receiving antenna that is 400 feet above street level. Control is obtained simply by operation of a switch and a push key. In Figure 3, we see the characteristic reflection phenomena exhibited on a 161.1 mc signal.

•

signal. In most cases, this test occupies but a few minutes. The mobile unit transmits a steady audio tone test signal. The master control engineer connects a *VU* meter to the receiver circuit and operates the antenna control, *MPK*, until the meter reads maximum. On strong signals, the position of the receiving antenna is not critical. Due to limiting in the f-m receiver, the *VU* meter will show about the same reading even though the receiving antenna is rotated 180°. However, on weak signals, the directional properties of the antenna are quite pronounced.

The use of directional antennae on both transmitter and receiver has resulted in successful pickups from very difficult locations, and relays of special events that could not otherwise be broadcast.

As an example, the need arose for covering an event of local importance that was scheduled in a park on the floor of a valley. Examination of the location indicated that very poor, if any, results would be obtained, as it was impossible to arrange for line of sight transmission from the mobile unit to the receiver. Preliminary tests provided only a very weak signal from the mobile unit. It was very difficult to carry on communications between the mobile unit, WEMV, and master control, WAAI. Different locations were tried in the same area by driving the mobile unit around the park. At one point, WAAI reported the signal as very strong. Investigation of the situation revealed that the transmitting antenna was pointed in a direction away from the receiver, at the valley wall or cliff. The 161.1 mc signal was apparently reflected in a manner illustrated by Figure 3. This same phenomena was observed on several successive tests a few days later, and at the time the event was broadcast.

Since this experience, advantage has been taken whenever possible of the possibility of reflecting signals from trees, buildings, cliffs or whatever object is convenient, with generally good results.

Tall, thickly leaved trees are very useful in the summer, but the bare branches seem to be little help in the winter. Figure 4 illustrates the use of a tree at a point on level ground almost below the horizon of the receiv-

•

Figures 4 (left), 5 (center) and 6 (right)
Figure 4 illustrates the use of a tree for reflection. Figure 5, directional antenna mounted on wrong side of house, affording poor reception. Figure 6, terrain peculiarities that were noticed in North-South transmission tests.

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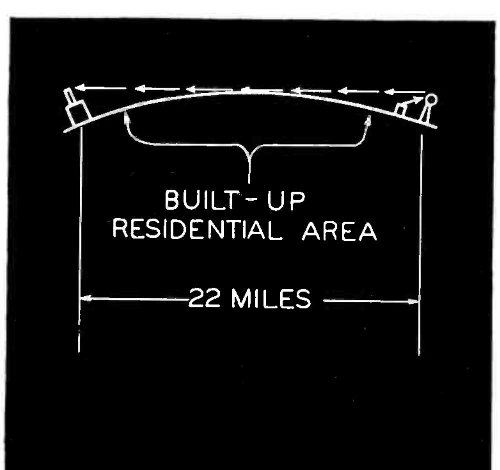
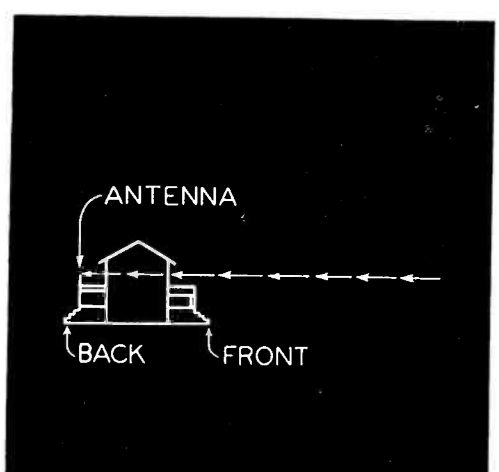
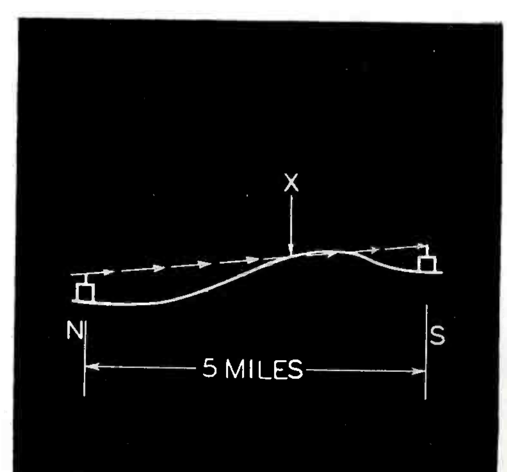






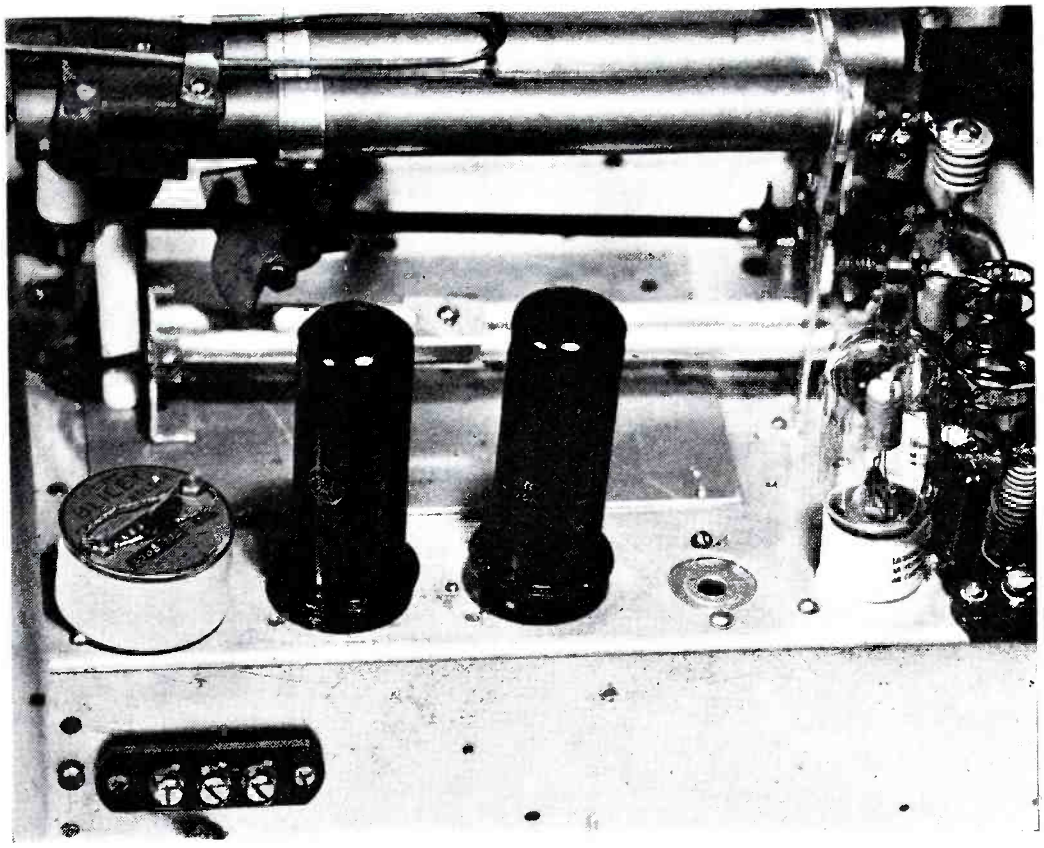


Figure 7
The r-f section of the 225.6 mc a-m transmitter. Note the hairpin coupling loop above copper plate lines, that are above aluminum cathode lines.

ing antenna. Without utilizing the reflection from the tree, communication could not be carried on between WEMV and WAAI, but the reflected signal was strong enough for a successful relay.

On another occasion, at the Cleveland Airport, a signal was reflected from a hangar wall with better results than over a direct path. Not all obstacles to signal transmission are overcome by bouncing a signal from a convenient object, however.

The author has had interesting experiences with a 10-watt 225.6 mc crystal controlled a-m transmitter. With the cooperation of H. A. Caskey, NBC engineer, tests were conducted over a five-mile North and South path, after six months of successful communication with William Riley, 25 miles East, and Samuel Harris, 30 miles West. The Eastern path was to much higher ground, while the Western path was along the shore of Lake Erie, partly over water. Mr. Riley and Mr. Harris have operated amateur stations W8GGA and W8UUS, respectively, for a number of years and have engaged in many u-h-f tests.

Mr. Riley and Mr. Harris used *Krause square-corner* horizontal antennas. Mr. Riley's antenna was 18 feet high, later raised to thirty feet. It was aimed West. Mr. Harris' antenna was forty-feet high, aimed East. Mr. Caskey used a three-element horizontal antenna, with twenty-five and thirty-five feet heights, aimed North. The author used a three-element horizontal antenna, thirty feet high for East and West transmission, and then a forty-feet high antenna for North and South transmission.

Mr. Riley's directional antenna was located on a second floor back porch, but on the wrong side of the house, as shown in Fig. 5. The signal followed a twenty-five-mile optical path except for the bulk of Riley's frame house. Moving the antenna up on a pole above the house showed no noticeable improvement.

Communication with Mr. Harris was carried on, during a terrific thunder storm without static or interference, except for the sparks jumping from the antenna transmission line.

After these experiences over the twenty-five-mile paths, it was reasoned that the five-mile North and South path should easily provide stronger signals. At the Southern end of the path, Mr. Caskey erected his high antenna and installed a receiver. Tests were run. No signals were heard. Examination of topographical maps showed terrain peculiarities, indicated by Figure 6. Mr. Caskey then moved receiver to his car and received excellent signals North of *X*.

After further unsuccessful tests, the height of the author's antenna was increased ten feet, but still no signals could be heard over the five-mile path. Next, the transmitter was moved to Mr. Caskey's location without providing communication with the author's location. With the receiver in Mr. Caskey's car, the signal now could not be heard North of point *X*. Finally, Mr. Caskey's new antenna pole was torn down and a ten-foot extension added. The additional ten feet of height proved to be the answer to communication over the five-mile path. Signals were very strong and reliable, thereafter.

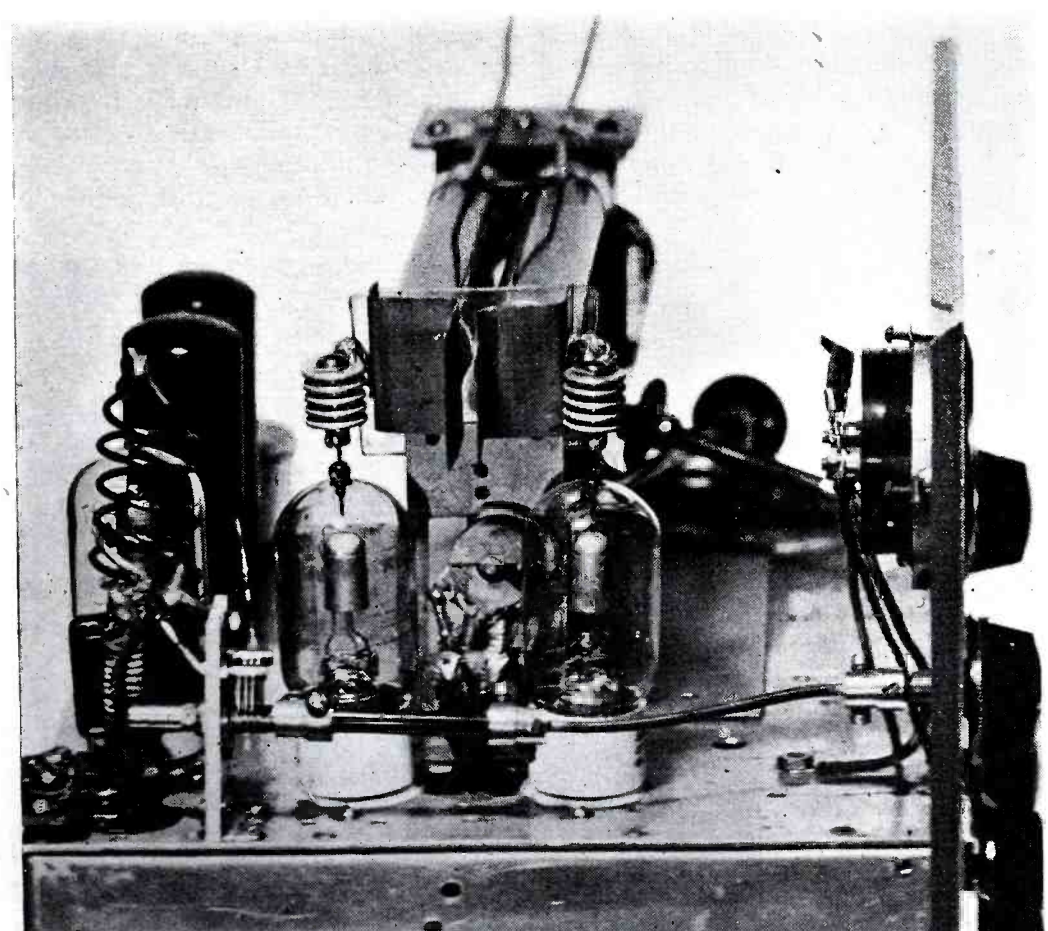


Figure 8
Another view of the r-f section of the 225.6 mc a-m transmitter showing plate tank fins.

PROPERTIES OF

by C. BRUNETTI

Senior Radio Physicist, National Bureau of Standards, Washington, D. C.
Formerly Assistant Professor Electrical Engineering, Lehigh University

AND

J. A. WALSCHMITT

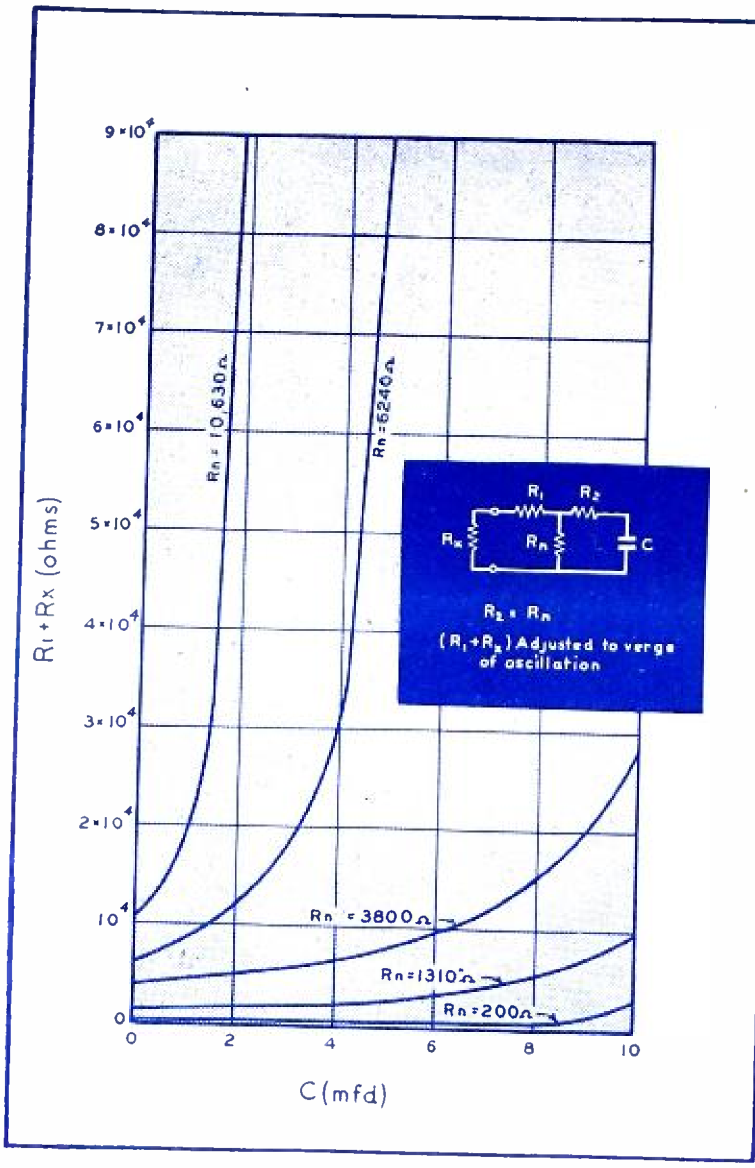


Figure 3

Curves showing the maximum internal impedance (resistance) allowable across negative inductance terminals.

IN 1931 a circuit for obtaining negative inductance was described[1], (Figure 1). This was followed by a patent on it, issued in 1933[2]. While the circuit has appeared in textbooks[3] and has been discussed theoretically in the literature, there has been no indication that it has been tried in the laboratory and its performance characteristics determined. This can be attributed mainly to the fact that the circuit requires a source of negative resistance and in so doing introduces certain practical difficulties. It is the purpose of this paper to describe some of the properties of the circuit of Figure 1, using a transitron[4] as a source of negative resistance, a source which requires only a single vacuum tube.

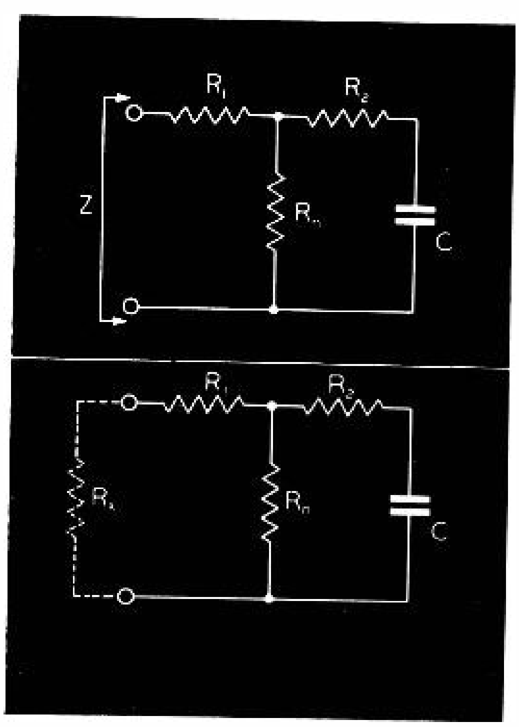
This paper is based on work carried on by the authors at Lehigh University.

Uses of Negative Inductance

A reliable and practical negative inductance may find use in transmission line problems[5], in special networks such as filters and corrective networks, and may lead to obtaining impedances proportional to the *nth* power of the frequency[1] where *n* may be any positive or negative integer.

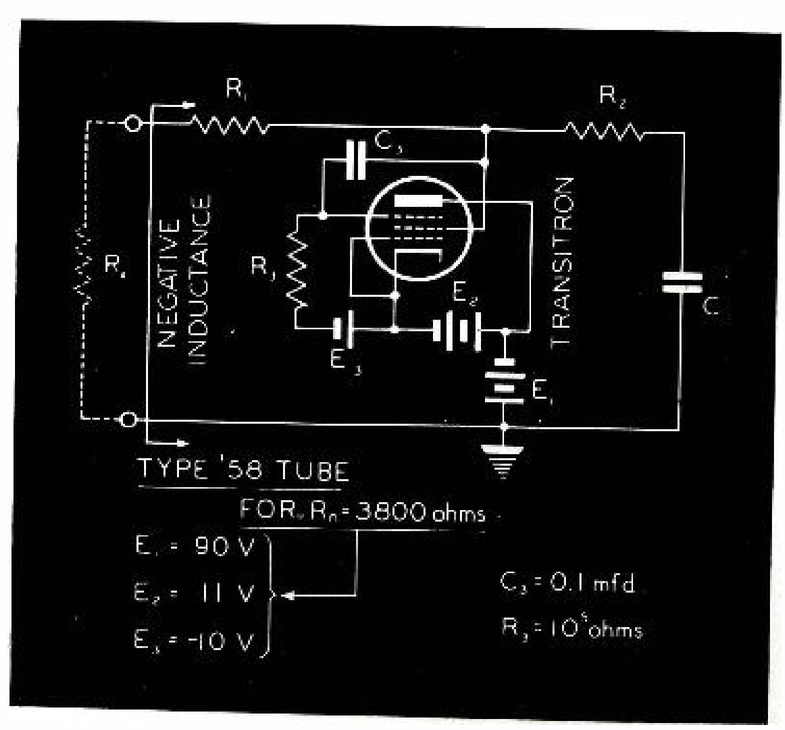
What Negative Inductance Is

Negative inductance is the name applied to a reactive circuit element whose reactance varies as the first power of the frequency but is negative in sign. At any given frequency, therefore, a negative inductance will present the same type of reactance as a capacitor. However, if the frequency is increased, the reactance of the capacitor will decrease in absolute value while that of the negative inductance



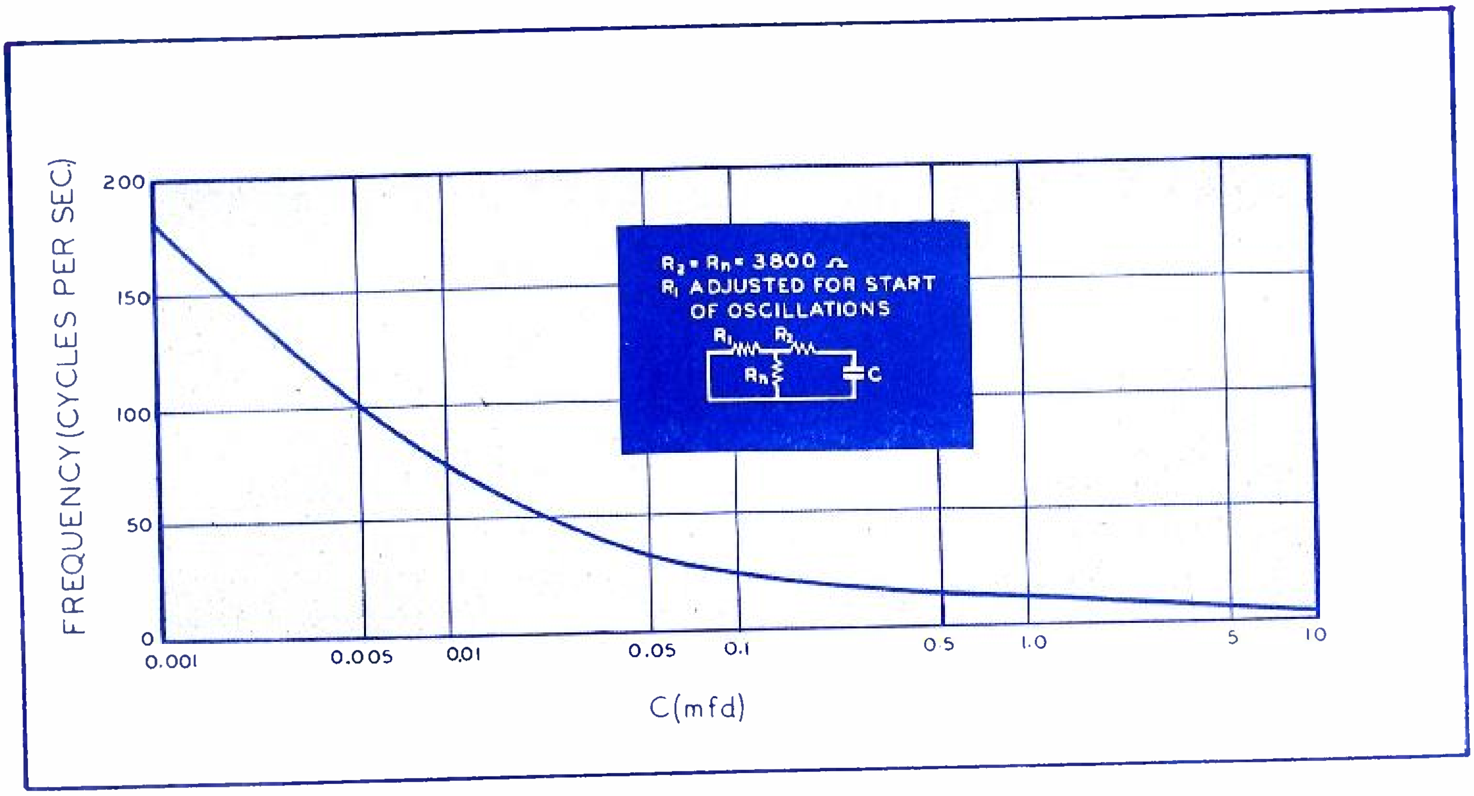
Figures 1 and 2 (left) and 4 (right)

Figure 1 (top, left) shows the negative inductance circuit. In Figure 2 (bottom, left) we have the impedances external to Rₙ. Figure 4 illustrates the use of the transitron as a negative inductance element.



NEGATIVE INDUCTANCE

Circuit Effects Revealed by Transition as Source of Negative Resistance



will increase in absolute value.

Figure 5

The frequency of the relaxation oscillations occurring when $R_{x\,max}$ is exceeded

R_n As A Negative Resistance

Referring to Figure 1, if R_n is a negative resistance of absolute value R_n, the equation for the impedance of the circuit is

$$Z = \frac{R_1R_2 - R_n(R_1 + R_2) - j\,\dfrac{(R_1 - R_n)}{wc}}{R_2 - R_n - \dfrac{j}{wc}} \qquad (1)$$

If the resistances are adjusted so that $R_1 = R_2 = -R_n = R$, the equation simplifies to

$$Z = -j\,R^2wC = jw\,(-R^2C) = jw\,(-L_n) \qquad (2)$$

Equation *(2)* is that of an impedance which satisfies the definition for a negative inductance (L_n) having a value of R^2C henries.

Range Restrictions

It would appear that any desired value of negative inductance could be obtained simply by suitable choice of *R* and *C*. However, the properties of the sources of negative resistance available seriously restrict the range of negative inductance that may be had. The impedance of the external circuit to which the negative inductance is connected, for example, influences the behavior of the latter. To avoid undesired relaxation oscillations which may occur as the result of the presence of the negative resistance element, the impedance of all branches in parallel with the negative resistance, when a transitron is used as a source for the latter, must be less than the absolute value of the negative resistance itself. In Figure 2 the impedance of the R_1, R_x branch in parallel with the R_2, C branch must be less than R_n. R_x is the impedance looking towards the circuit in which the negative inductance is connected. With any fixed value of C, R_x must not exceed a certain maximum value for stable operation. The maximum value of R_x is a function of R_n and may be determined from Figure 3, the data of which were obtained with the circuit of Figure 4. If R_x exceeds this maximum value, relaxation oscillations will occur in the circuit. In Figure 5, we see the frequency of the relaxation oscillations which occur in this case.

Ideal Relationship

It is not always practicable to maintain the ideal relationship $R_1 = R_2 = R_n$ because of the limitations on the magnitude of the external resistance R_x and the physical size of *C* and of the requirement that operation be stable. It is therefore of interest to consider the effect of small variations from the ideal in each of the parameters of equation *(1)* on the impedance *Z*. If R_1 is equal to R_2 but less than R_n, the resultant impedance will not be a pure negative reactance but will contain a positive resistance component. If R_1 is equal to R_2 and greater than R_n, a negative resistance component will appear together with the negative reactance. This is because the value of *C* must usually be kept fairly large in order to insure stable operation. With *C* large, it may be difficult to obtain small values of negative inductance (equation *2*) as the control over the parameters of the circuit is generally limited. Also, when *C* is large or the frequency high, R_2 must be very nearly equal to R_n in order to obtain an impedance which approaches a pure negative reactance. Referring to equation *(1)*

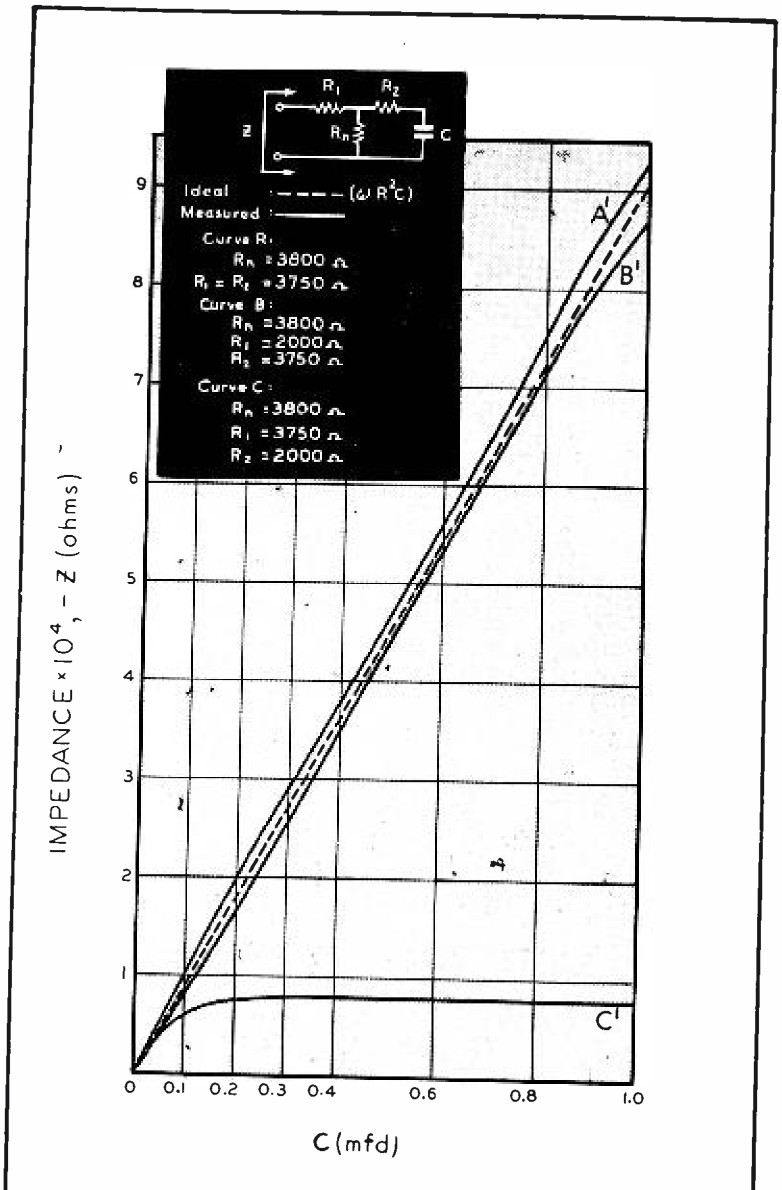
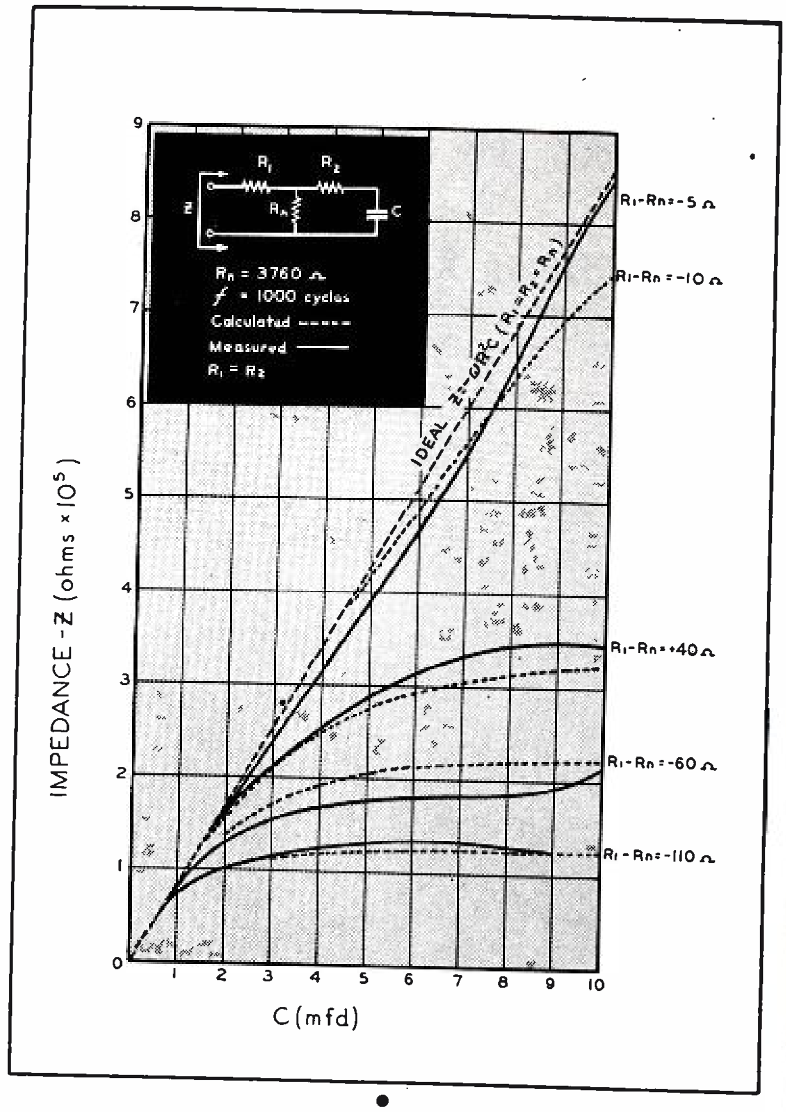
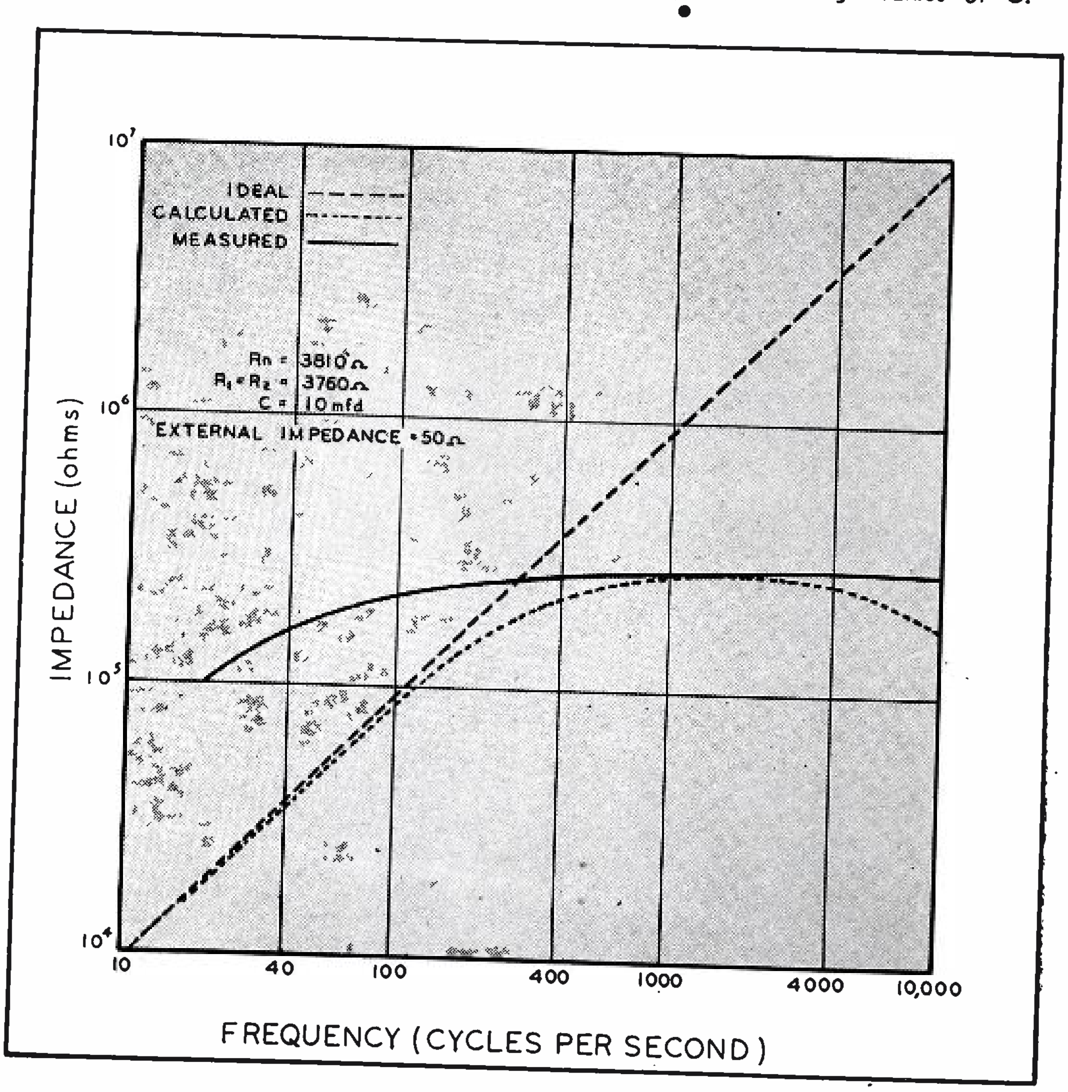


Figure 7
The performance of the circuit of Figure 1, for small values of C.



Figures 6 (top) and 8 (below)
In Figure 6 we have the effect of the quantity $(R_1 - R_n)$ on the input impedance of the circuit of Figure 1. Figure 8 illustrates the frequency response for large values of C.



this means the term $(R_2 - R_n)$ must be negligible compared to $1/wc$. To illustrate how critical this is:

Let

$$C = 10 \text{ mfd}$$
$$R_1 = 3{,}700 \text{ ohms}$$
$$R_2 = 3{,}700 \text{ ohms}$$
$$R_n = 3{,}750 \text{ ohms}$$
$$f = 1{,}000 \text{ cycles}$$

Then,

$$Z = 2.69 \times 10^5 \,\underline{|-17.6^\circ}\ \text{ohms}.$$

Parasitic Oscillations

In this case a difference of only 50 ohms, or 1.3%, between R_2 and R_n results in an almost pure negative resistance rather than a pure negative inductance.

It is easier to approach a pure negative inductance if the condenser *C* is made small. If this is done, however, the circuit becomes more susceptive to parasitic oscillations and requires more care in design. It is also necessary to keep $R_1 - R_n$ small. The magnitude of R_2

Figure 9
The frequency response for medium values of C.

is not critical. To illustrate:

Let

$C = 0.1$ mfd
$R_n = 3{,}800$ ohms
$R_1 = 3{,}750$, $(R_1 - R_n = -50)$ ohms
$R_2 = 3{,}600$ ohms
$f = 1{,}000$ cycles

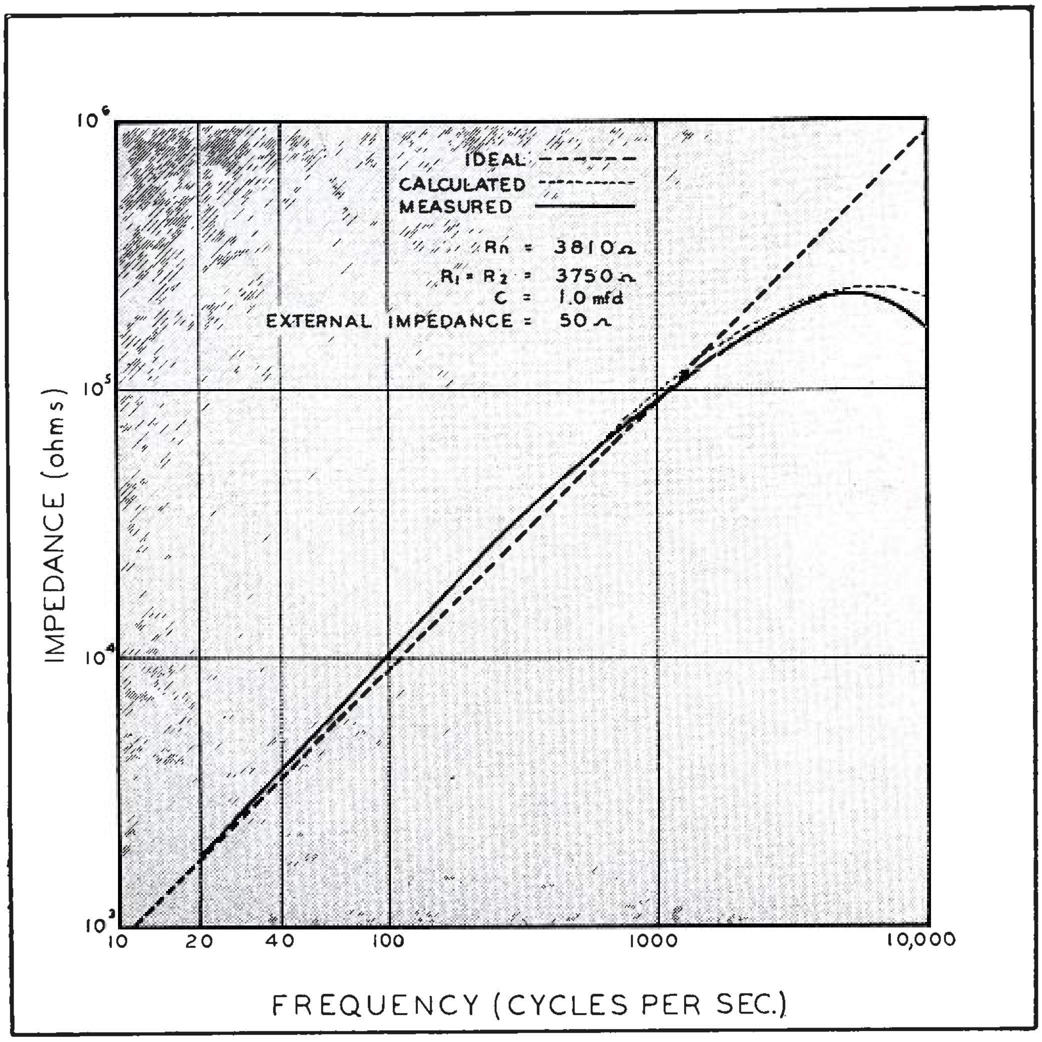
Then,

$$Z = 0.88 \times 10^4 \underline{|-88.2^\circ} \text{ ohms},$$

which is practically a pure reactance.

It is apparent, therefore, that in order to obtain a pure negative inductance, the magnitudes of the quantities $(R_1 - R_n)$ and $(R_2 - R_n)$ must be closely controlled with special cases requiring that either one or both be kept small. This makes it necessary to use a source of R_n that remains constant with time and usage and to know the magnitude of R_n accurately.

The performance of the circuit of Figure 1 is illustrated in Figure 6. The capacity *C* was varied, and the impedance looking into the circuit was obtained by measuring the voltage across the input terminals and the current into the circuit. The latter was determined by the voltage developed across the resistance, R_1. This method was followed in obtaining the data of



Figures 6 to 12 inclusive. A second method, which allows measurement of the phase angle also, is described later. The straight dashed line indicates the theoretical condition where $R_1 = R_2 = R_n$ and represents a perfect negative inductance having no resistive component. With a capacity (*C*) of 1.0 mfd, the theoretical negative inductance is 13.5 henries.. The solid curve for which $R_1 - R_n = -5$ ohms closely approaches this ideal condition. The remaining curves show a comparison between the calculated impedance and the measured impedance for various differences in R_1 (and R_2) from R_n. The curve for which $R_1 - R_n = +40$ ohms represents an impedance having both a negative inductance component and a negative resistance component.

Straight Line Relationship

As these curves were obtained with fairly large values of capacity, a slight difference in R_1 (and R_2) from R_n results in large deviations from the ideal straight line relationship. This large capacity also yields high values of negative inductance which are not always as useful as the lower values. In Figure 7 we see how much less sensitive the circuit is to differences of R_1 from R_n when small values of *C* are used. Curve A^1 illustrates a case where $R_1 = R_2$ and the difference between them and R_n is 50 ohms. The approach to the ideal is seen to be very close. Curve B^1 illustrates how insensitive the circuit is to variations in

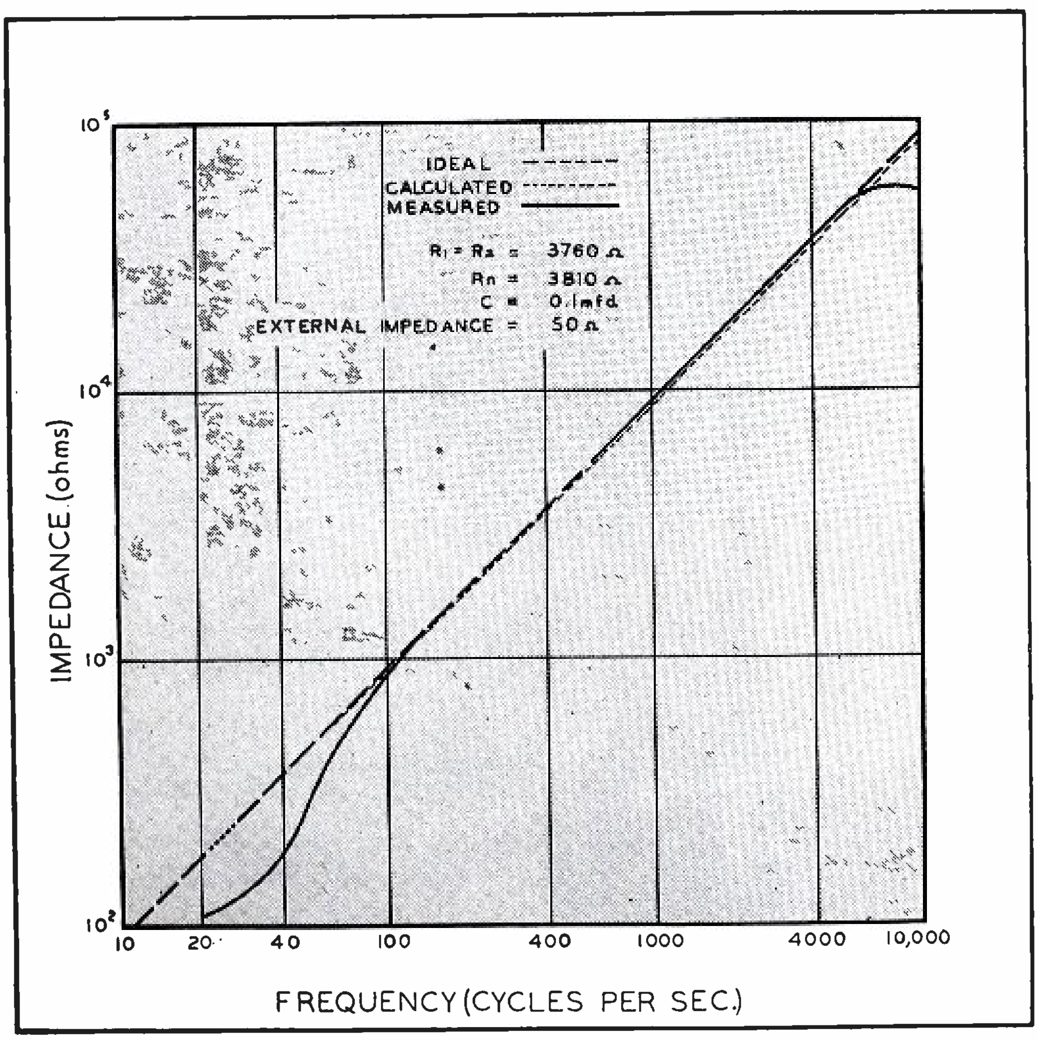
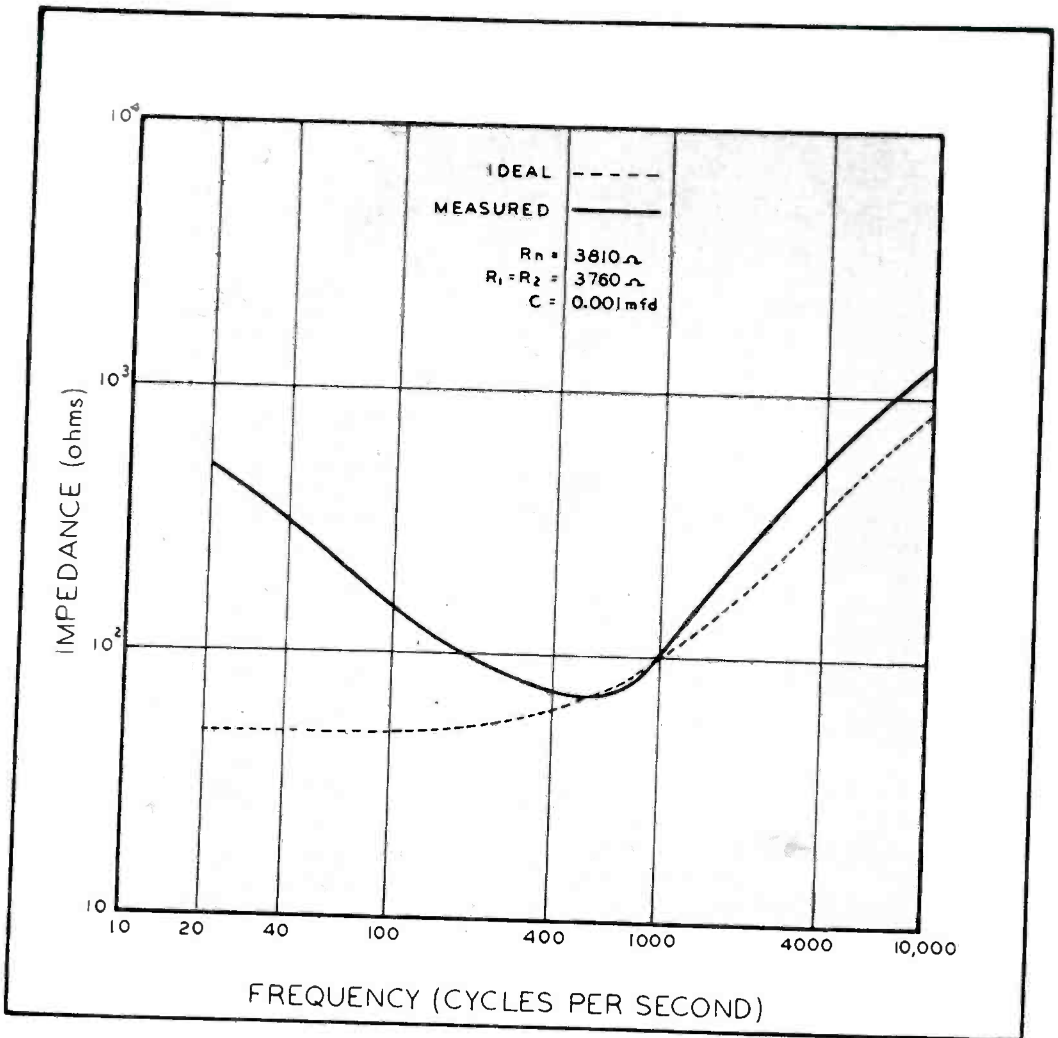
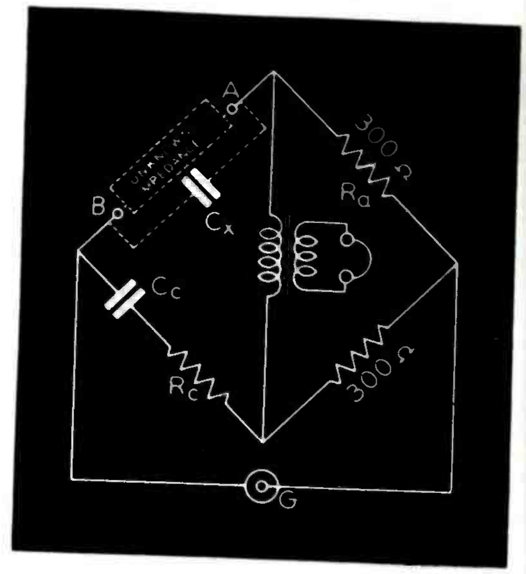


Figure 10
The frequency response for small values of C.





Figures 11 (left) and 13 (top)
In Figure 11, we have the effect on the frequency response when C is made too small. Figure 13 shows the bridge used for measurement of resistive and reactive components.

R_1. Curve C' shows the serious effect of a large difference between R_2 and R_n.

Approach To Ideal

The impedance of the circuit of Figure 1 as a function of frequency is seen in Figure 8 which shows the effect of small differences in R_1 (and R_2) from R_n when *C* is large. A considerably better approach to the ideal negative inductance is seen in Figure 9 which was obtained with *C* reduced to 1 mfd. Here, as in Figure 8, the greatest deviation from the ideal occurs at the high frequencies. A value of *C* of 0.1 mfd gives an even closer agreement as shown by Figure 10. However, if *C* is made too small, Figure 11, the frequency response again becomes critical to differences in R_1 (and R_2) from R_n. In this case the greatest deviation from the ideal occurs at the low frequency end. This is because the term $(R_1 - R_n/wc)$ is no longer negligible when compared to $R_1 R_2 - R_n (R_1 + R_2)$ in equation *(1)*, a condition which must be fulfilled for ideal results.

Large Variations In R_1

Curve *A*, Figure 12, illustrates the effects of very large differences in R_1 (and R_2) from R_n in a circuit having a capacity of 0.1 mfd. The agreement with the ideal is very poor at both the high and low frequencies. Curves *B* and *C* show the effect of each of R_1 and R_2 respectively, on the impedance as a function of the frequency. The disagreement with the ideal is explained by the fact that the term $(R_1 - R_n/wc)$ of equation *(1)* is again not negligible at the low frequencies when R_1 differs considerably from R_n. Likewise, when R_2 differs considerably from R_n, the term $(R_2 - R_n)$ is not negligible compared to $1/wc$ at the high frequencies.

To measure more accurately the (*Continued on page* 84)

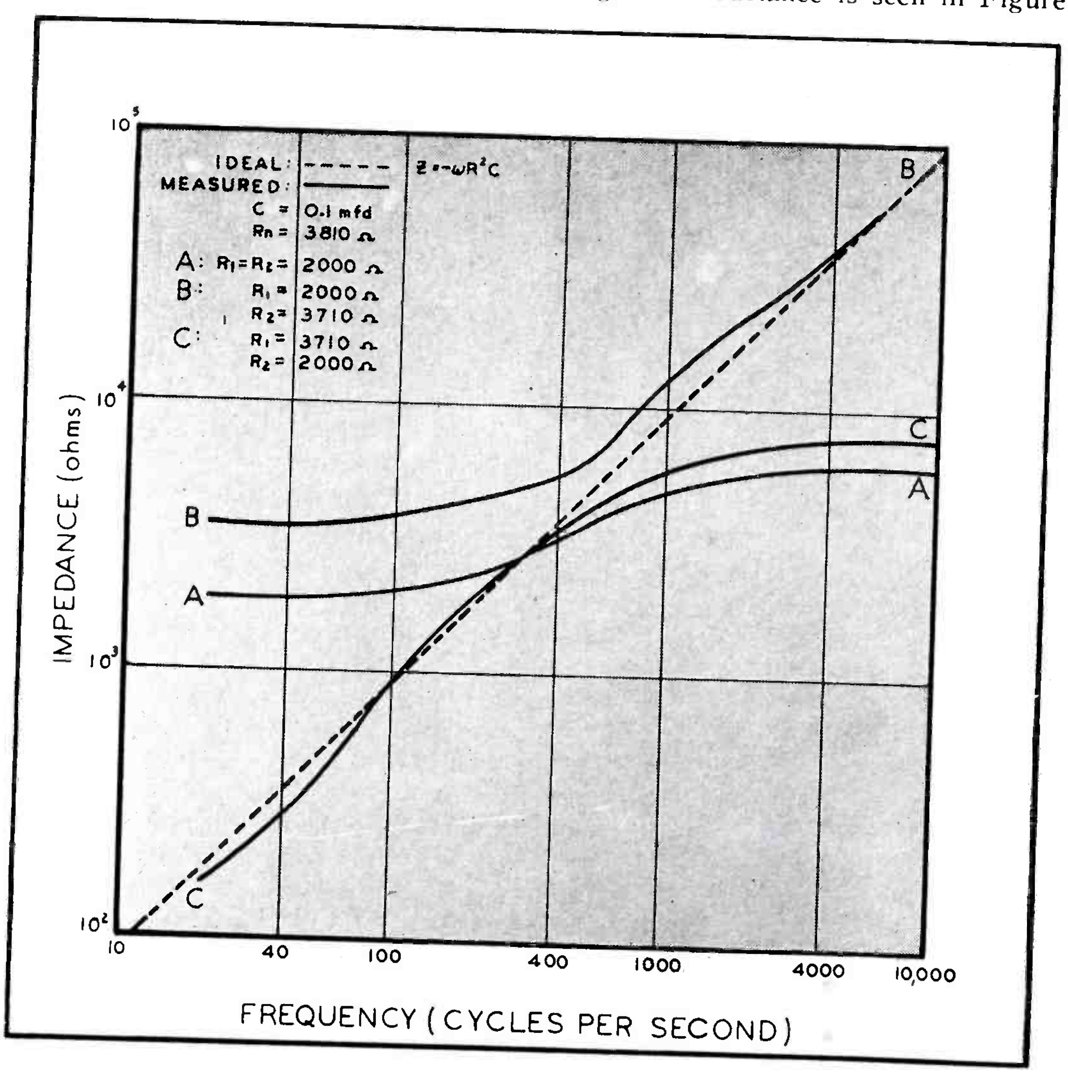


Figure 12
The effect on frequency response of large differences in R_1 (and R_2) from R_n.

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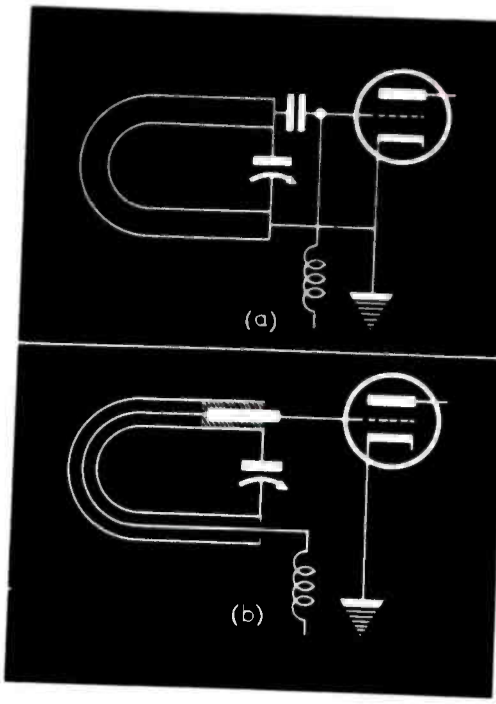
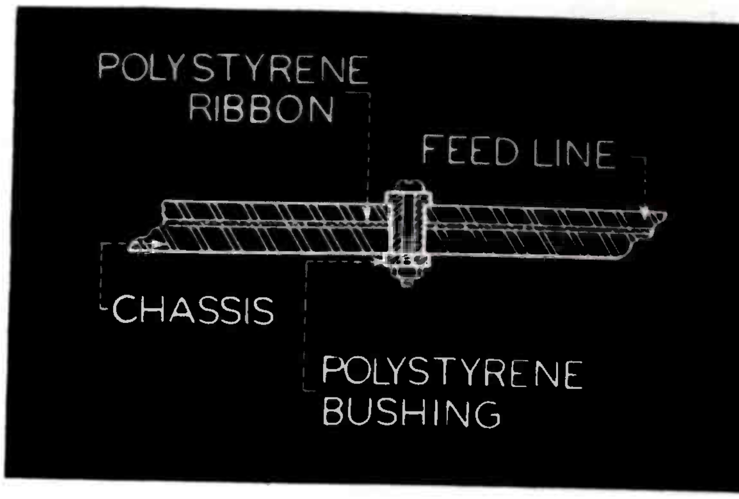


Figures 1 (left) and 2 (right)
In Figure 1, *A* we see a shunt fed u-h-f input circuit; *B* shows the mechanical adaptations applied to the circuit *A* to reduce contact resistance. A cross-sectional view of a typical voltage feed line, is shown in Figure 2.



U-H-F DESIGN

by ART H. MEYERSON
New York Fire Department Radio Laboratory

To insure continuously good results of u-h-f equipment, special attention must be paid to certain inherent properties of the circuits used. Such factors as contact resistance, circuit stability, tuning methods, circuit Q, tube admittance, shielding, and coupling, while important at lower frequencies, take on added stature at u-h-f. In addition, the writer has found that the efficiency of u-h-f equipment declines rapidly with use. The discussion that follows will review these factors, both in the experience of the writer and other investigators.

Contact Resistance

It would be impossible to review each factor by itself, since one bears an important relationship to the others; for example, contact resistance. This is an important factor in u-h-f design for continuously good operation. It has been determined that flat surface contacts of copper, silver-plated, give good results, provided the surfaces are smooth and even. Better contact, with no apparent deterioration, is made possible by silver soldering. The ordinary type of lead solder sets up points of high r-f resistance. This, of course, applies only to those points where r-f is present, and not to feed circuits.

Reduction of Points of Contact

In all units constructed by the author, circuits were so designed as to reduce the number of points of contact necessary to complete that circuit. In Figure 1 *A* is shown a schematic diagram of a portion of an r-f circuit. It consists of a circuit element, in this particular case a resonant line, capacitive coupler between the tube and the circuit element, and a r-f choke for shunt feed. To increase efficiency, a lead was silver soldered to a slug. This formed one side of the capacitive coupler to the resonant line. After inserting the slug into the resonant line, properly insulated, the lead was brought out at the far end, and formed into a choke. The tube used was of the acorn type. The slug had previously been silver soldered to a tube contact, which was then assembled on the tube socket. All parts were silver plated. (See Figure 1 *B*.)

This leads to several important points. Copper tubing will form an oxide coating after several months use. It has been found that this oxide coating causes a serious loss in circuit Q, probably due to its rectification characteristic. One method used to prevent this oxidation is to coat the copper parts with enamel or lacquer. While this is effective, it is impractical. An easier method is to silver plate all components.

Cylindrical Condensers

In u-h-f work cylindrical condenser construction has been found superior to ordinary mica condensers. For one thing, connection to both ends of the same plate of the condenser is possible, thereby permitting the r-f to flow across the condenser. Where used as a bypass, the inductive reactance is reduced, and a continuous ground plane is achieved. This is a particular advantage for filament and *B* leads, where the source is some distance from the tube elements.

A similar technique involves the use of the chassis as one side of a condenser for feeding the aforementioned filament and *B* circuits (Figure 2). Here a flat metal strip, insulated from the chassis with polystyrene ribbon, is used as a voltage feed for these components. The effect is equivalent to the cylindrical type of construction.

Tuning at U-H-F

Probably the most difficult problem at u-h-f is a satisfactory method of tuning. Ordinary tuning condensers are not feasible since they offer high resistance paths to the flow of u-h-f current. Pressure contacts develop noise very quickly and also create points of r-f resistance. The lead lengths become increasingly important as frequency of operation increases, and minute adjustments cause correspondingly large changes in frequency.

To secure micrometer adjustment of capacity, a tuning method devised by the CAA in the construction of u-h-f aircraft equipment, was adapted to resonant lines by the author (Figure 3). This tuning condenser depends on a differential thread between points *A* and *B*, for micrometer adjustment of the condenser plate *C*. The two bars *D* and *D'* are recessed into the resonant lines to prevent plate *C* from turning. They are spring-loaded for rigidity. To overcome noise which developed after several months of use, and which was traced to the bars rubbing against the lines, polystyrene sleeves were inserted in

U-H-F PRACTICE

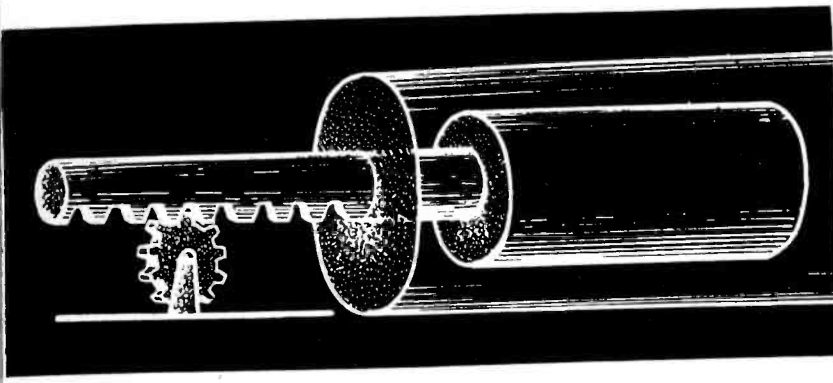


Figure 4
Rack and pinion method of frequency control. This method is used for filament or inductive tuning on the very highs. This diagram has been exaggerated to show construction. Actually the slug is tightly fitted to the tube.

FACTORS

the lines where the bars entered and flexible leads (E and E') were silver soldered from the lines to the condenser plate. This method is excellent for covering a small band of frequencies. By making the inner thread thirty-six to the inch, and the outer, thirty-two to the inch, an advance of .0035″ per 360° rotation, was attained.

For covering a wider frequency band, the use of ceramic trimmers is recommended, provided a short flexible lead is soldered to the movable plate and used as a contact point in place of the regular eyelet type contact. The two methods mentioned may be combined, providing a large frequency coverage with vernier adjustment.

Folded Resonant Lines

Incidentally, resonant lines may be folded, to reduce space occupied without materially affecting their operation. The only rule to follow here is that it be folded in the greatest semicircle possible for the length of line used.

A third tuning method used, employs the cylindrical type of construction in conjunction with a rack and pinion, Figure 4. This type of construction is particularly adaptable to stub tuning, as exemplified in the Barrows oscillator. It is also used at frequencies above 1,000 megacycles in hollow wave guides.

Where straight concentric lines are used as circuit elements, the tuning condenser shown in Figure 3 is used at the open end, as shown in Figure 5. Folded concentric lines are preferred, however, since they require less space and are more adaptable to use as circuit elements (Figure 6 *A*). One method of tuning is to use a vane mounted as shown in Figure 6 *B*. By rotating the vane through 90° the capacity between the inner and outer lines is increased or decreased. Another method provides for the use of a polystyrene cylinder which can be inserted between the inner and outer cans to reduce the dielectric constant of the condenser formed by these, as shown in Figure 6 *C*. The latter method has the added advantage of increasing the ruggedness of construction. In still another method a pair of spring copper leaves are silver-soldered to the outer tube and adjusted by means of the screws marked *A* and *B* in Figure 6 *D*.

T Bars Above 500 MC

For frequencies above 500 megacycles, *T* bars can be used with excellent results, Figure 7. Two flat discs are insulated from the table top of the *T* bar. The tube mounts directly on these discs, and the plate and grid are shunt fed from a point furthest from the tube elements on the discs. Tuning is accomplished by the method shown in Figure 3.

Frequency Stability

Frequency stability is difficult to attain at u-h-f. Variations due to temperature changes give the greatest trouble. Since temperature rise is a function of cabinet or case construction, ventilation, and layout, there are no hard and fast rules. If a tuning condenser with a negative temperature coefficient were used, it would be impossible to previously determine how much heat was acting on it at the point where it was mounted. In addition, the condenser would have to react as quickly to the increase in temperature, as the part for which the compensation is intended; otherwise the frequency would drift first in one direction and then the other.

However, temperature compensating devices may be constructed to give operation comparable to crystal control.

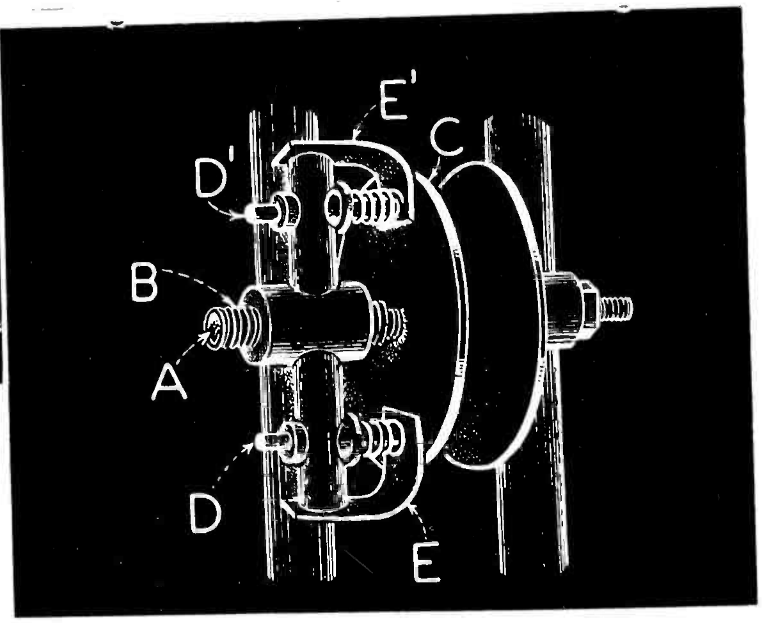


Figure 3
A cross-sectional view of a tuning arrangement for tuning resonant lines. The differential screw on the left permits micrometer adjustment of capacity, while the straight thread on the right plate allows wider variations of frequency.

All u-h-f circuits usually drift down in frequency, for length of operation. Therefore, most compensating devices must cause a decrease in either capacity or inductance. Where resonant lines are used, mounting the open end on polystyrene will cause a decrease in inductance. For with heating, the polystyrene will expand, increase the spacing between the lines, and thereby decrease the inductance.

Frequency Control

Another frequency control method is that shown in Figure 8. As the heat increases, the polystyrene rod expands, withdrawing from the lines and increasing the dielectric constant. Its effectiveness can be increased by mounting it closer to the hot end of the line. This method has an additional asset in that it can also be used for fine frequency control.

For stability in concentric lines, metals with variant coefficients of expansion, such as copper, brass, bronze and aluminum are used for the inner and outer lines. By constructing the line so that copper is used for the inner conductor and brass or bronze for the outer, a negative coefficient of expansion is achieved. The method shown in Figure 8 *B* was used for negative temperature compensation of the tuning method shown in Figures 3 and 7.

Coupling

Coupling between the tube elements and the circuit elements plays an im-

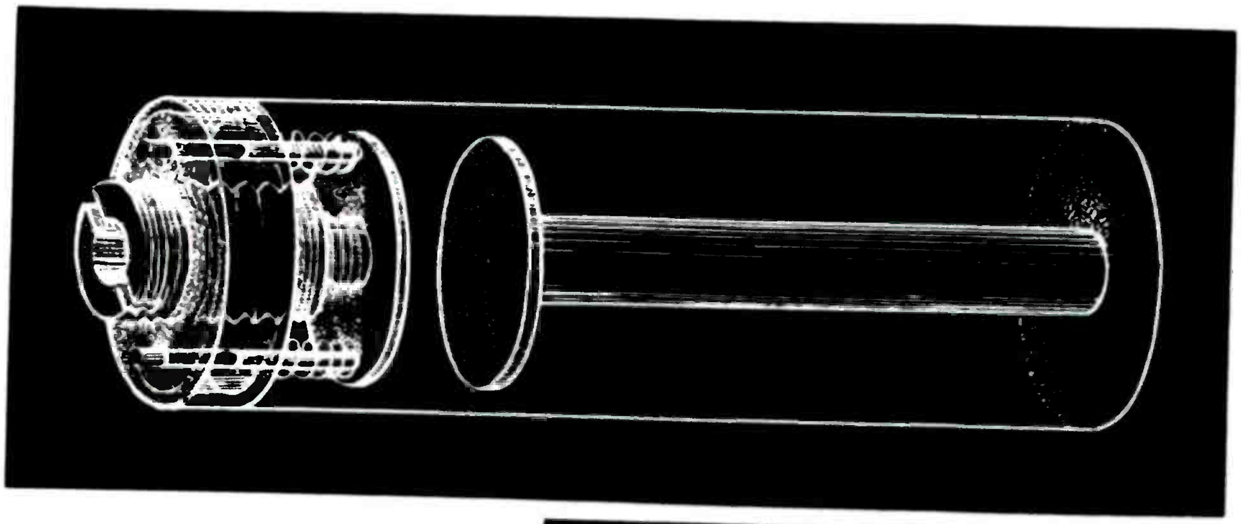


Figure 5

This tuning method is the same as that shown in Figure 3, adapted to concentric lines. Adjustment of the differential screw permits fine frequency control of the concentric lines.

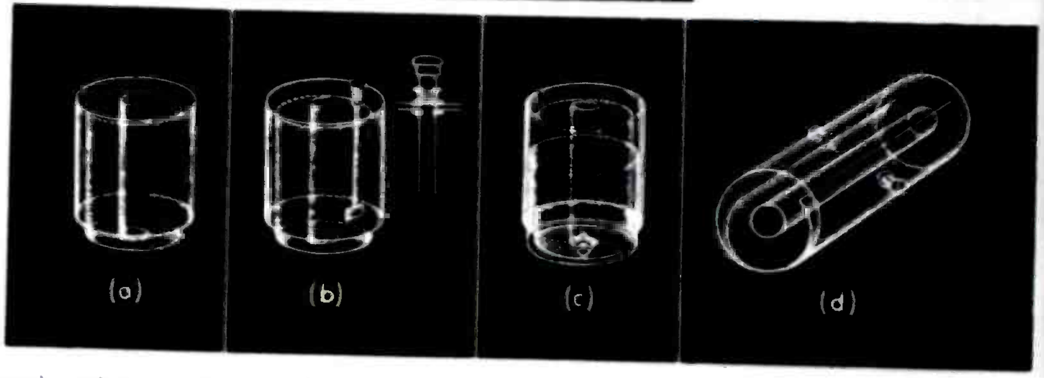


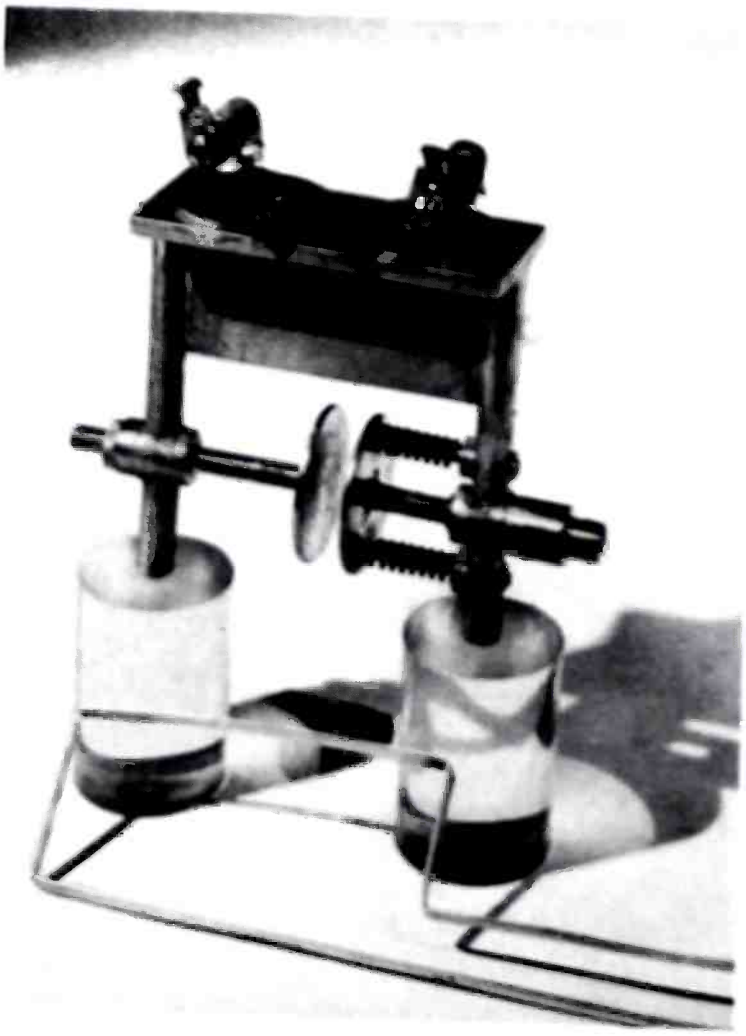
Figure 6

A conventional folded line is shown at *A*. *B*, a method of tuning a folded line with a vane inserted between inner and outer elements. Rotation of this vane through 90° varies the capacitive reactance. *C*, another method of frequency variation through variation of dielectric constant between folded portion of inner and outer line. By turning screw in bottom, polystyrene tube is advanced between these elements. *D*, still another tuning method for concentric lines. Turning two screws on outer element advances two spring leaves attached to it toward the inner line, decreasing characteristic surge impedance.

portant role in frequency stability. Tapping down on the circuit element is one method of reducing the loading effect of the tube admittance. Another is to decrease the value of the coupling capacitance between the tube and the circuit element where shunt feed is used. Care must be taken, however, not to reduce the coupling to too low a value. In the case of capacitive coupling sufficient capacitive reactance may be introduced into the circuit to materially reduce the voltage developed across the tube input.

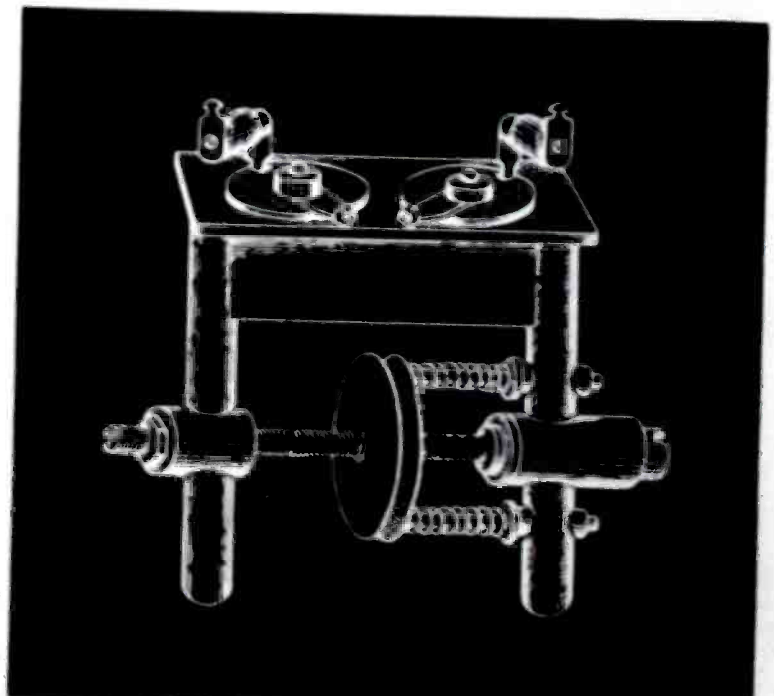
Shunt feed is preferred to series feed at u-h-f, since it reduces temperature effects on circuit elements. In addition, it will generally be found that shunt feed adapts circuits more readily to compactness. This is essential in u-h-f construction. The losses introduced by shunt feed are negligible when compared to those due to low tube-input admittance. The latter is a function of tube construction, and the only recourse is the use of tubes specifically constructed for u-h-f.

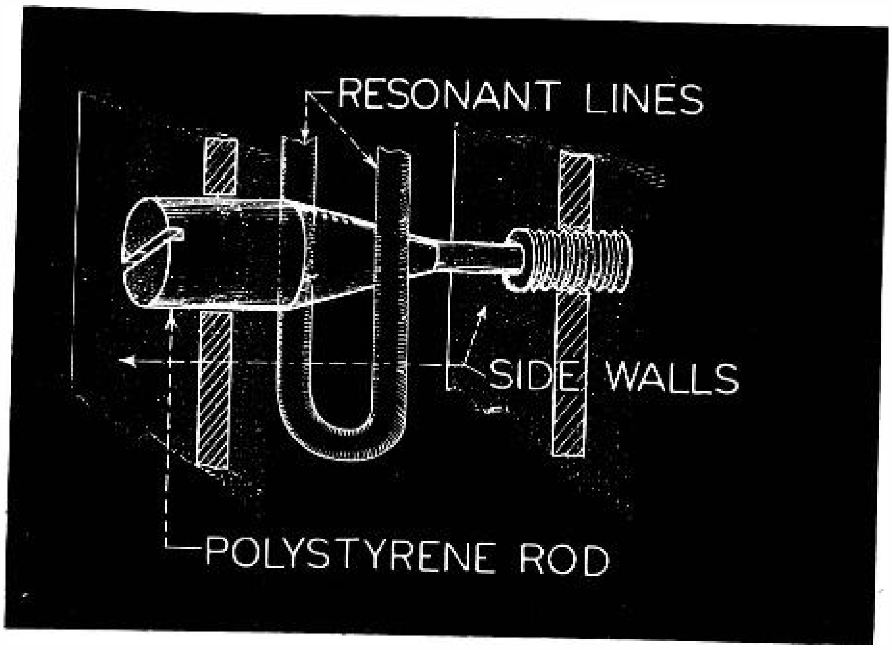
Circuit *Q* is a prime factor in u-h-f design. The losses in ordinary coils coupled with their inherent capacity

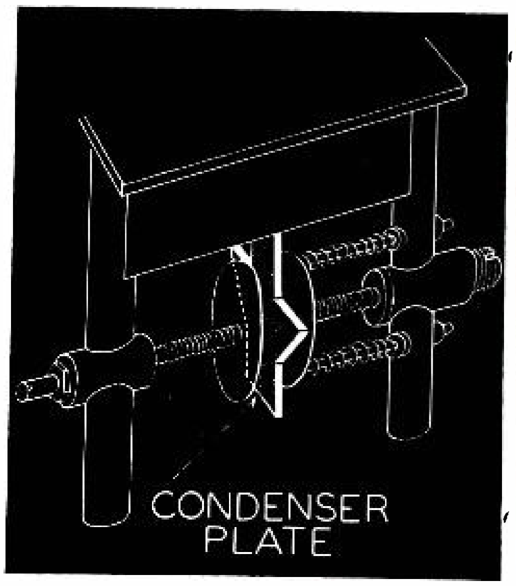


Figures 7 (below) and 7A (left)

Figure 7, a *T* bar used as a circuit element. Note tuning method which is the same as that shown in Figure 3. Bringing the two top plates, which are shunt fed, closer together results in decreased tube loading on the circuit element. At left is a constructed *T* bar unit, with a coupling loop.







Figures 8*A* (left) and 8*B* (top)
Figure 8*A* shows a method of temperature compensation for resonant lines. Any increase in temperature results in a withdrawal of the polystyrene rod, since one end is firmly attached to the case wall on the screw side, and is a slide-fit on the opposite wall. Figure 8*B* shows a similar method applied to the tuning arrangement for the *T* bar.

precludes their use. Strict attention must be paid to such factors as the size of conductor and spacing in both resonant and concentric lines. Reukema has shown that the ordinary formulae for resonant and concentric lines neglect radiation resistance and therefore materially affect optimum operating characteristics. For maximum Q, when radiation resistance is included for resonant lines, the ratio is $D/r = 6.186$, where D is the distance between centers and r is the radius of the conductor. For concentric lines the ratio is $b/a = 4.22$, where b is the outer conductor radius and a the inner conductor radius. For maximum impedance, corresponding values are $D/r = 20.96$ and $b/a = 14.3$. Further, the radii vary with frequency.

Another factor in determining the radii is the percentage of line length used in proportion to frequency of operation. The formulae used is:

For shorted parallel lines designed for maximum Q

$$D \text{ optimum} = \frac{.134\,\lambda^{5/6}}{\sqrt[6]{\dfrac{\lambda}{x}\left(\dfrac{80 + F}{1 + S}\right)}}$$

where λ = wavelength in cm.

$$S = \frac{\sin 2\beta x}{2\beta x}$$

$$\beta x = \frac{2\pi x}{\lambda} \text{ where } \frac{x}{\lambda} =$$

ratio of line length to wavelength.

$$F = 120\left[\frac{1}{3} - \frac{2}{Y^2} + \left(\frac{1}{3} + \frac{1}{Y^2}\right)\sin^2 Y + \frac{1}{Y^3}\sin 2Y\right]$$

$$Y = \beta x$$

For 1/8λ $F = 15.84$
$S = .6366$
For 1/4λ $F = 31.37$
$S = 0.$

For shorted concentric lines designed for maximum Q,

$$b \text{ optimum} = \frac{.14051\,\lambda^{0.9}}{\sqrt[6]{\dfrac{\lambda}{x}\left(\dfrac{J}{1 + S}\right)}}$$

where λ = wavelength in cm.

$$S = \frac{\sin 2\beta x}{2\beta x}$$

$$\beta x = \frac{2\pi x}{\lambda} \text{ where } \frac{x}{\lambda} =$$

ratio of line length to wavelength

$$J = 120\left[\frac{1}{15} + \frac{1}{Y^2} + \left(\frac{2}{15} + \frac{9}{Y^4}\right)\sin Y^2 - \frac{12}{Y^4} - \left(\frac{1}{Y^3} - \frac{6}{Y^5}\right)\sin 2Y\right]$$

For 1/4λ $J = 13.37$
$S = 0.$

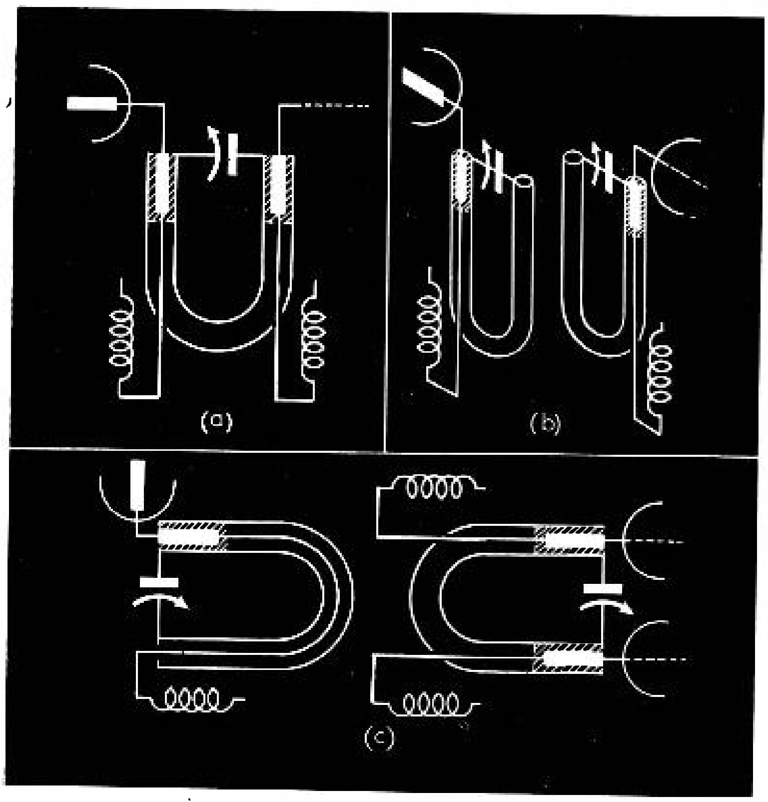
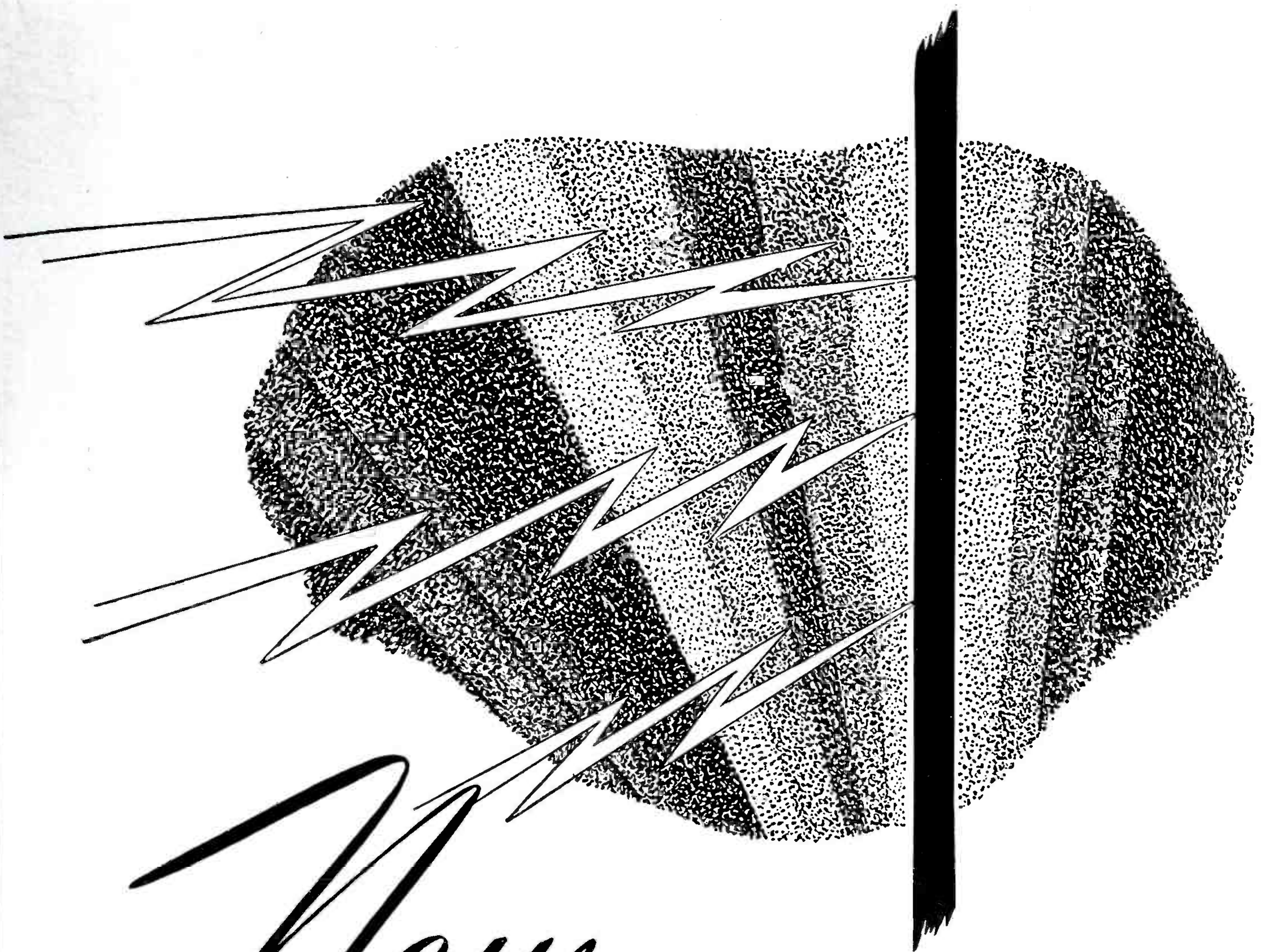


Figure 9
A resonant line used as a circuit coupling element is shown at *A*. *B* shows two resonant lines similarly used for increased selectivity, or where coupled to an oscillator. *C* shows the same elements used for coupling a buffer stage to a push-pull final.

These formulae apply to coupling elements as well, since in most cases, the latter are also circuit elements. Some deviation in conductor size as developed in the formulae is permitted, where non-resonant coupling is desired. For example in antenna coupling in transmitters and receivers, smaller diameters are permitted. However, it would be well to use the factor 6.186



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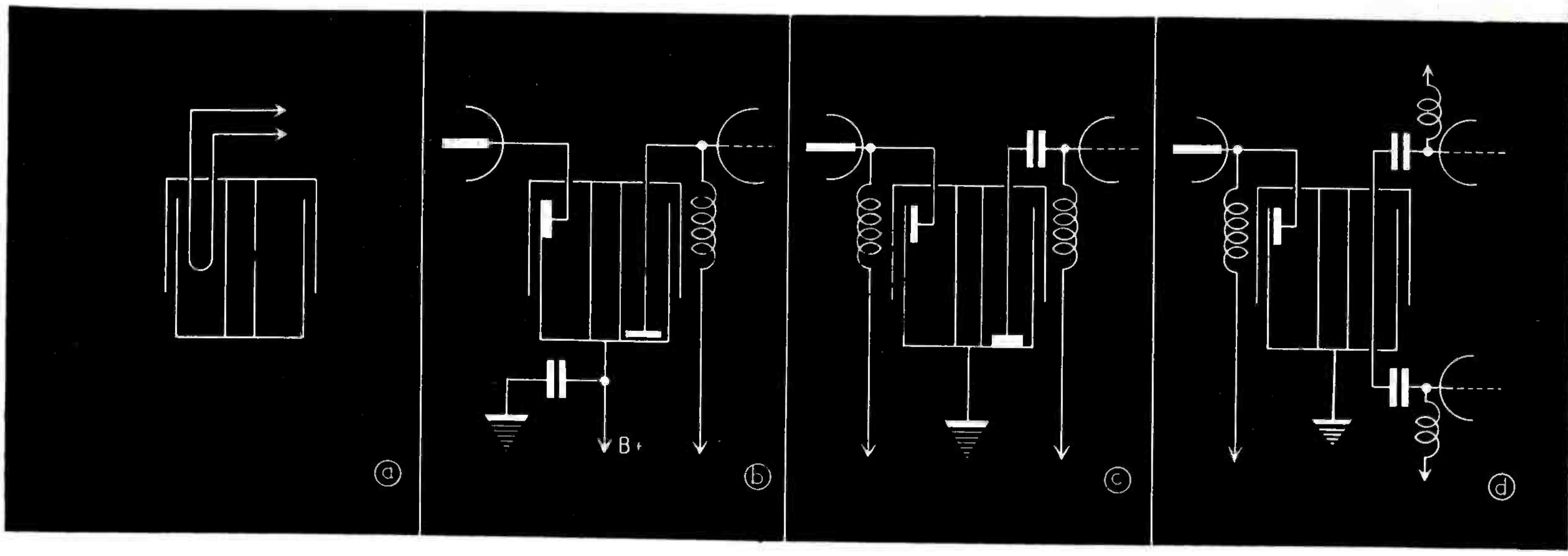


in determining the spacing.

When resonant lines are used as interstage coupling elements, either of two methods may be used. (Figure 9 *A*, *B*, *C*.) In Figure 9 *A*, one resonant line is used to couple power from the plate of the previous circuit to the following amplifier. However, this method cannot always be used, since it may be necessary to couple an r-f stage to an oscillator, as in transmitters or s-r receivers. In this case the circuit shown in Figure 9 *B* is used. This method increases the selectivity since there are two tuned circuits. In Figure 9 *C* is shown how easily resonant lines may be adapted for a push-pull amplifier.

Concentric Lines As Coupling Elements

Concentric lines present a greater problem as coupling elements. The r-f field in a concentric line lies between the inner and outer conductors. When coupling to an antenna, the method shown in Figure 10 *A* is used. This consists of a hairpin loop inserted about halfway between the inner and outer conductor. When used as an interstage element, the methods shown in Figure 10 *B* and *C* are used. In Figure 10 *D* is shown a method used for push-pull. A method for coupling from a *T* bar unit, is shown in Figure 11.

Shielding

Shielding at u-h-f differs slightly from that at lower frequencies. Nonferrous metals are preferred, since the greatest problem is the prevention of the building up of r-f voltages between widely separated points on the chassis. One method used to overcome this is double shielding, or one shield inside of another. Where possible, the use of concentric units is recommended, since there is very little radiation from the outer conductor.

Figure 10

A simple method of coupling to concentric or folded lines is shown at *A*. A hairpin loop is inserted between the inner and outer elements. *B* shows concentric line used as a circuit coupling element with the element at d-c potential. *C* shows the same element at ground potential. *D* shows the adaptation of a concentric line to a push-pull circuit.

Coupling Between Oscillator and Output

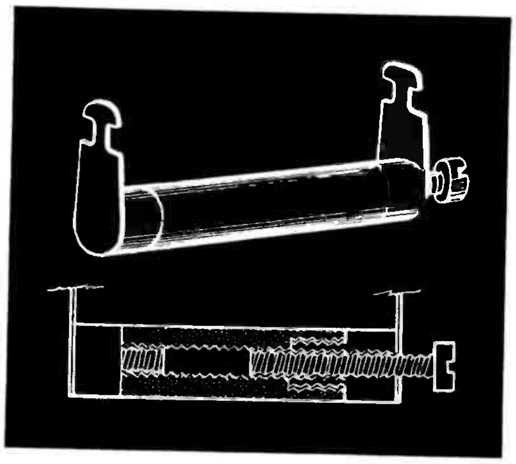
Coupling between oscillator and output stages, with accompanying feedback will result, unless input circuits are well shielded from output circuits. This point is mentioned here because of the necessity of almost airtight shielding between these circuits. In the matter of neutralization, where triodes are concerned, a neutralizing capacitance with low capacity, shown in Figure 11, may be constructed. This consists of a section of threaded polystyrene rod, capped at one end, with a screw insert at the other, the two ends connected between the grid and plate of the tube. This type of construction is necessary since values ranging between 1.5 and 3 mmfd are usually necessary for compensation in u-h-f triodes.

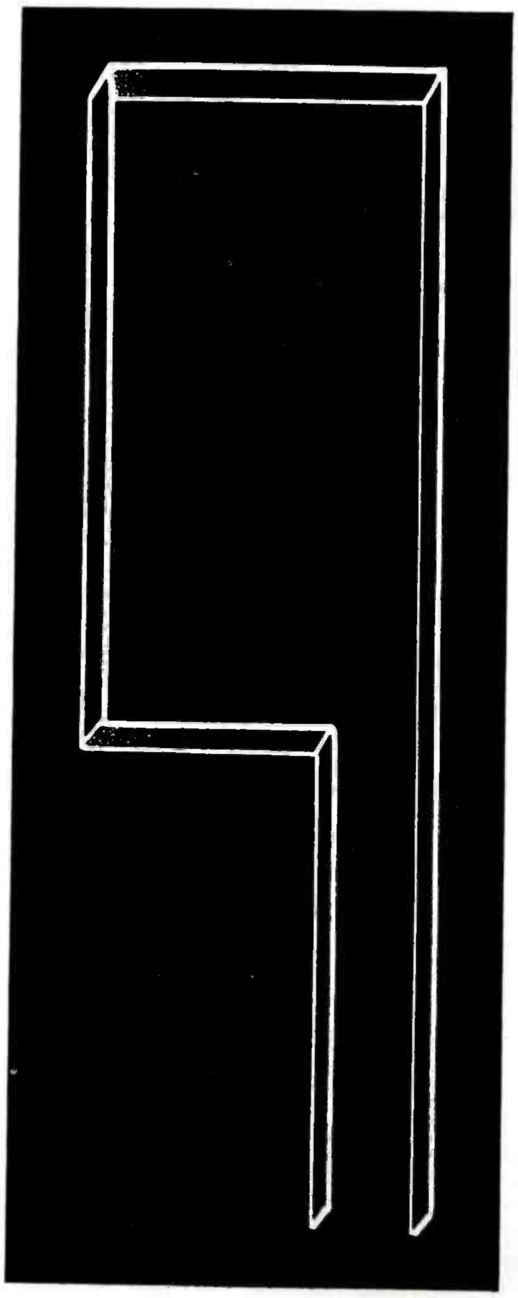
Mechanical Engineering A Requisite

Many improvements in the mechanics of construction at u-h-f are still to be found. Mechanical engineering must be used to solve many electrical problems. And a true appreciation of the action of u-h-f waves is necessary to accomplish this.

Another point is the problem of re-

(*Continued on page* 70)





Figures 11 (right) and 12 (left)

Figure 11 shows method of coupling to a *T* bar. The loop is framed around the edge of the table top and insulated from it (see page 22). Figure 12 illustrates a neutralizing condenser.

FROM "HAM" TRANSMITTER RIGS

TO INTER-PLANE COMMUNICATION

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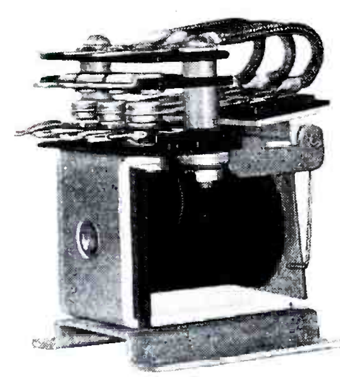
★ Today they are off the air . . . voices stilled . . . home-built rigs carefully covered. For most of yesterday's "hams" are lending their experience, knowledge, and ingenuity to the war effort . . . creating and perfecting new communication devices . . . the amazing new flight recorder, for instance . . . or Radar. But whether they work in a wartime lab or have their "office" in a Fortress, they are still close to one of their early friends—"Relays by Guardian".

One of the newer developments is a multi-purpose aircraft radio relay pictured at the right. It is built in contact combinations up to three pole, double throw. Coils are available in resistances from .01 ohm to 15,000 ohms. At 24 volts DC it draws 0.12 amperes. This relay is also built for AC with a contact rating of 12½ amperes at 110 volts, 60 cycles. Standard AC voltage is 92-125 volts but coils are available for other voltages.



Aircraft Radio Relay
DC Model—Bulletin 345
AC Model—Bulletin 340

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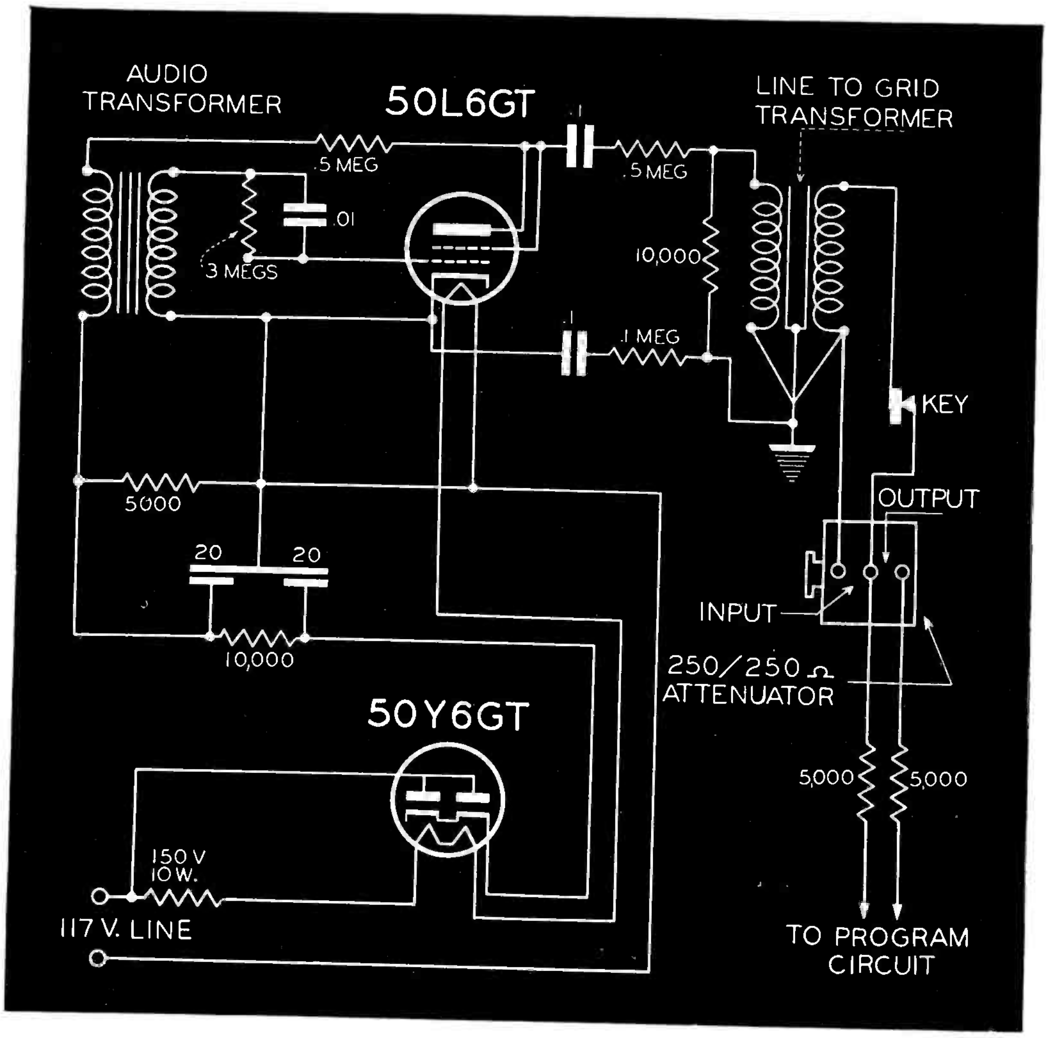


Figure 1
1000-cycle audio oscillator, with its own power supply, used to operate sound effect device.

HIGH SPEED SOUND EFFECT SIGNAL DEVICE

by HARRY E. ADAMS

Chief Engineer, WIBC

Any station featuring news on the hour every hour, as many are, will appreciate the value of using a distinctive sound effect to introduce each news period. Sound effects records may be used, but their life is short under such constant use, and their use introduces operating difficulties, besides "tying up" a turntable at the time of each news period; a practical objection at many stations.

The device to be described fills the need nicely, and is the ultimate in ease of operation. Briefly, an audio oscillator is used to generate a 1,000-cycle tone which is keyed by a continuously running slow-speed motor. The oscillator runs steadily, the output being keyed by the machine key and fed through an attenuator into the program circuit. The attenuator is located convenient to the *control operator,* so that to introduce and to sign off a news period he has only to open the attenuator, leaving the signal on for as long as desired, then fade it out.

The oscillator, as the diagram shows, is simplicity itself, but has its own power supply, ample output for the purpose, and a pleasing tone. The keying problem is simplified greatly by allowing the oscillator to run and placing the key contacts in the output. This provides clean keying with no chirp or click. The attenuator used must be one which will provide infinite attenuation on the last contact so that no signal will leak through when the attenuator is closed. We used a discarded 250/250 ohm unit.

The character of the output of the oscillator, both pitch and tone quality, depend on the audio transformer used as well as the condenser and resistor combinations, and can be easily varied to suit.

The keying disc and its driving motor required the most experimental work. If junk parts are to be used, as they were here, it is best to obtain the motor first, as its speed will determine the design of the disc as well as placing definite limitations on the number of letters or words to be used. Concerning this point, we found a speed of about 50 words per minute to give the best imitation of a high speed

(Continued on page 68)

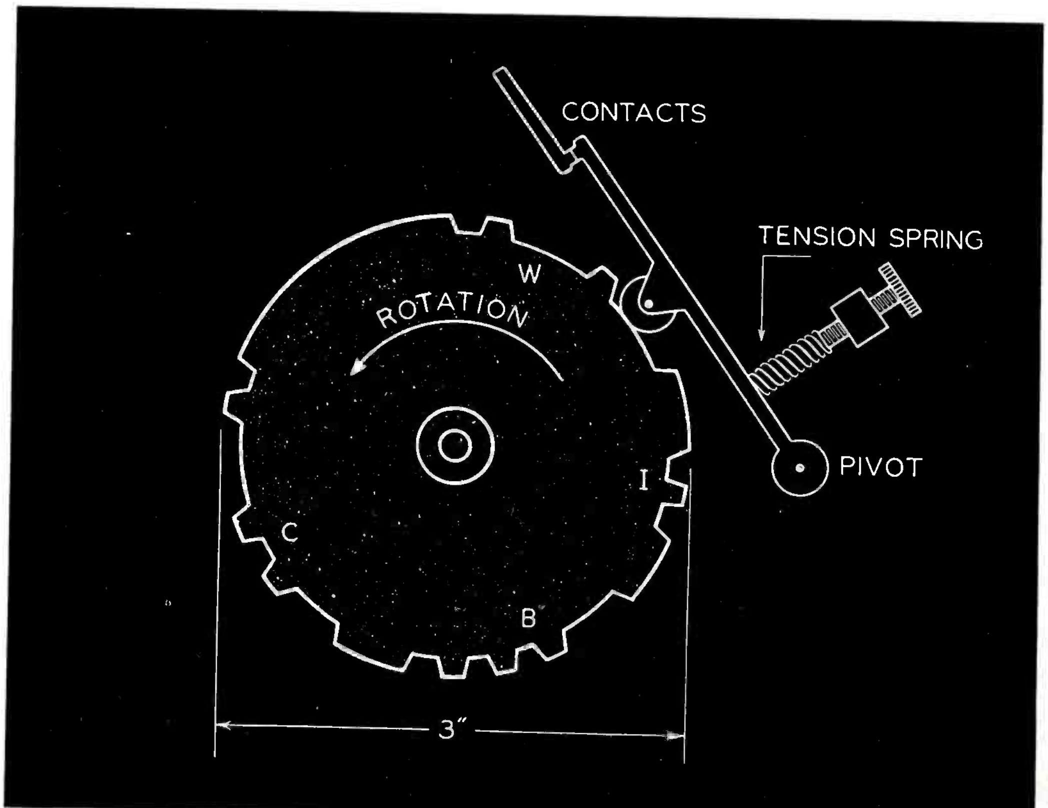
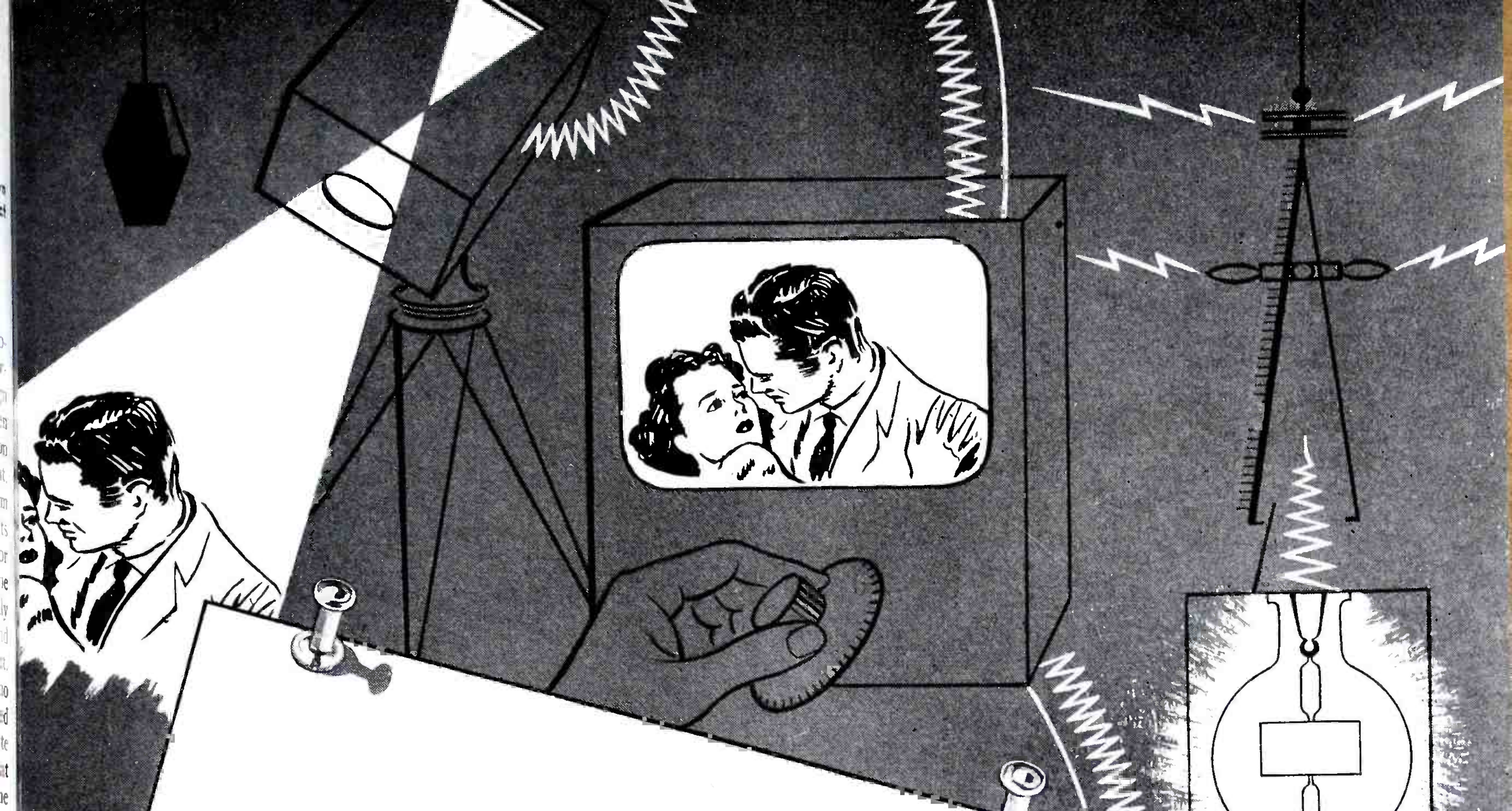


Figure 2
Specially developed keying disc providing transmission of call letters WIBC at fifty words per minute rate.



lectronic briefs: television

To produce a moving picture it becomes necessary to break down the action into a series of still pictures. Each still scene is flashed on the screen individually but done so rapidly that the human eye sees a smooth action. If the motion picture projector is slowed down the action becomes jerky. Each still picture is called a frame. The conventional movie projector flashes between 24 and 30 frames per second on the screen. Television is based upon the same principle but the problems involved are much more complex.

Television, using the same basis for creating picture action as the movies, breaks down the picture or scene to be broadcast into a series of still pictures called frames. But each frame must also be broken down into approximately 200,000 tiny segments, each segment being broadcast separately and reassembled at the receiving end so rapidly that 30 frames can be flashed on the screen every second. Thus some 6,000,000 separate signals must be transmitted per second. Furthermore each of these signals starts as light, is converted into an electrical impulse, broadcast and then reconverted to light again. To make television talk, a conventional sound transmitter must be coordinated and synchronized with the picture broadcast.

As with all things in the field of electronics, vacuum tubes are what make television possible. Remember; Eimac tubes njoy the enviable distinction of being irst choice among leading electronic gineers throughout the world.

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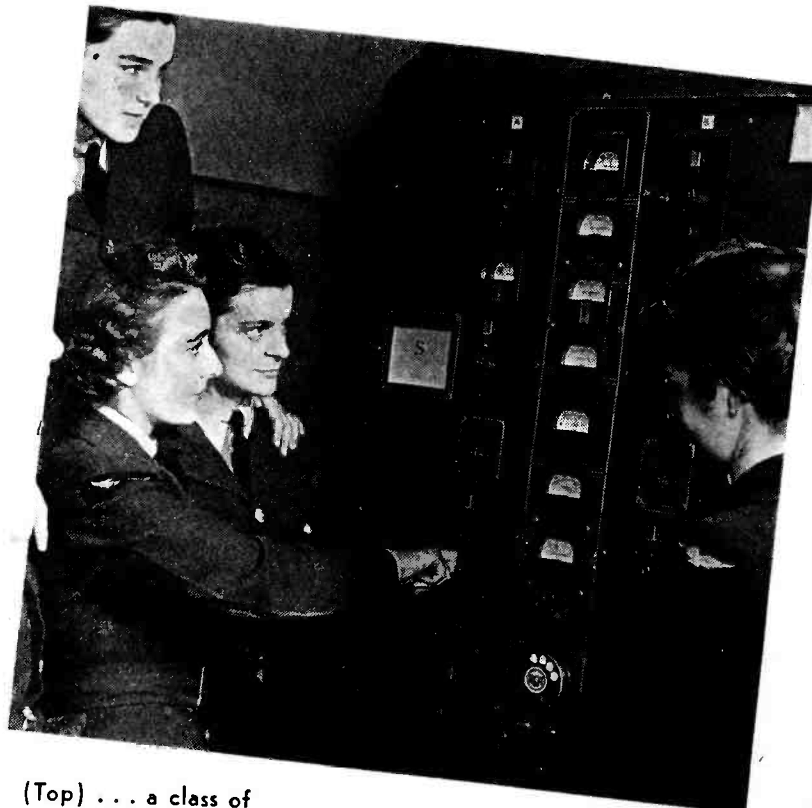
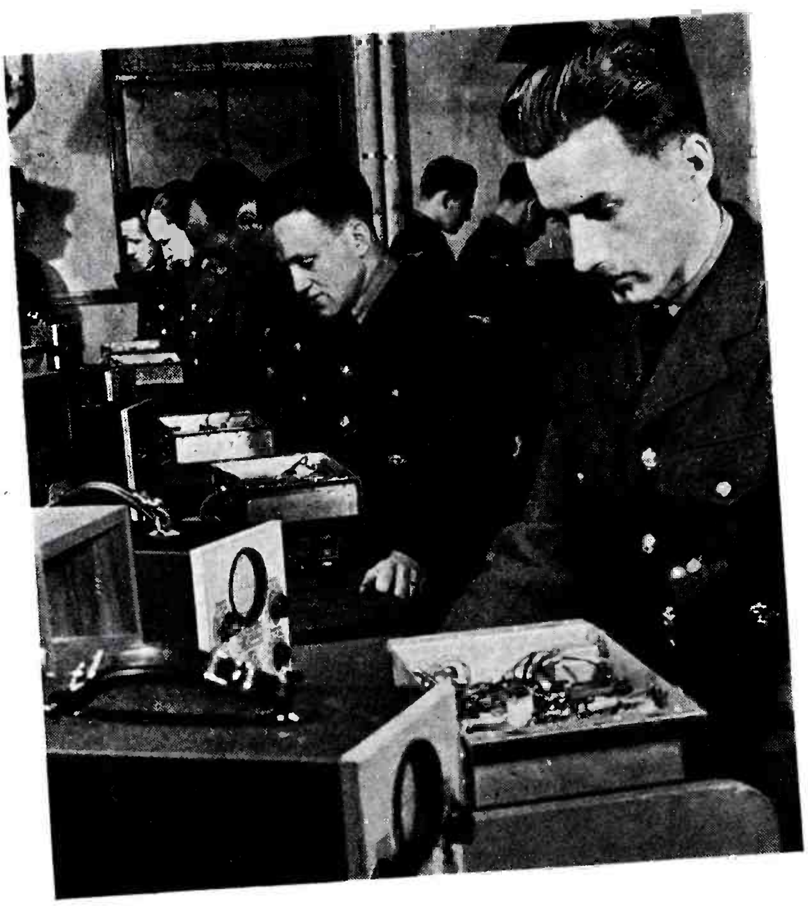
(Top) . . . the cathode-ray demonstration panel that is used extensively in instruction at the RCAF school.



(Top) . . . a class of women at a transmitter.



(Top) . . . a section of the maintenance laboratory. Here again, cathode-ray instruments play an important role in instruction.

ILLUSTRATIONS on this page were taken at the No. 1 Wireless School at Montreal. Chief instructor is twenty-seven year old Wing Commander K. R. Patrick, RCAF. In the RCAF, wireless means radio communications; radio refers to radio location apparatus. Women, who are new to this school, are taught operation of ground equipment. Below appears the planes used exclusively to teach maintenance, operation and direction finding.

(All photos courtesy RCAF)

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TRANSIENTS IN

The Transient Basis for the Necessity of a Bandwidth for Passing Dots is Discussed

by GEORGE B. HOADLEY AND WILLIAM A. LYNCH

Assistant Professor
Graduate Electrical Engineering Dep't
Polytechnic Institute of Brooklyn

Instructor
Graduate Electrical Engineering Dep't
Polytechnic Institute of Brooklyn

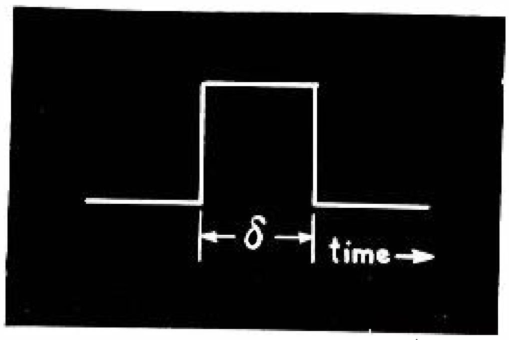


Figure 1
The wave-shape for a Morse dot.

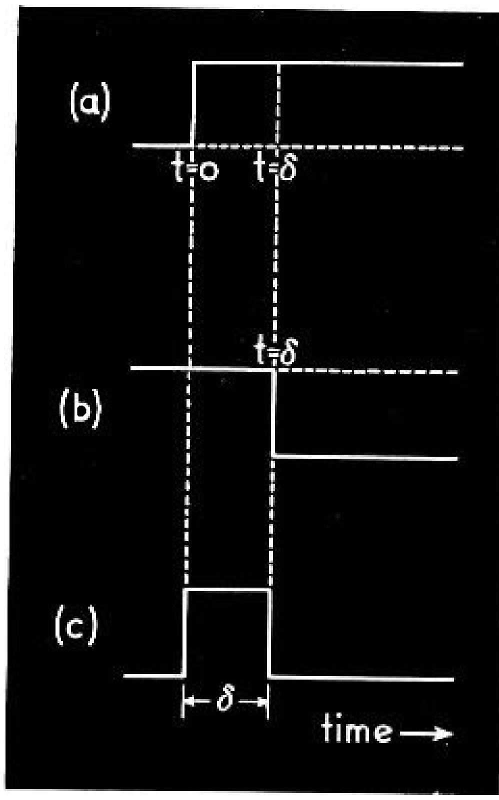


Figure 2
Construction of a dot by addition of two step functions.

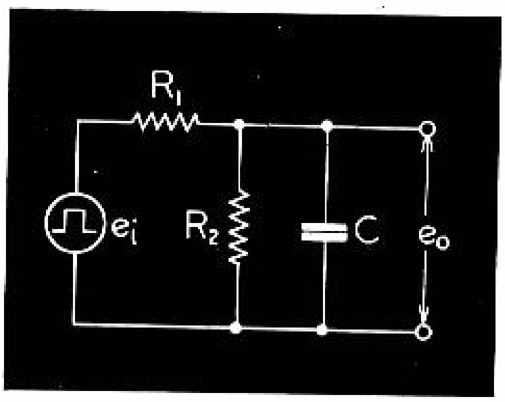


Figure 3
Equivalent plate circuit of the uncompensated amplifier.

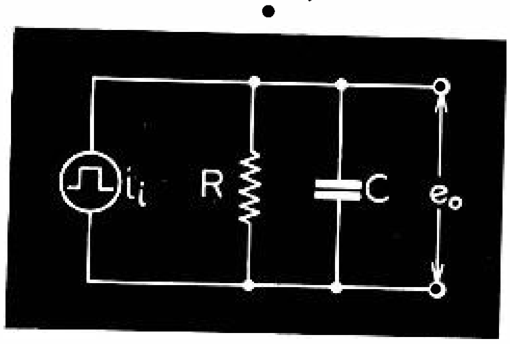


Figure 4
Norton equivalent circuit for the circuit of Figure 3.

RECENTLY the old problem of fidelity of transmission of the Morse dot has become of considerable interest. Although this problem has been rather thoroughly treated, it seems desirable to present some of its salient features.

We will study the application of a voltage curve of the type of Figure 1 to various circuits which might be used as coupling circuits in amplifiers. We will determine the output voltage of the coupling circuit when the voltage of Figure 1 is applied to the input.

The type of voltage wave which we have described can most conveniently be thought of as the superposition or addition of two unit functions or step functions as is shown in Figure 2. Here we have a step function shown in (*a*) and in (*b*) another step function, which is negative and has been delayed in time by an amount δ. The addition of these two waves is shown in (*c*). It is seen that the two waves cancel each other immediately after the second one begins and that their sum is zero forever after. In this manner, the solution to our original problem has been reduced to the solution of the simpler problem of a step function. We merely find the solution for the step function and then subtract this solution from itself with the introduction of a time delay δ.

Determining Waveform of Output Voltage

This process can be made more clear by a specific example. Let us consider the circuit of Figure 3. The input voltage e_1 has the form of the dot of Figure 1, and we want to determine the waveform of the output voltage e_0. Our first step will be to simplify the network by Norton's Theorem which gives us the circuit of Figure 4. Here we notice that the shape of the applied current is still that of Figure 1. This has resulted from the fact that in applying Norton's Theorem we have used only the resistive part of the circuit. If we had used more of the circuit our current wave shape would have been altered.

Our problem now is to find the output voltage e_0 in the circuit of Figure 4. If we apply the step function of Figure 2 (*a*) to this circuit we find that the solution for e_0 is a rising exponential as is shown in Figure 5 (*a*). The response to the negative step function of Figure 2 (*b*) is the curve shown in Figure 5 (*b*). When these two solutions are added together the curve of Figure 5 (*c*) results. This is the solution which we desire for our circuit of Figure 4.

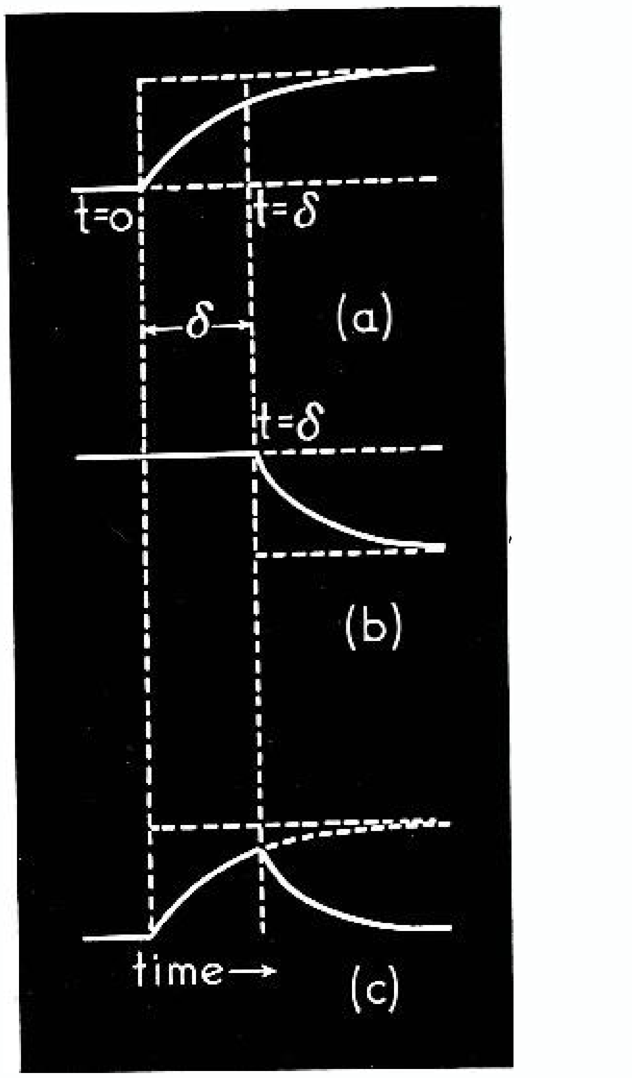
Shape of Input Voltage

From Figure 5, we can readily see the manner in which δ, the length of duration of the pulse, affects the solution. As δ becomes larger, the first transient becomes more nearly completed before the transient of Figure 5 (*b*) commences. This yields an output transient which more closely approximates the shape of the input voltage. Also, we can observe from a study of Figure 5 that if the time constant of the circuit were reduced the resulting wave would be a better approximation to the input.

Fourier Integral

It is well known that the transient solution and the steady state a-c frequency response curve of a network can be related to one another by mathematical means. In fact, one of the standard methods for obtaining the transient solution is to apply the Fourier integral* which uses the equa-

COUPLING CIRCUITS



tion for the complex steady-state response and transforms it into the transient solution.

Steady-State Response

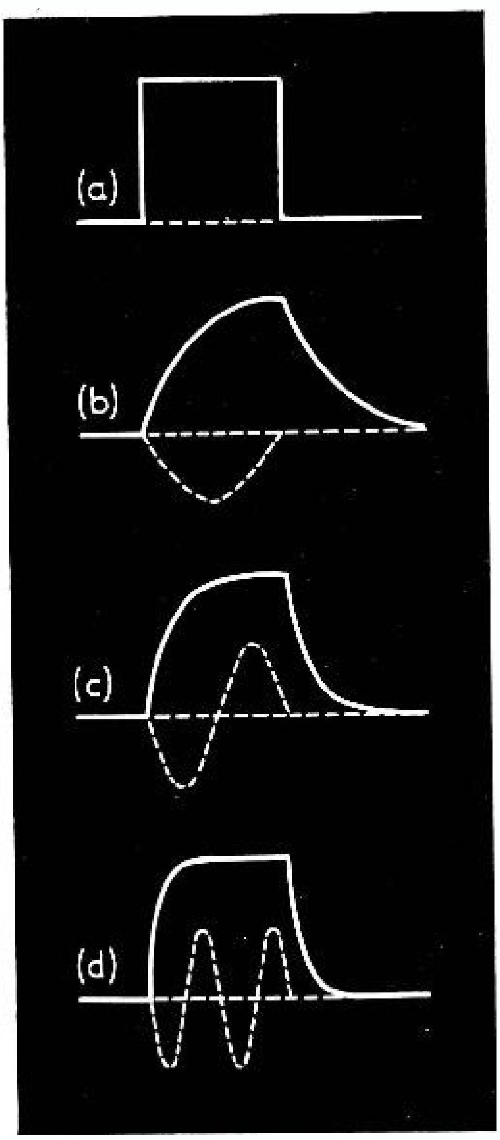
The steady-state response for our circuit is shown in Figure 6. Both phase and amplitude responses are shown since both must be known in order that the transient response may be evaluated. In our circuit the cut-off frequency, that is the frequency at which the response is down to 0.707 of the value at zero frequency, is determined by the values of R and C. It turns out that it also may be expressed directly in terms of the transient time-constants in such a way that a decrease in time constant is equivalent to an increase in cut-off frequency. Thus, in studying the result of Figure 5 (c), we observe that if we increase the cut-off frequency while the dot width δ is held constant we obtain response curves as shown in Figure 7. In this figure, (a) is the input curve and (b) shows the response when the period of the cut-off frequency is equal to 2δ. This is indicated in the figure by the dotted half-sinusoid which shows that for this particular response the cut-off frequency was such that its period was twice the duration of the dot. In (c) we see the result when the period of the cut-off frequency is equal to the duration of the dot and (d) shows the situation when two periods of the cut-off frequency are equal to the duration of the dot. This shows clearly that as the cut-off frequency is raised the output approximates the input more and more closely. A basic idea, which is a generalization of this result, may be stated as follows. In order for a dot to be reproduced faithfully by a circuit the cut-off frequency must be sufficiently high. This value is not a definite one but is determined largely by the fidelity of reproduction which we desire.

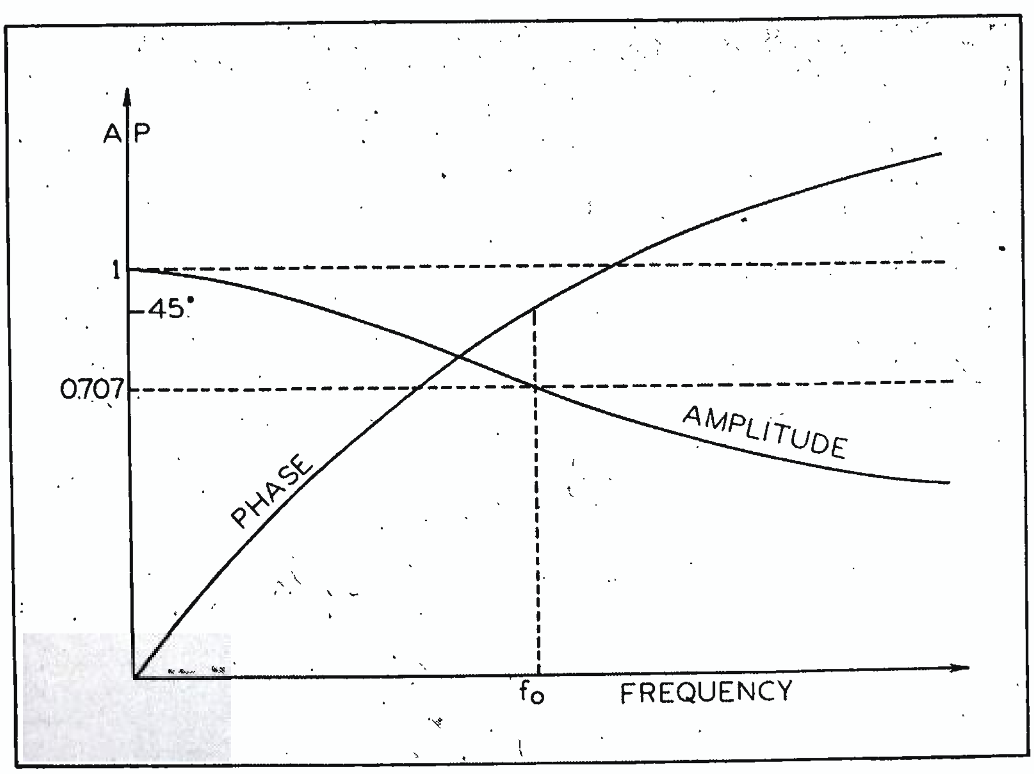
The circuit which we have been studying is basically the high-frequency equivalent circuit for the resistance-coupled voltage amplifier shown in Figure 8. Comparing the various elements between Figure 3 and Figure 8,

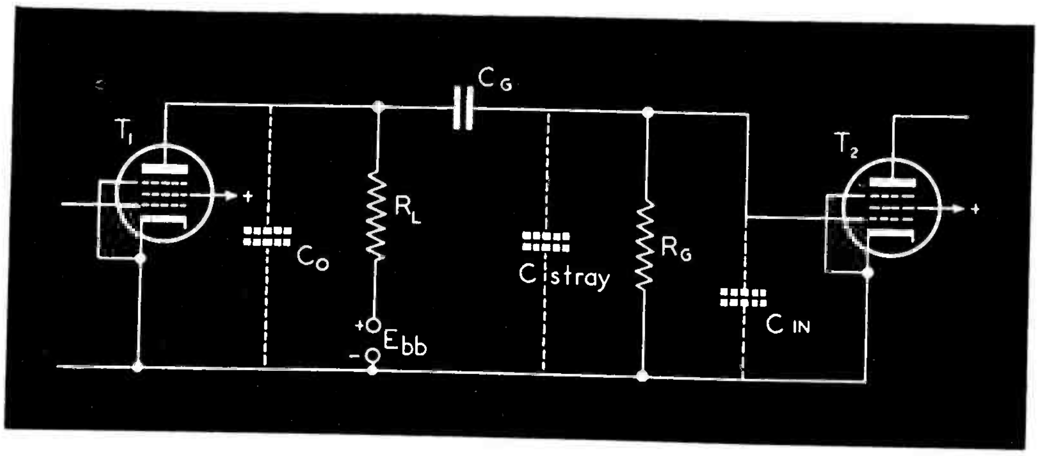
**This study of transients is a fascinating part of circuit theory. The reader who wishes to find out more about it would de well to study the book by Gardner and Barnes, entitled* Transients in Linear Systems. *Some of the same material may be found in* Communication Networks, *Volume II, by Guillemin. Another interesting approach is found in* Operational Circuit Analysis *by Bush.*

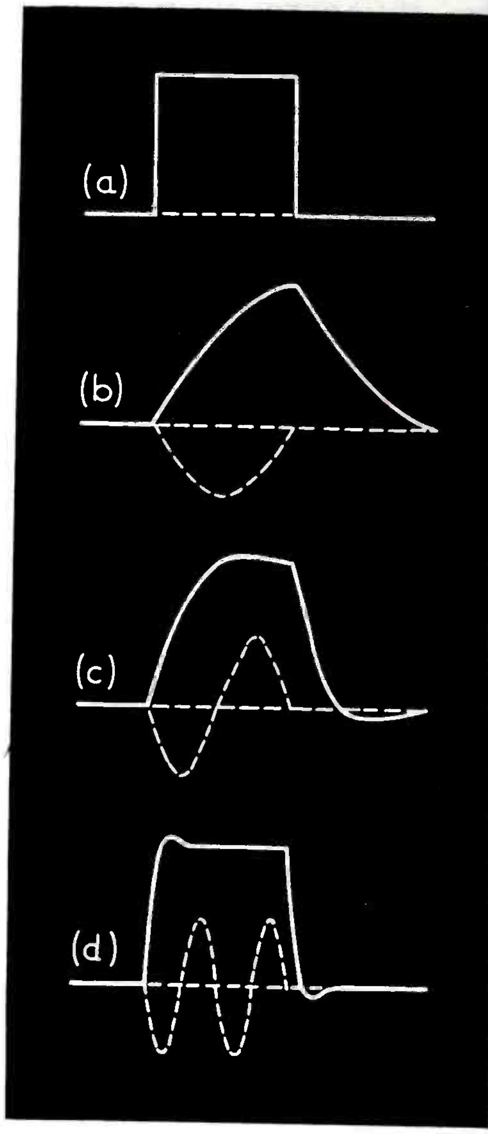
Figures 5 (top, right), 6 (below) and 7 (right)

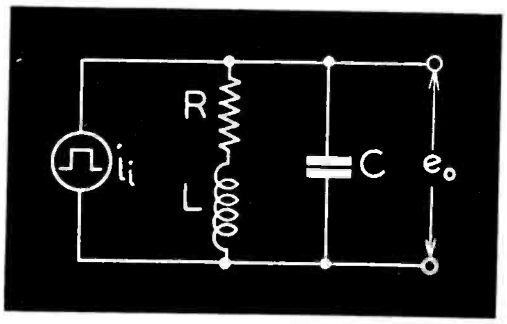
Figure 5, construction of the response transient by the addition of two responses to step functions. Figure 6, steady-state response of uncompensated amplifier. Figure 7, transient response of an uncompensated *R-C* coupling circuit.











Figures 8 (top), 9 (left) and 10 (right)
Figure 8, actual coupling circuit of the uncompensated amplifier, showing shunt capacitances. Figure 9, equivalent plate circuit of shunt-peaked amplifier. Figure 10, transient responses of shunt peaking circuit for $K = 0.5$.

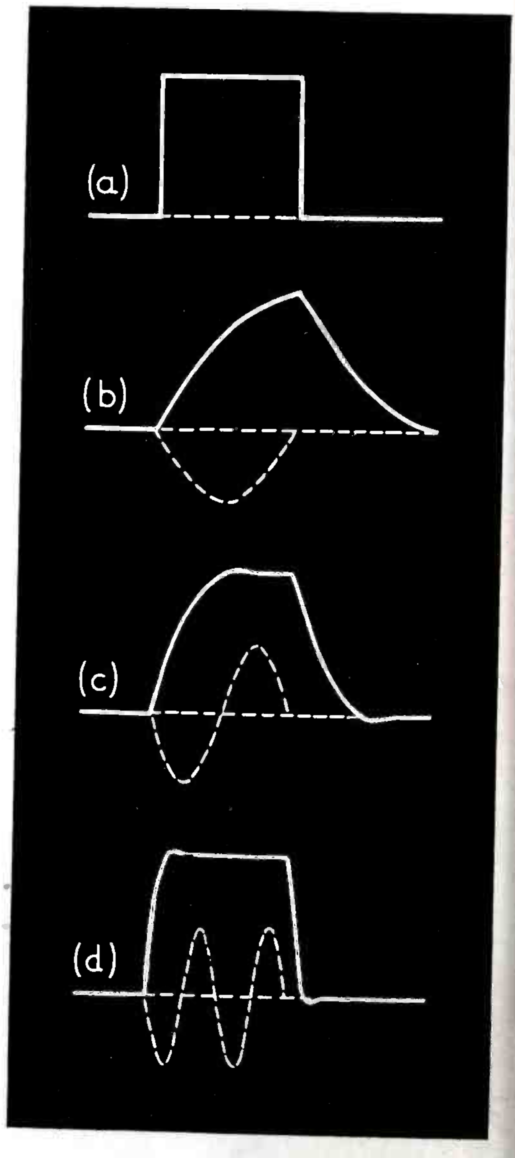
we see that R_1 is the plate resistance of T_1; R_2 is R_L and R_G in parallel. C is the combination of C_0, C_{IN} and C_{stray}, all in parallel. C_G is neglected except that its physical size and its proximity to shields contribute to C_{stray}.

Television Application

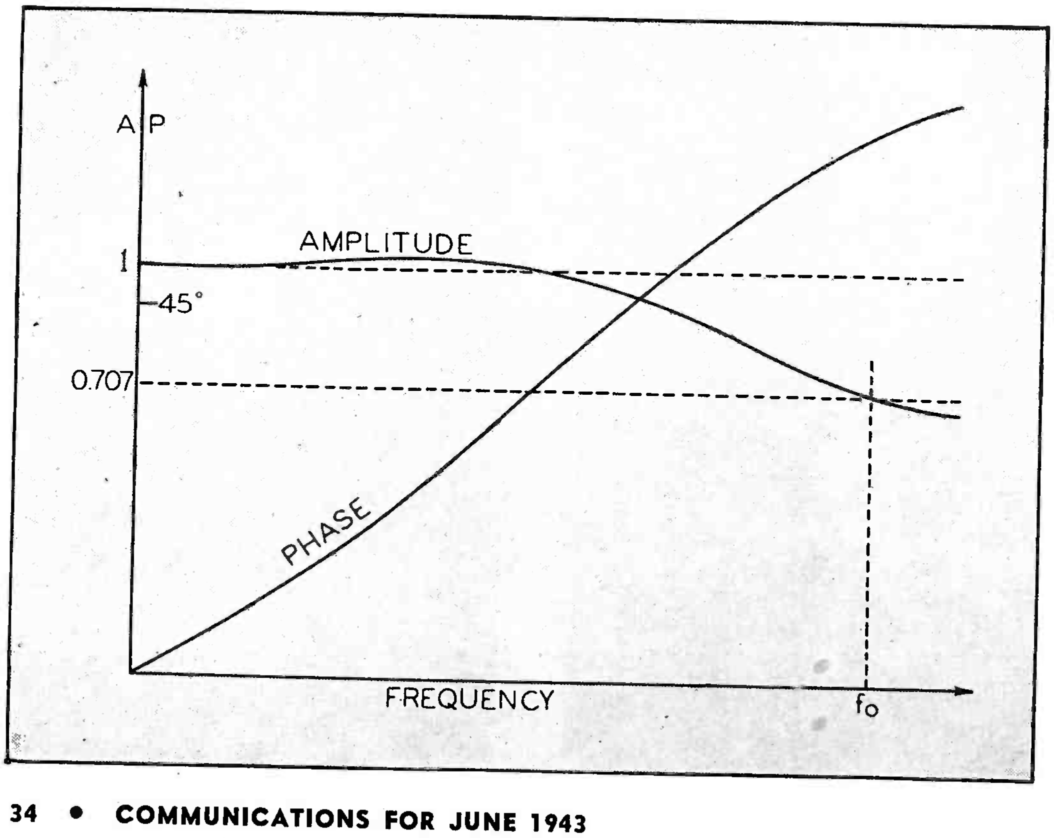
In television work, it is necessary to reproduce faithfully dots or pulses of rather short duration and it is found that the circuit of Figure 8 does not have a sufficiently high cut-off frequency. As a result, many attempts have been made to compensate this circuit, that is, to extend its cut-off frequency to higher values. Two of these methods are known as shunt-peaking and series-peaking. Let us examine transients in these.

Shunt Peaking

The equivalent circuit for the shunt-peaking is shown in Figure 9. It will be observed that an inductance has been placed in series with R_L and R_G has been neglected since it is very high. Various authors have proposed specific design criteria for determining the size of the inductance and these



Figures 11 (right) and 12 (below)
Figure 11, transient responses of a shunt-peaking circuit for $K = 0.414$. Figure 12, steady-state response of shunt-peaking circuit with $K = 0.5$.



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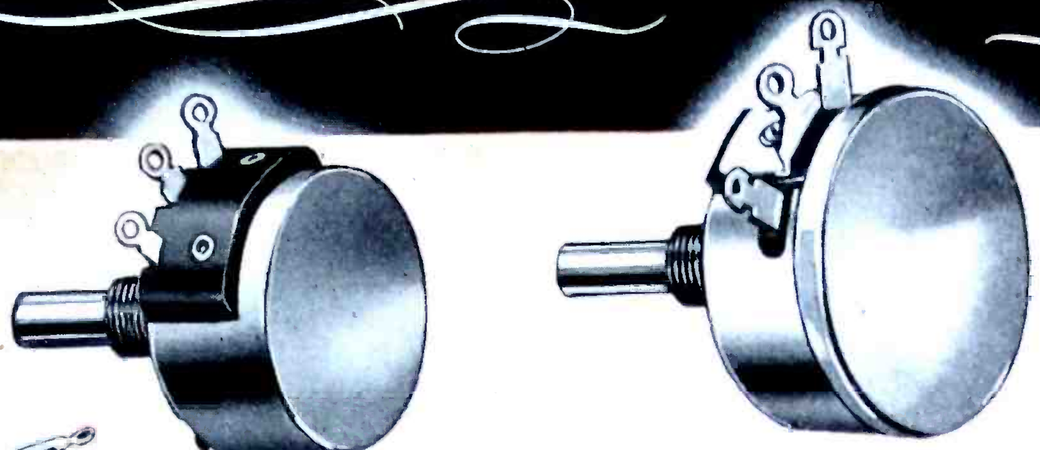

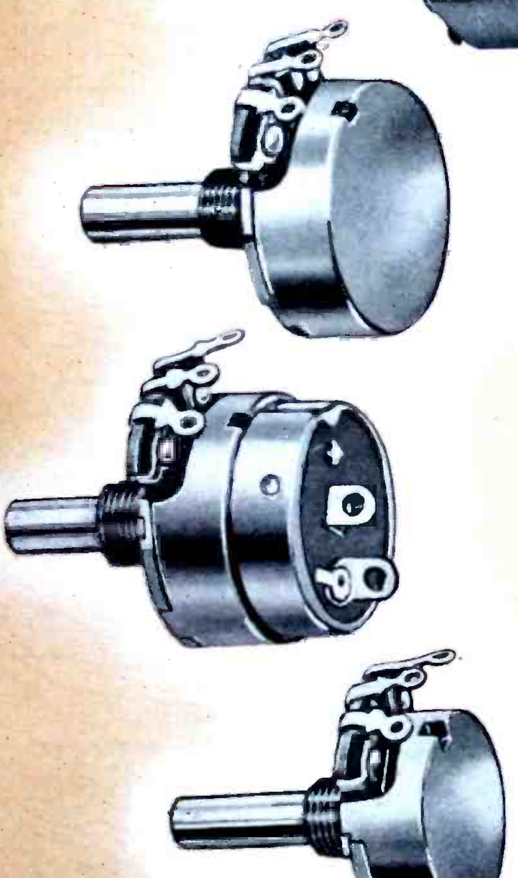

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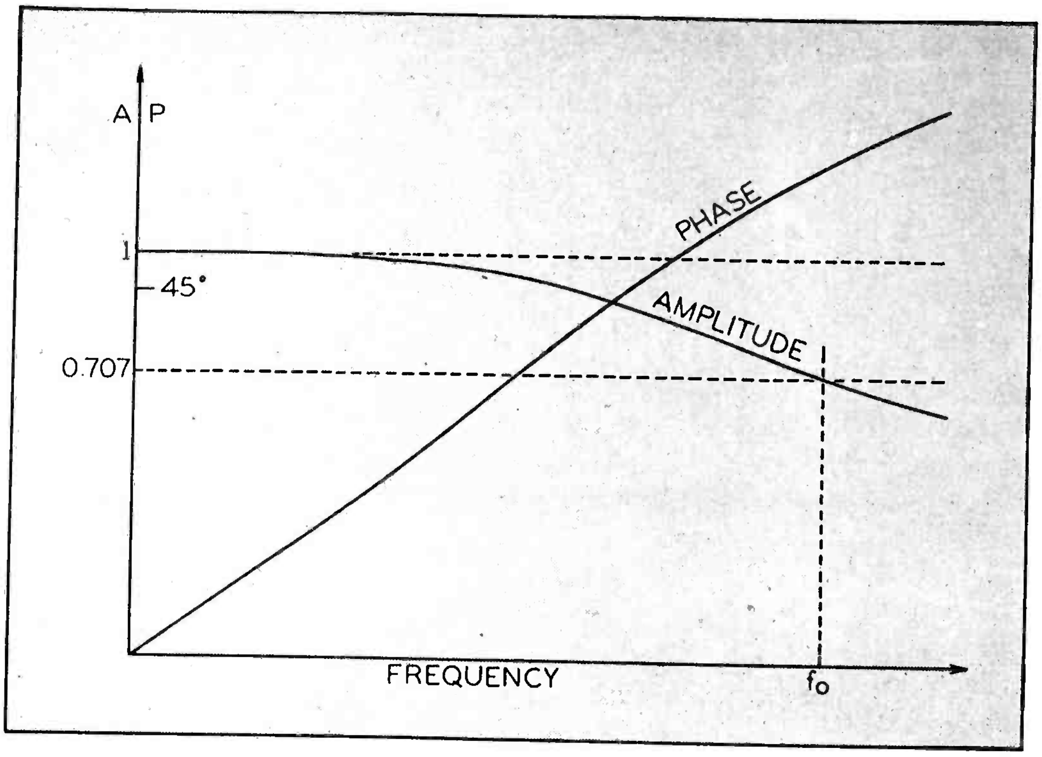


Figure 13
Steady-state response of shunt-peaking circuit with $K = 0.414$.

criteria can best be expressed in terms of a constant K which is $\omega_0 L/R$ in which ω_0 is the angular cut-off frequency before the addition of inductance and R is the value of load resistance. We will examine the transient response for two values of K, namely, 0.5 and 0.414. These results are shown in Figures 10 and 11. The steady-state response curves for these networks are shown in Figures 12 and 13.

Transient Curves

Examination of these transient curves reveals some rather interesting properties. Looking at Figure 10 (*d*) we see that here the two transients have been well separated since the curve becomes substantially flat before the second transient begins. The individual transients reveal a slight overshoot which is indicative of an oscillation which is heavily damped. The curves of Figure 11 indicate that with this value of K the oscillation has been practically eliminated.

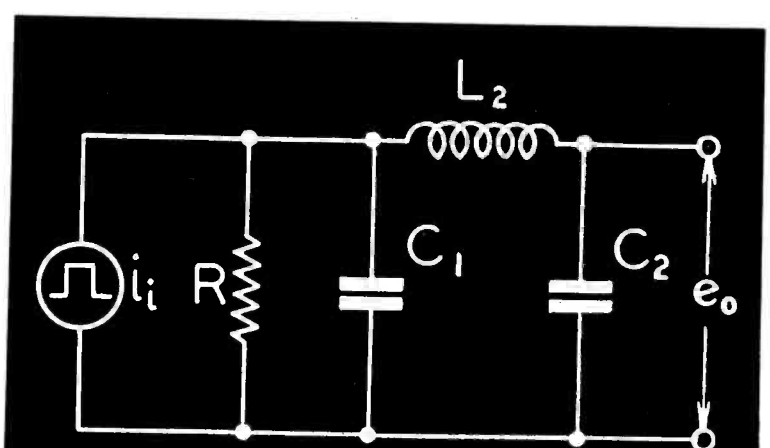
Series Peaking

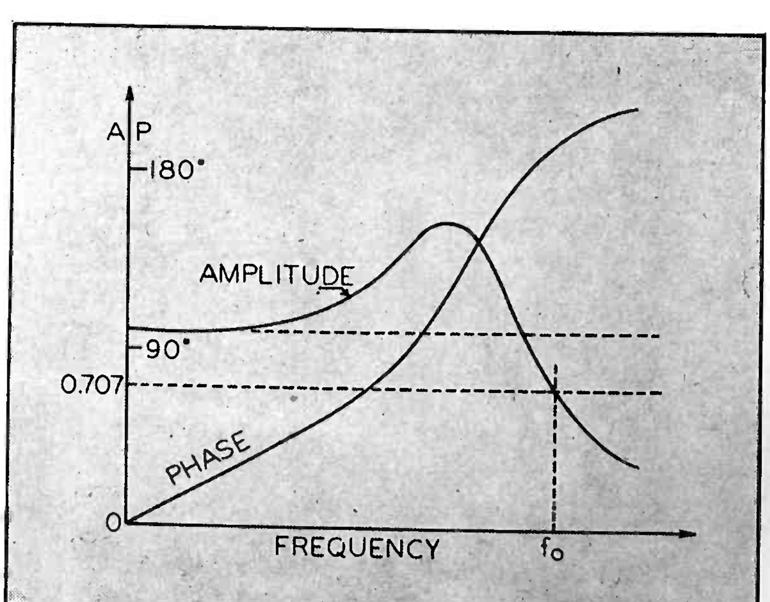
Another circuit which is sometimes used in video circuits is the series-peaking circuit shown in Figure 14. Here the capacitance in the circuit has been divided by the inductance L_2. The circuit then has the appearance of a single π-section filter. As the problem is usually presented, there are two design constants available. One is the size of the inductance which again can be specified by a constant K which is $\omega_0 L/R$. The other design constant is the ratio of C_1 to C_2. Inspection of the circuit shows that the response to a step function would consist of an exponential term plus either a damped sinusoid or the sum of two other exponentials. As a critical boundary case, these two might be the same in which case the form of the response equation would have to be changed slightly. In Figure 15, there is shown the amplitude and phase response for this type of network, under the condition that the ratio of the capacitances and K are both unity. The first of these conditions was chosen primarily because it is analytically convenient and the second was chosen in order that the amplitude response should be as flat as possible at the origin. Inspection of Figure 15 reveals that this method of choosing K produces an undesirably large peak in the response. The transient solution for this network is shown in Figure 16. Here another phenomenon makes its appearance. In (*b*) it is noted that the maximum response occurs after the input has returned to zero. In all of the responses of this figure, a definite time delay is noted in the curves. This agrees with theoretical predictions which indicate that networks which do not have zero phase shift will introduce time delay. Also, these curves show the improvement of response shape as the cutoff frequency is raised. However, no matter how high the cutoff frequency is raised there always would be undesirable oscillations in this circuit which can be remedied by changing the value of the factor K.

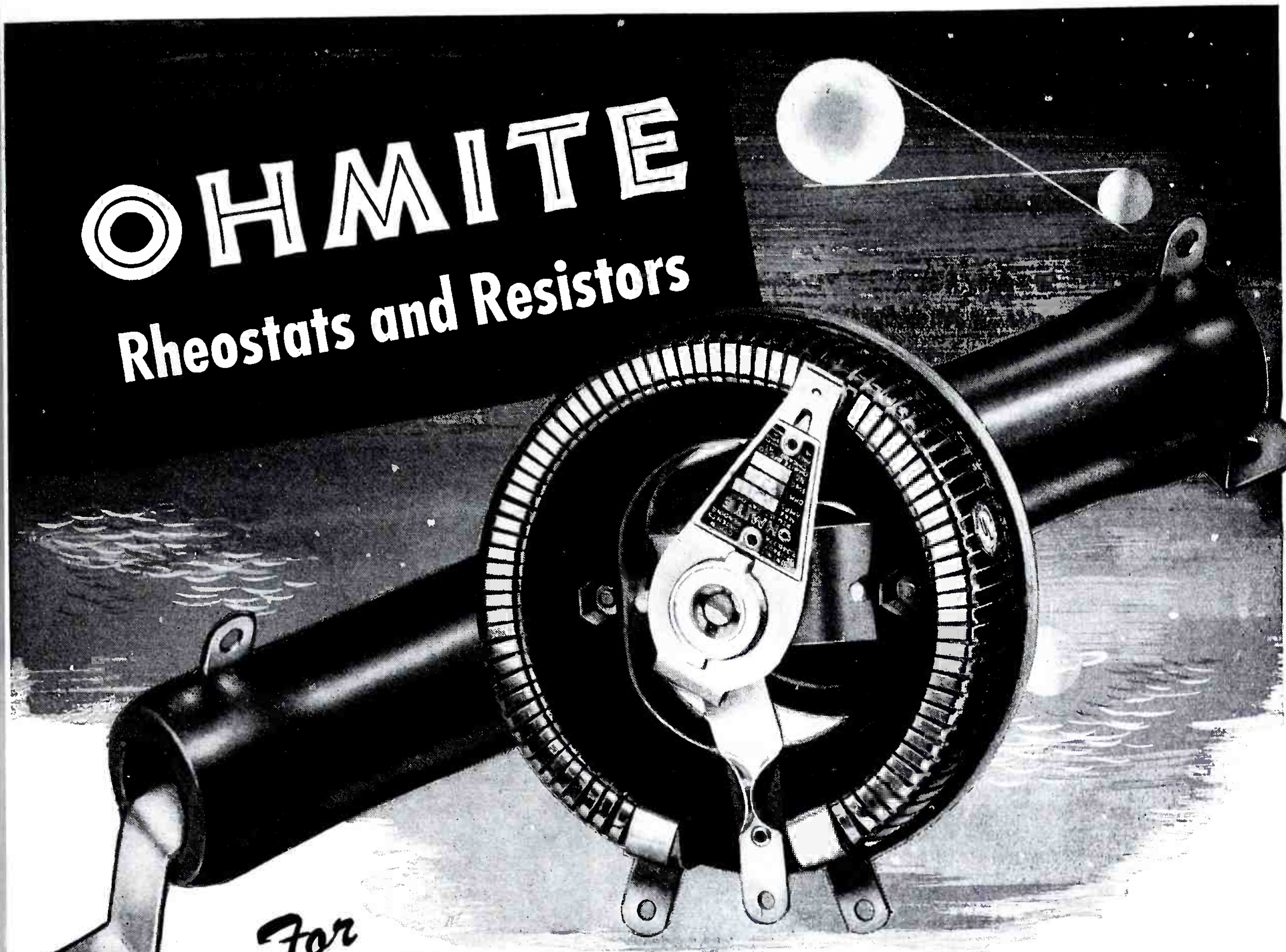
Idealized Filtering

The question of a general transient solution to idealized filtering networks is of interest. Professor Guillemin in his second volume on *Communication Networks* presents an interesting analysis of this problem. Figure 17 shows some curves adapted from Guillemin's book (Figure 205). These again show the improvement in wave

Figures 14 (below) and 15 (right)
Figure 14, equivalent circuit of series-peaked amplifier.
Figure 15, amplitude and phase characteristics of series-peaking video amplifier circuit for $K = 1$.







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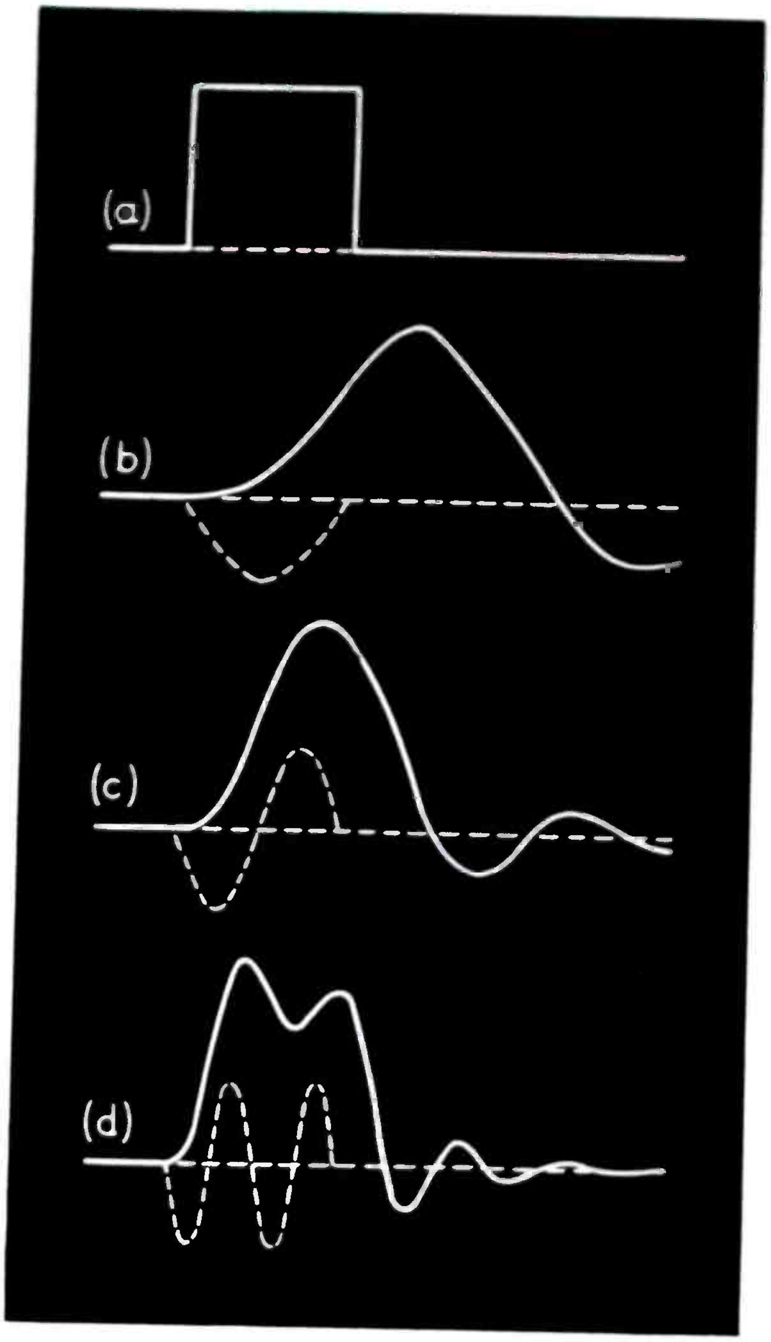
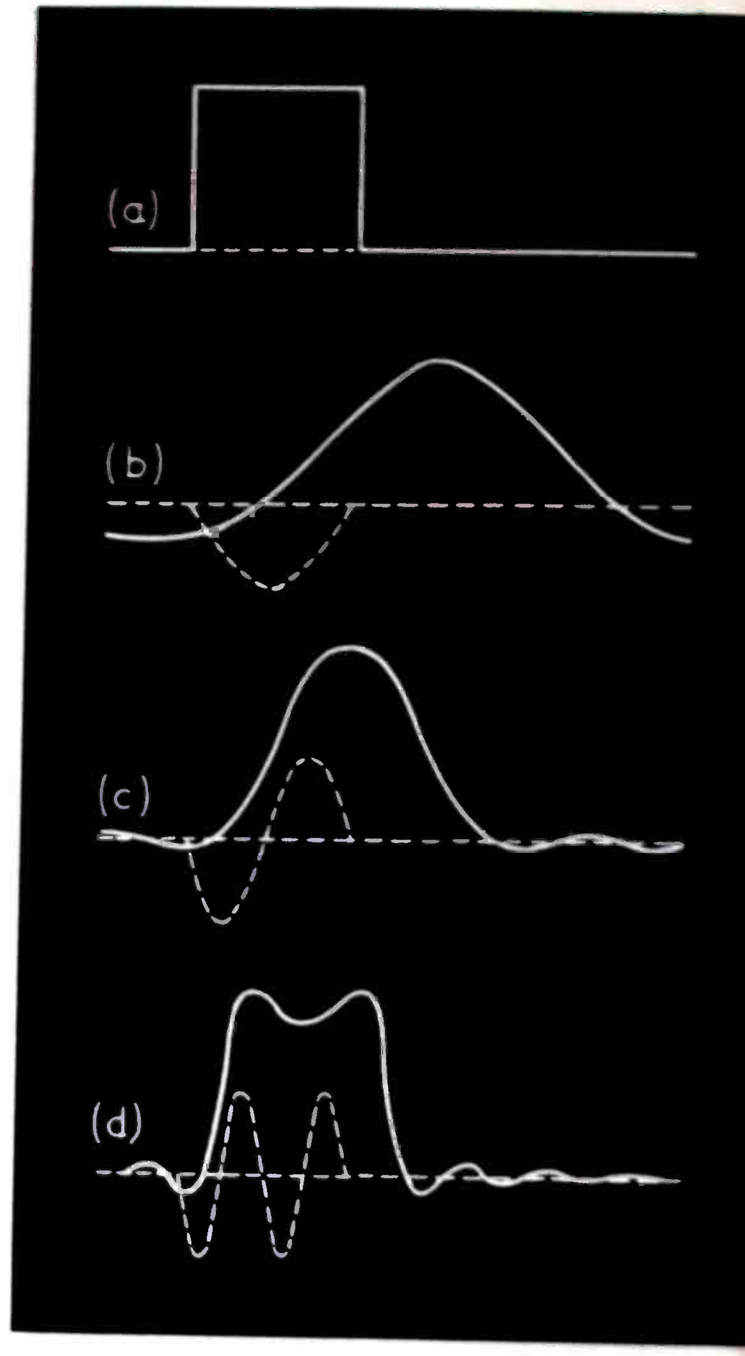




Figures 16 (left) and 17 (right)
Figure 16, transient responses of a series-peaked circuit with $K = 1$ and $C_1 = C_2$. Figure 17, transient responses of the idealized low-pass filter whose transmission characteristics are shown in Figure 18. (Adapted by permission from *Communication Networks*, Vol II, by E. A. Guillemin, published by John Wiley & Sons, Inc.)

shape resulting from an increase in the cut-off frequency. They also show a time delay which was computed for an overall phase shift of 180°. One feature of these curves deserves especial mention. They show a response before the input begins. This really does not mean that the network has *second sight*, but simply that the ideal amplitude and phase characteristics of this network as shown in Figure 18 are not physically realizable. It is quite interesting to compare these curves of an idealized network with the curves of Figure 16 obtained for a physical network.

The examples above have all shown one characteristic in common, namely, that in order to reproduce faithfully a single Morse dot a sufficiently wide-pass band must be available. It is not sufficient for one to design a network on the basis of its d-c transmission alone and expect faithful reproduction. The cut-off frequency in itself is significant only when it is compared with the duration of the dot, as we have done in the various drawings of responses.

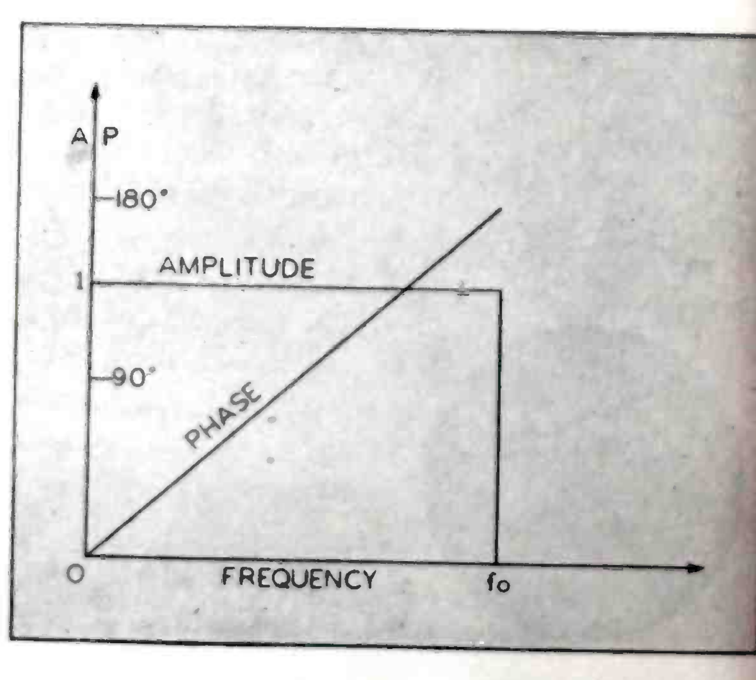


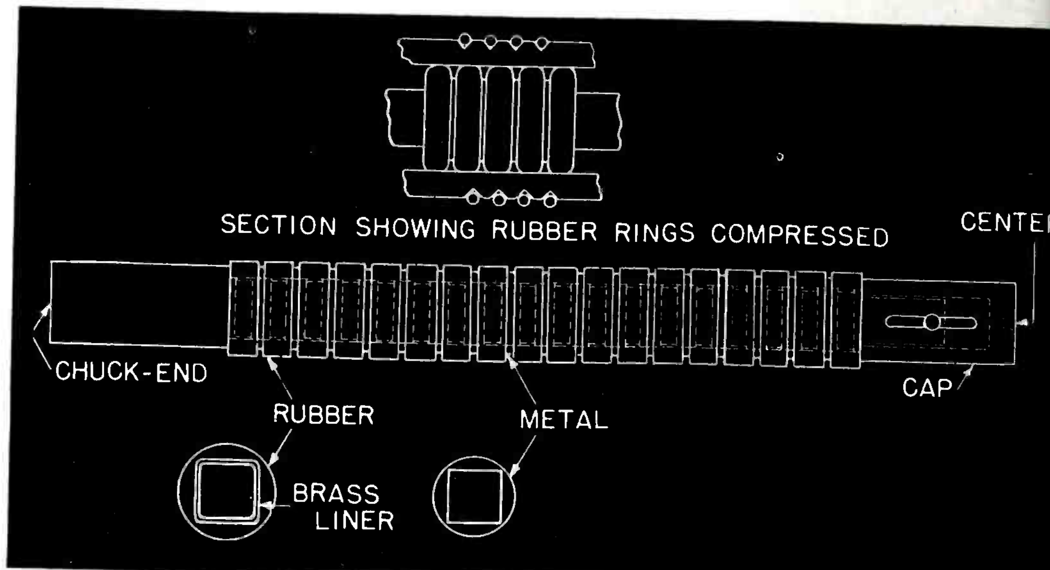
Figure 18
Amplitude and phase characteristics for the idealized network whose transient responses are shown in Figure 17.

PRODUCTION AIDS

SUGGESTIONS of the man and woman in the plant have expedited production of many a communications component.

Recently, for instance, an arbor minimizing breakage of ceramic coil forms during the winding operation was devised by A. C. Schlansker, a foreman in the General Electric Electronics Department. The breakage problem was inherent in the operation due to varying mechanical tolerances of the forms and the fact that the coils are wound under high tension.

The arbor devised consists of a square shaft which can be held in the chuck of the winding machine. Assembled on the shaft are alternate metal and soft-rubber brass-lined washers with a diameter slightly smaller than the minimum inside diameter of the ceramic form. When the coil form is slid over the winding arbor, a sliding cap which fits over one end of the square shaft is pushed against the stack of rubber and metal washers by a tailstock center device. The resulting compression of the rubber washers bulges their diameters, and they obtain a firm, evenly distributed grip on the surface of the ceramic coil.



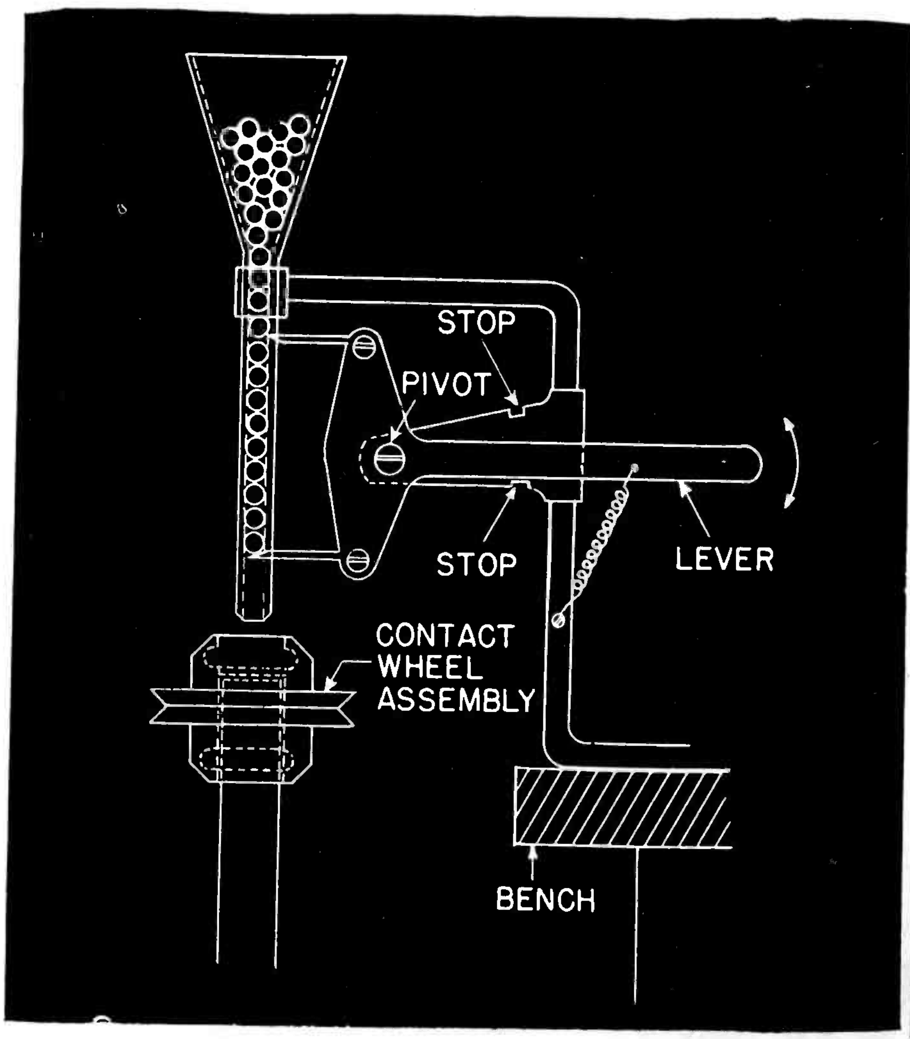
A. C. Schlansker's method of minimizing ceramic coil form breakage.

Loads Ball Bearings Easily

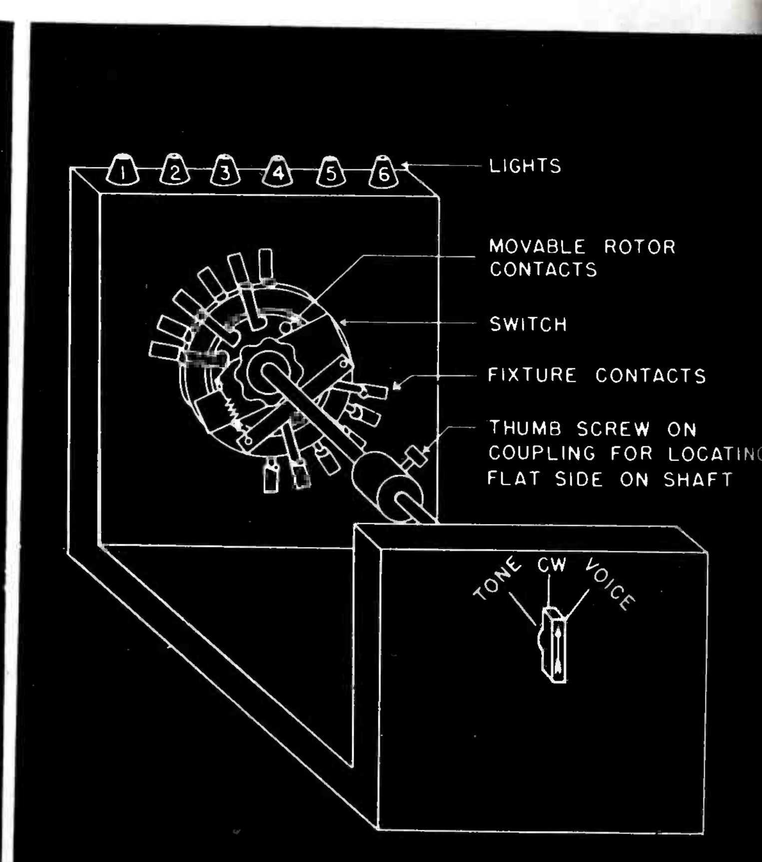
Loading of ball bearings into contact wheel assemblies for radio transmitters in mass production were simplified by a fixture devised by W. D. Simpson, an assistant general foreman in the General Electric Electronics Department.

The device consists of a funnel-shaped hopper with a tubular section attached to its lower end. The inside

(*Continued on page* 70)



Fixture for loading ball bearings into contact wheel assemblies.



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A STUDY OF IRON

Types, Methods of Production and Applications at L-F and H-F Analyzed

by S. YOUNG WHITE

Formerly of Loftin-White

THE most common tool of the radio engineer is the tuned circuit. The three most widely used forms employ the variable condenser, permeability and the resonant line varied in some way. Both the line and the variable condenser are well within the field of experience of the radio man, but the iron core in permeability tuning is a rather mysterious device to most of us. Literature on the subject is limited. And many obvious questions have not been answered too completely. Thus it has been difficult to evaluate permeability tuning from the viewpoints of performance and economics. This article is an attempt to report on the present status of the iron core, and to show why many apparently simple questions cannot as yet be answered with any degree of certainty.

What is an iron core? It is made of iron of exceptional purity, or of iron oxide (Fe_3O_4, ferresoferric oxide, or magnetite), or carbonyl produced iron, that may contain a few per cent of carbon and nickel. The particle size is about a third of a thousandth of an inch. Each particle is insulated with an extremely thin film of bakelite. The particles are then mixed with about 3% bakelite and moulded into one piece under many tons of pressure. The bakelite is cured by the heat developed by the molding operation, and we have our core. The above is typical. We shall discuss several variations of each step and various materials used, later.

Core Production Dependent on Many

Particle production is a job for a metallurgical chemist. He knows nothing of the radio frequency requirements. He merely varies the cores until the radio man is satisfied.

The radio man in turn, is usually not too familiar with magnetic principles. He thus finds it necessary to request many cores until a core with commercial characteristics is produced.

If a magnetic specialist enters the picture, he finds a very strange world indeed. He is used to high flux densities and he finds extremely low ones. He is used to closed cores at 60 cycles that have a permeability of a thousand or twenty-thousand. He finds himself working with *apparent permeabilities* of two. Saturation is impossible. The magnetic art is very complex and the great part of it is empirical anyway. Accordingly, most of what the magnetic engineer knows must be discarded. He finds that the controlling phenemona are those that he could usually neglect at power or audio frequencies.

The obvious solution seems to lie in the choice of a physicist who would direct the above three engineers.

Ferromagnetism

The only reason we use an iron core is for its magnetic effect. In defining *ferromagnetism* the dictionary says . . . it is the property of *any* metal that causes it to behave like iron in a magnetic field. This is a rather vague definition. There are, however, two points of basic modern theory that seem particularly applicable to the small iron particle.

The basic building block of matter is the hydrogen atom, which consists of a central nucleus with a single electron rotating about it. In addition to having orbital motion around the nucleus, the electron also *spins* around an axis passing through its center.

When we add another electron we have helium. This new electron has the same charge as the first, is repelled by it and takes up a position on the opposite side of the nucleus, at the same distance. It also takes on an orbital motion similar to the first one. But the sense of the spin of this second electron is reversed. That is, if the first one spins clockwise, the second spins counter-clockwise.

The next electron that is added will take up a position somewhat further away from the nucleus than the first two, forming a new "shell." This is due to the fact that the first shell can contain only two electrons. Each electron that is added, however, will spin in an opposite sense to the last. They follow this *pairing-off* rule until enough have been added to make iron, or 26 electrons in 4 shells. In effect, the last four added all spin in the same direction and have no companions that neutralize them. Since it is the spinning of the electron and not its orbital motion that is the basis of ferromagnetism, these four unneutralized electrons give the iron atom a strong external, magnetic field. This prompts the problem . . . why do we have unmagnetized iron?

The Magnetic Domain

Let us see. A very significant discovery of a *magnetic domain* was made several years ago. Iron was shown to consist of these domains, each about one micron cross section and ten microns long, (a micron is a millionth of a meter, and there are 25.4 microns to a thousandth of an inch). Each domain is about twenty-million atoms long, and the four unneutralized electrons in each atom spin in the same direction, giving a very intense magnetic field. These domains lay side by side and end to end, like a bundle of pencils. Now for a real mystery. Along their sides and at their ends, these domains are separated from their neighbors by only a thousand atoms or so. Yet they are completely isolated from each other and polarized at random. Consequently the whole piece of iron may show no external field, but each domain has a magnetic field far stronger than any we can produce in the laboratory.

By imposing an external field we can re-orientate those domains not lined up with the field. Their flux, in effect, is added to that of the external field. The external field easily passes through the boundary layers that isolate the domains, proving that these boundaries are not magnetic insulators. Saturation occurs, of course, when all the domains line up.

The writer was fascinated by this theory when he came across it, because it appears to link with the fact that all successful commercial iron for

CORES

radio use comes in particle sizes, very similar to that of a domain, namely five to ten microns. There are other reasons why this size is used, but the coincidence is striking. The writer was considerably puzzled when he discovered, before the theory was published, that some of the iron of great promise at u-h-f was strongly magnetized. Puzzling also was the fact that although it was generally believed that such iron could not be used in a reversing field, this particular iron was working well at two hundred-million cycles.

The first step in making a core is to obtain iron in some fairly pure form and then purify it still further. Many cores start as scale in the pickling vats of steel mills where an oxide is formed by steam in contact with hot iron. One process will remove the carbon, the next the sulphur, and so on. Perfectly pure iron would be ideal, since it probably would have a permeability of a million or so, but in practice it is unattainable.

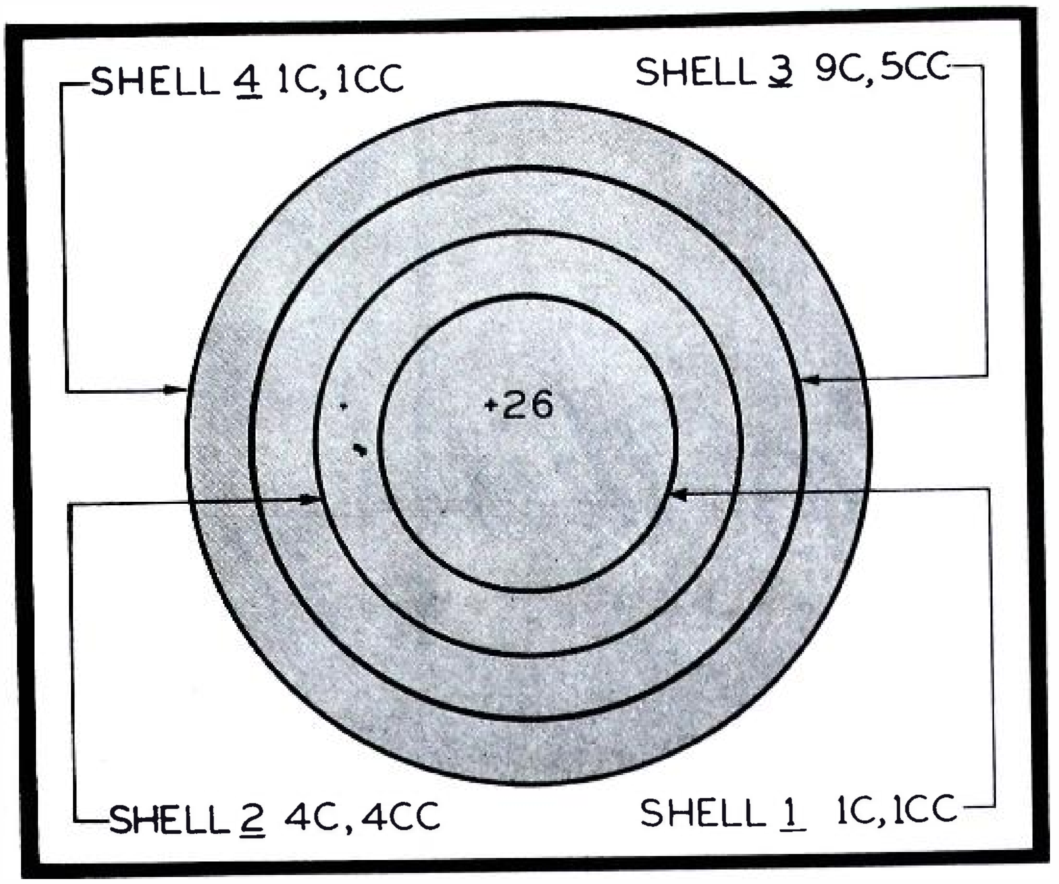

Figure 1

A magnetic picture of the iron atom, which has its electrons in four shells (C = clockwise and CC = counter-clockwise). Each electron spins in opposite directions to its preceding one, canceling out their magnetic effect, except in the third shell, which has an excess of four) all spinning in the same direction. This unbalance occurs only in the ferro magnetic atom.

Two Classes of Impurities

There are two general classes of impurities. Iron crystalizes in a cubic lattice. Generally those impurities that crystalize in cubic lattice will act as simple adulterants. That is they will take up space that should be filled with iron. Otherwise, no harm results. They are always less than a percent, anyway.

The main enemy is sulphur. It crystalizes in other than a cubic lattice and considerably effects the desired performance of the iron. The amount required is only a trace. Since you don't know whether you have ten per cent of a trace, or eighty per cent, you can only test the iron when it is in a coil, to check this characteristic. This is a major cause of the non-uniformity of commercial cores. Some impurities also affect the size of the domain.

An interesting sidelight on impurities is that the addition of a huge amount of oxygen will form magnetite Fe_3O_4, and the resultant core will give the same tuning range at u-h-f as the pure iron, although oxygen is non-magnetic. Natural magnetite is non-uniform and so it must be artificially produced.

Iron carbonyl, a liquid consisting mainly of iron and carbon of great purity, also may be your starting point. That will be discussed later.

Having your iron, it must then be divided into particles in the size range of ten microns or so. preferably by some means that provides nearly all particles of the same size.

The Schoop Gun

The use of a Schoop gun provides one rather easy method of dividing. With this gun you melt iron wire in a flame of gases under pressure. The liquid metal sprays out in the form of tiny drops of the size you wish. These small balls are practically all surface, anyway. Surface tension is thus very important. It causes the drop to form a perfect sphere. As the outside begins to cool, tremendous pressure is exerted on the inside. At the same time, crystallization sets in as the drop cools. The process can be controlled by having the cooling balls fall in a water bath.

An infinite series of cores can be made this way by controlling gas pressure, size of wire, length of cooling path and so on. The resultant cores will be of the oxide type, of course.

Dendrite

Hydrogen reduction can be used, giving a dendrite form of pure iron. This process consists of heating the iron in a hydrogen atmosphere, and oxygen and other impurities are driven off. The hydrogen is also absorbed by the iron crystals and, in some way, improves their magnetic properties. Dendrite resembles the leaves of a pine tree and is never spherical. It is very soft and black. If the powder is put in a mold and subjected to a pressure of ten tons or so, a solid slug of pure soft iron will result. It will look like a five cent piece. This is the most common type of core.

A ball mill, or filing, could be used to divide the iron, but in the form of thin flakes the eddy currents will be too high.

Carbonyl Iron

Carbonyl iron is produced from liquid iron carbonyl that has been raised to high temperature. Balls of iron form out of the resultant gas. The process is very complex and the resultant iron rather poisonous. Thus it is best handled after it has been coated with insulation, when it is quite safe. The writer has never been able to obtain carbonyl nickel, since it is intensely poisonous. Thus its behavior cannot be discussed.

A screening operation may be desirable to insure uniform size of the particles required. Insulating each particle with a very thin film becomes the next step. As we mentioned previously

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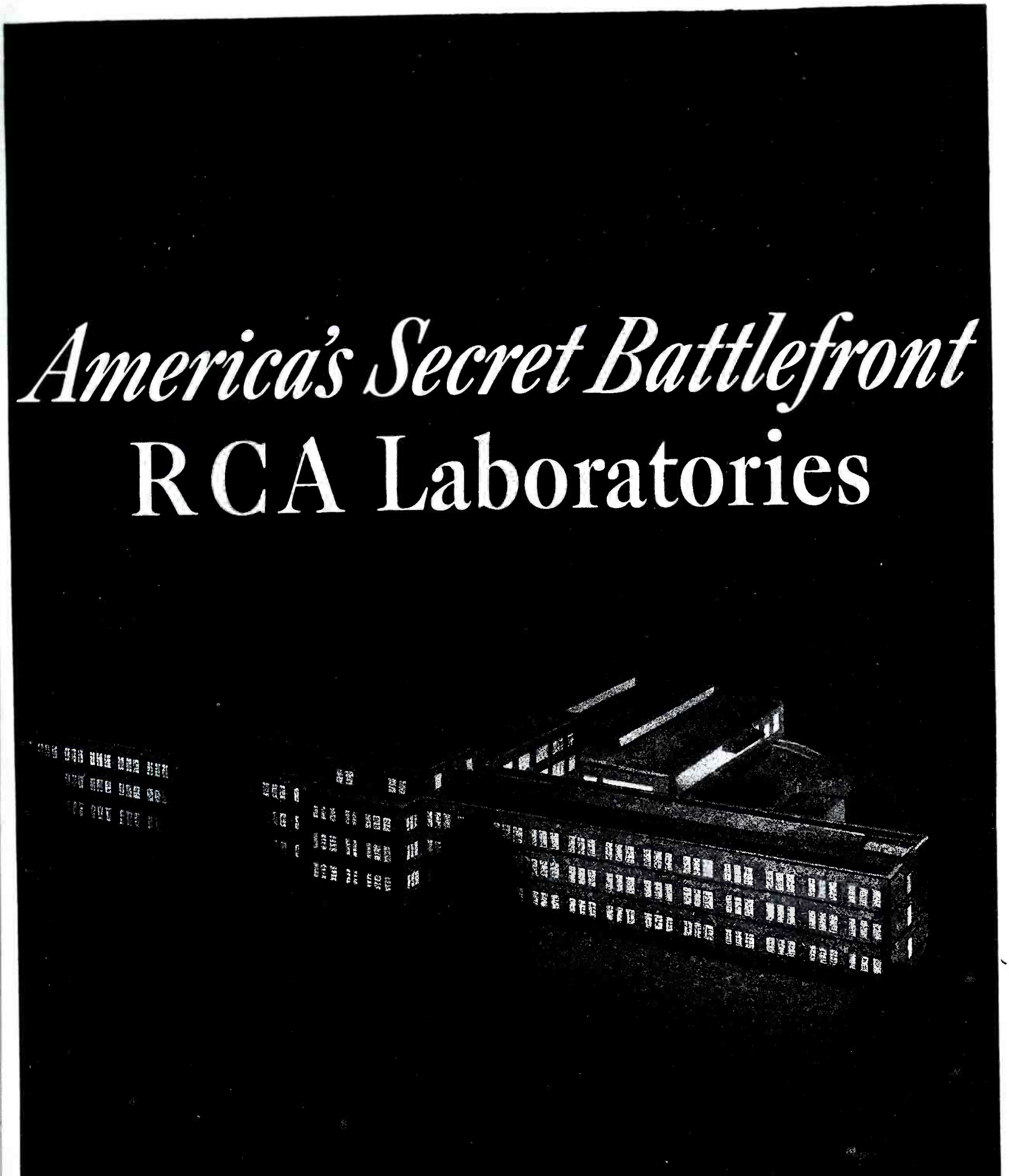

Laboratories

FOR RADIO-ELECTRONIC RESEARCH

(*Continued from page* 43)

bakelite is usually used, although ceramic, polystyrene, and endless varnishes may be used. The bakelite liquid is mixed with a wetting agent in the process, and the iron powder thoroughly stirred into it. The bakelite is then cured, forming a solid mass which must then be reduced to a powder again by a mechanical operation.

If carbonyl iron, which consists of very hard spheres with polished surfaces is used, it is important to remember that the balls are almost touching, being separated by a thin film of cured bakelite varnish. In the mechanical operation of tearing them apart, it is doubtful if the film of insulation splits exactly between the balls. It is more probable it tears loose from one ball, leaving a small bare spot on its surface. With the hydrogen produced soft dendrite, it is probable that the operation will tear the iron particle itself, and also strip insulation from one whole side of the rather flattened piece.

High Resistance of Carbonyl

This reaction is probably the cause of carbonyl core showing thousands of megohms of d-c resistance when measured on a bridge, while the hydrogen core will show only fifty-thousand ohms or less. Two adjacent carbonyl balls might have their bare spots touching, forming a combined path for eddy currents and insulation test, but it is not possible for a third ball to touch the junction so formed. The mutilated and stripped soft hydrogen iron particles, however, when assembled into a core under enormous pressure, can form long chains of short circuits. This may also be one reason that hydrogen iron is unusable at u-h-f.

After insulating the iron particles, a binder is added. This may be about 3% bakelite. This is merely to bind the particles together into a core. It performs no insulating function of any importance. Small amounts of powder are then very carefully weighed for each core. With hydrogen this is done to insure uniformity, but with carbonyl it is doubly necessary, since the material is so hard that if too much is put into the mold it is not compressable, and the mold may break.

The material is moulded with one stroke of the press with many tons of pressure. The heat generated by the operation cures the bakelite and the core is finished. Sometimes additional curing is done, but not very often.

The thickness of the insulation can perhaps be visualized from the fact that one pound of varnish covers many acres of particle surface. It is interesting to note that if a half-inch long core were enlarged to the size of a city gas tank one hundred feet high, the particles would be one-quarter inch in diameter.

Using the Core

After the core is finished comes the problem of its proper use. You might, for instance, choose to trim an inductance to a precise value. Since the total tuning range would only be a percent or so, to adjust for manufacturing tolerances, this places little emphasis on the core, so we will pass on to a more difficult application.

You might choose to increase the *Q* of a coil by using a low loss core and as large as you can afford. You can reduce the number of turns on the coil, as you add iron. At low frequencies of a megacycle, you will find that copper losses have been reduced, but iron losses have been introduced instead. Actually, you are a net gainer, since the copper losses are the greater. At 100 mc however, the copper losses are so low that a *Q* of 700 is easily obtainable, whereas present day cores have rather high losses in this region. Thus iron will not be of much help to you in this situation.

The Core in a Tuned Circuit

The third possibility of core use includes its application in a tuned circuit, such as an oscillator, over a range of frequencies. A disciplined assembly capable of a high order of stability and precision is vital. This presents a real problem. Every possible phenomena, no matter how apparently minor it may seem, must be considered.

Let us set up an ideal circuit of three turns of wire, 3/8" internal diameter and 3/8" long, with a ceramic condenser directly across it. This will provide a minimum of external circuit to worry about. Let us tune this with a condenser of about 20 mmfd so that its frequency is 150 mc. The *Q* may be 700. When we slowly introduce the iron core, we find that many things happen. In fact, so many effects result that we must divide them up into inductive, capacitive, and resistive branches.

Inductive Problems

Let us take the inductive problem first. The ferromagnetic effect of the particles will *increase* the inductance. The eddy currents in each particle, and in chains of short-circuited particles will *decrease* the inductance. This combat goes on in all cores. Thus far it has been impossible to isolate the two effects.

Drill rod serves as an excellent medium to illustrate the combat between the eddy current effect lowering the inductance and the magnetic effect raising it. A drill rod, the size of a pencil lead, will have a preponderance of magnetic effect, and thus increase the inductance somewhat. A quarter-inch drill rod, because of the large short circuited end-turn eddy current effect, will lower the inductance. Somewhere in between a size can be found that will leave the inductance unchanged, due to the perfect balance of these two phenomena.

Concentric Sphere Particles

Another rather successful u-h-f core is composed of carbonyl iron particles in the form of concentric spheres.

There is also some reason to suspect that the thin insulating film may combine with the iron in some way to form a nonmagnetic product that reduces the effective diameter of the particle. Since almost the whole mass of a sphere is in the skin, this loss may be serious.

Since the basic particle is so open to doubt as to its size and structure, the method of calculating values becomes a serious problem too.

Let us return to our tuning problem to study this situation. As the core is introduced it increases the inductance of each turn and also the mutual inductance between each turn and every other turn. The amount of such inductance change, or tuning range, depends on the permeability of the core, its length, and diameter in relation to the internal diameter of the coil, the latter being of great importance.

Core Permeability

To find the permeability of a core, the material is usually made up into a test toroid, and a coil wound on it. Measurements are made at 1 kc, and perhaps at 1 mc. It has been found impracticable to test at 150 mc. Permeabilities may well be twelve, measured this way.

When used in a coil the core will have an *apparent permeability* which depends on the coil as much as the core. In our problem it may be about two-and-a-half. The *apparent permeability* is merely the amount that particular core changes the inductance of that particular coil. If the inductance is increased by two, the frequency will decrease by the square root of two, or 1.414, or 41%. This may be modified by capacity effects.

All calculations on eddy currents versus ferromagnetic effect might be based on particle size. The Germans came out with the theory several years

(*Continued on page* 48)

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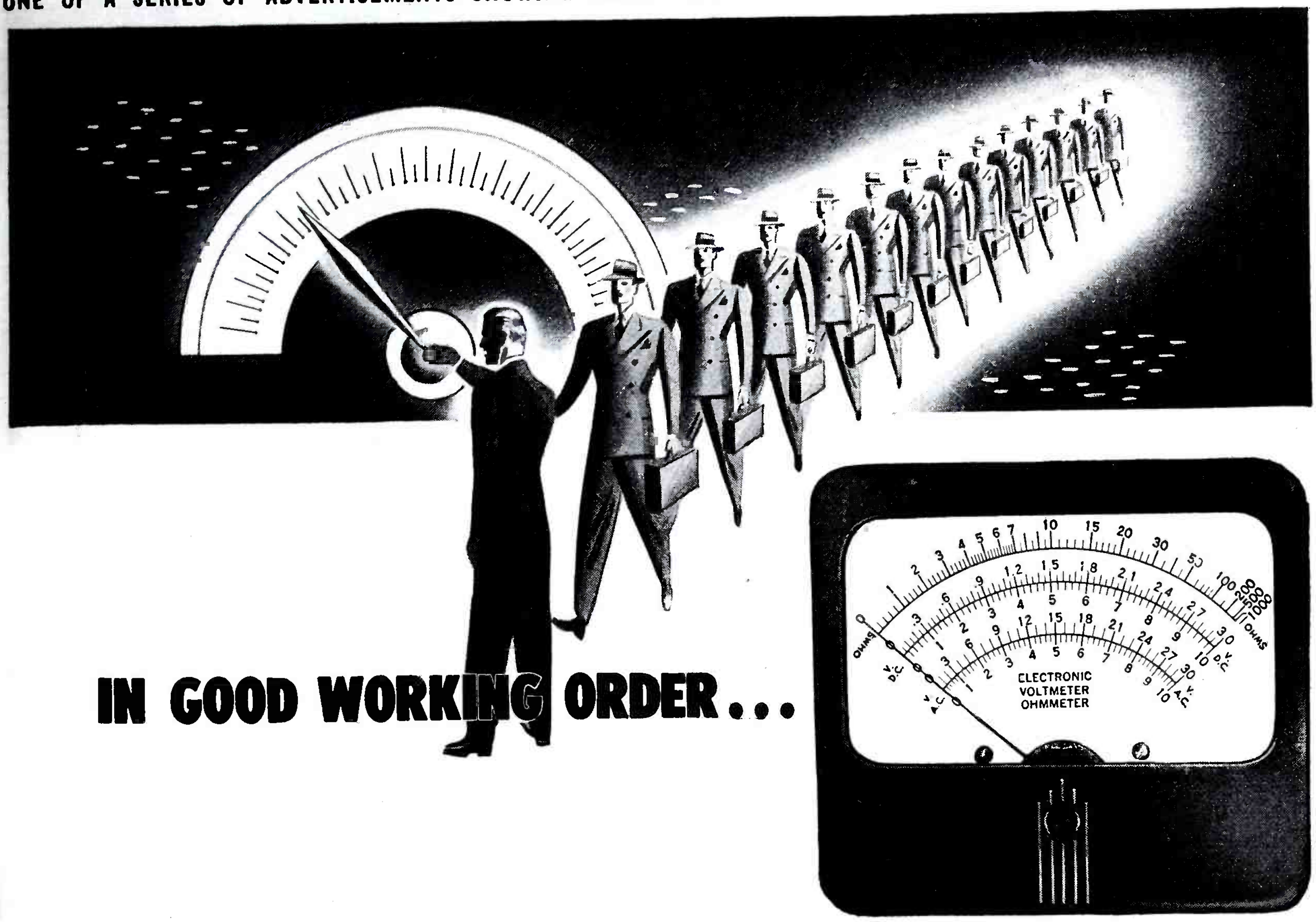

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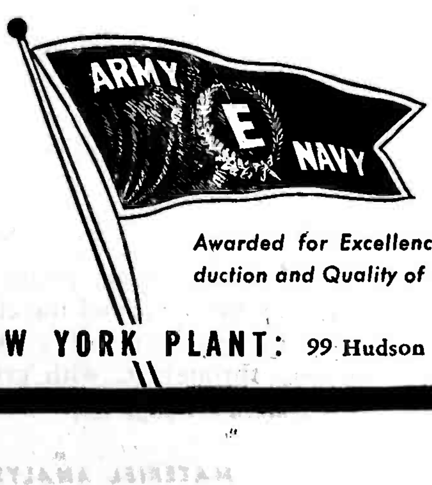

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(*Continued from page 46*)

ago that particle size would have to be reduced as a function of the square root of the frequency. If a ten-micron particle worked at one mc, a one-micron size would be necessary at 100 mc.

Structure of Spheres in Core

It is the nature of the geometry of small spheres that if one-micron balls are assembled into a core, there will be very little iron in the core due to the space factor involved, as well as the insulation problem. Thus the tuning range would be very small. However, two types of cores work rather well at this frequency, but both are internally divided. The magnetite core is atomically divided, in a sense. But, in addition, the lowest loss oxide core ever investigated by the writer had the physical form of rather huge balls, with a structure similar to a cantelope.

These balls were of twenty-five micron size and divided by polar planes into six sectors. They were hollow, the hole being about half the size of the sphere, and apparently each face was strongly magnetized, each one oppositely poled to its neighbor. While domains have no physical existence in the sense of having any mechanical divisions or properties, these sectors did have. For by pressure the balls could be cracked into pieces, with the lines of division along the meridians.

Capacity and the Core

The core is also a capacitor formed of balls of highly conductive material (iron) separated by almost infinitely thin layers of insulation. These occur in chains with their capacities in series and parallel. To investigate the nature of this capacity, two wide copper bands were wrapped around a ceramic tube, into which the core could be introduced. A copper core was laid inside the ceramic tube. Two condensers in series resulted, from one band to the copper core and from the copper core to the other band. This was carefully measured, and then a powdered iron core introduced. Allowing for the direct capacity from band to band, the capacity through the iron core was 40% of that measured with the solid copper core in place. The d-c resistance of this particular core was over a thousand megohms. This showed that the capacity in the core wasn't negligible.

As we introduce our core, then, we are introducing its free capacity to the system, as well as forming series capacitors from turn to turn. If the core is mounted on a conductive rod, and the rod grounded another direct capacity to ground will be introduced.

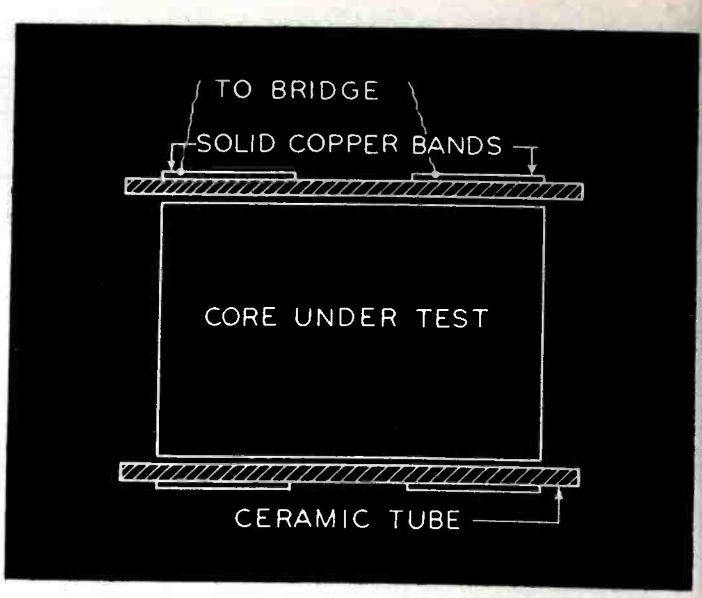


Figure 2
Determining the equivalent capacity of iron cores. The two copper bands shown form two capacities in series, with the core material the common plate. Capacity was first measured with a copper core in place and then the iron core substituted. The iron capacity was about 40% of that of the copper

The resistance introduced by the core originates in several sources. Eddy current losses are probably the most important, followed by hysteresis. Since it is almost impossible to take a good hysteresis curve of the core, we can only guess as the value of this. There are also dielectric losses in the insulation. These values are very difficult to fix, since materials in thin films usually have entirely different dielectric characteristics, than the same material in large cross section.

Insulation Resistance of the Core

On investigating the insulation resistance of a core, it was found to have a pronounced negative voltage characteristic. The thermal change of resistance was also negative. This indicates the possibility of the film being largely carbonized, although it is difficult to see how the necessary temperature to carbonize bakelite could be developed.

We all appreciate the necessity of laminating iron cores used in an alternating current field. When a solid core is used, the core forms a short circuited turn whose area is about the same as the inmost turn of the winding. Consequently the voltage induced in the core is about the same as a turn of the coil. This large area is broken up by the lamination of the core and insulation of each lamination to reduce this eddy current path to a much smaller area. At sixty cycles these laminations can be rather coarse. But as the frequency of operation increases, the laminations must be finer, since we have so many more cycles-per-second, that the loss-per-cycle must be reduced correspondingly, to maintain our watts-loss-per-second to a reasonable value.

The problem of insulation becomes very important, since each lamination must be coated with a smooth coat all over its surface. After awhile the laminations become so thin that a considerable portion of the core area is insulation, which performs no magnetic function. The next step is to use iron wires for the core, but at a million cycles these would have to be somewhat smaller than a mil in diameter. Therefore a core ⅜" in diameter would consist of over 100,000 such wires insulated all over, especially at the ends. This presents quite a mechanical problem.

We usually think of flux in a coil as being axial. But coils at 1,000,000 cycles used with magnetic cores do not have true axial fields, and wire lamination is effective only for truly axial flux. Thus such a core would have serious limitations even if we could make one. The next obvious step is to laminate the core in all directions at once, or use powdered iron.

Since the powdered iron contains within itself a series of air gaps, its permeability must be low. It will thus have no use at power frequencies.

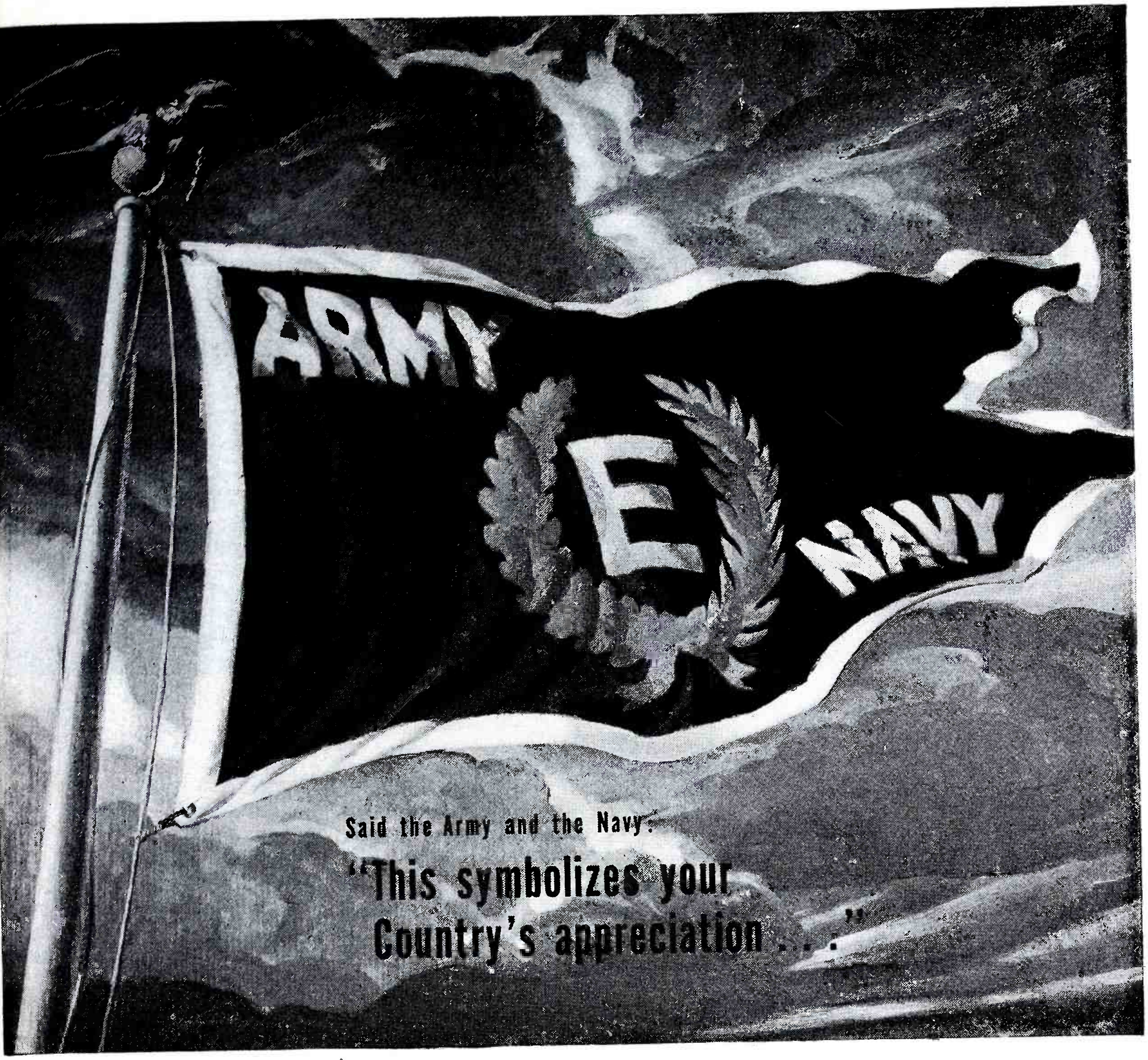
Such powdered iron cores have been commercially used for permeability tuning for some time. Incidentally, the Germans manufactured iron core broadcast receivers in quantity in 1924.

When some cores are mounted between contacts and breakdown voltages of the order of several-thousand volts-per-inch of core length are applied, the resultant breakdown is intermittent and of uniform amplitude and wave form. This might indicate pockets of gas. Because of the tremendous pressures used in assembling the core, this theory, however, is difficult to accept.

Raising the Q

A severe magnetic shock, produced by winding fifty turns around the core and passing the discharge of a 100-mfd condenser through it, with criti-

(*Continued on page 80*)


ARMY
E
NAVY
Said the Army and the Navy:
"This symbolizes your Country's appreciation . . . ."

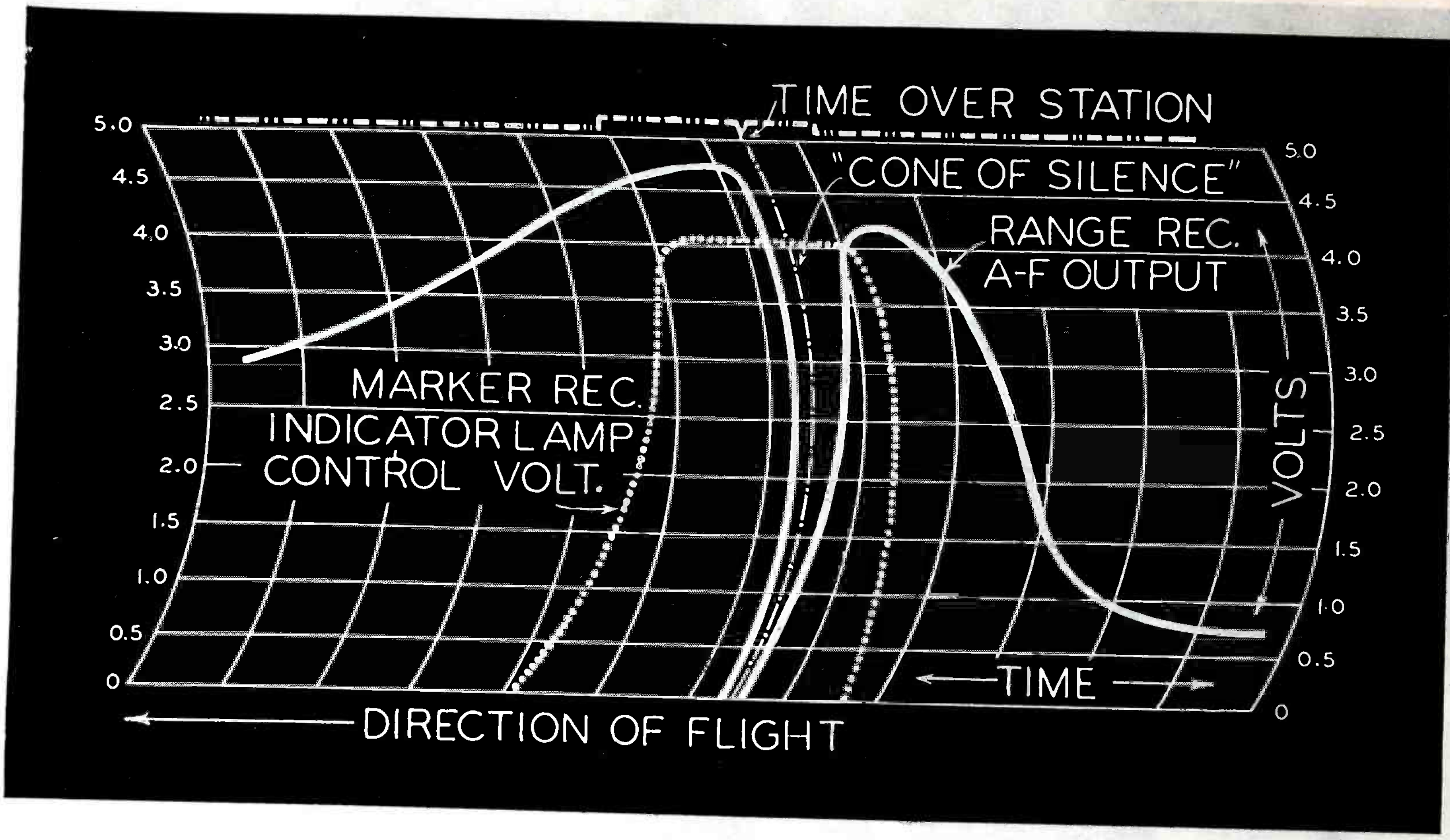


Figure 1
A typical test graph made to determine the characteristics of an antenna system, with a marker transmitter in operation. This was made with an Esterline-Angus recording voltmeter.

NAVIGATION AIDS IN AIRCRAFT COMMUNICATIONS

by RALPH G. PETERS

THE navigation aids on board aircraft, which include the beacon receivers, automatic compass, direction finder and marker receiver, are dependent on an assortment of specially designed ground equipment.

One of the important ground units is the simultaneous range station. This station transmits a directional beacon signal. At specified intervals weather reports are voice transmitted simultaneously with the beacon signals. These stations operate in the 200-400 kc band. The range station consists of two transmitters. One transmitter is alternately connected to one of the two sections of a modified Adcock antenna. The input to one antenna is keyed *A*, while the other is keyed *N*. This keying is done in such a manner so that the *A* and *N* interlock in the equi-signal zones resulting in a continuous tone. At intervals of 30 seconds an indentifying signal, which designates the name of the station, is transmitted first on the antenna that is keyed *N* and second on the antenna that is keyed *A*.

The second transmitter feeds a nondirectional antenna. The carrier frequency of this transmitter differs from the other transmitter by 1020 cps. This arrangement produces a 1020 cps side band. When so desired this second transmitter is modulated and used for voice transmission of weather reports and for communication with aircraft. On the aircraft, filters are used to select either the voice or the 1020 cps audio component output of the receiver. Immediately preceding a voice transmission a *warning signal* is transmitted to indicate to the pilot, who may have the voice rejection filter in use and would otherwise miss reception of the voice transmission. This signal consists of a series of dots.

The Adcock System

Each of the two pairs of antenna of the Adcock system maintains an antenna field pattern that is referred to as a *figure of eight*. Certain sections of the field pattern are of equal-signal. This is the *on-course* radio beam signal sector.

Low frequency low power marker stations (designated type *M*) operate in the beacon band of 200-400 kc. This type of station transmits a non-directional signal of limited coverage with a single letter indentification which is keyed continuously. These stations usually operate on two frequencies. The assigned frequencies are those of the two radio range stations located on the course on each side of the *M* marker transmitter.

The purpose of the u-h-f markers are to indentify and designate certain ground location to the aircraft in flight during adverse weather conditions. As in contact flight, with visibility that permits observation of known check points, the radio marker provides a check point under conditions when the ground is not visible.

Marker-Transmitter

The *marker-transmitter* station located on the ground operates on a car-

THE ONLY REAL HERMETICALLY-SEALED RESISTORS

...that will stand the most severe salt water immersion and temperature shock tests

SPRAGUE

KOOLOHM

POWER WIRE WOUND RESISTORS AND METER MULTIPLIERS

These Koolohms, designed for the toughest resistor applications facing the industry today, again emphasize the importance of exclusive Koolohm construction features combined with Koolohm engineering ingenuity in solving almost any wire wound resistor problem.

For Koolohms are entirely different from conventional wire wounds. There are no other resistors like them. No other type of resistor can match their performance on exacting jobs. AVAILABLE WITH NON-INDUCTIVE WINDINGS. Get the facts! Write for catalog and sample Koolohms. SPRAGUE SPECIALTIES COMPANY (Resistor Division), North Adams, Mass.

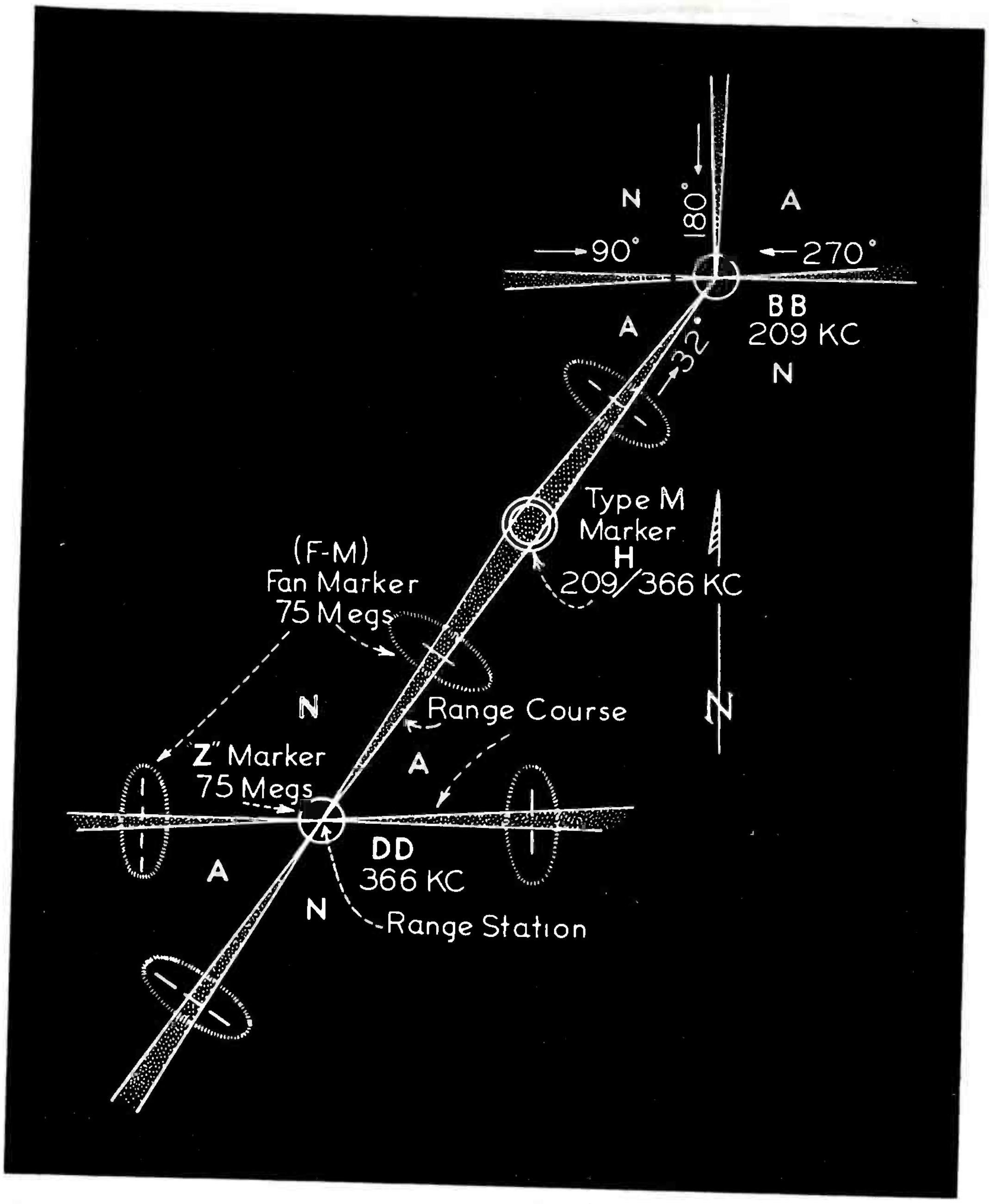


Figure 2
A section of a radio range chart illustrating the various marker positions.

rier frequency of 75 mc. The rated power output is 5 watts and 100 watts. The latter is used for the fan type markers. All marker transmitters are crystal controlled. Dual transmitters are used with automatic change over switches, which operate when the carrier of one unit fails.

The antenna array is such design that the radiation is projected vertically to a considerable height while the horizontal section is comparatively of small area.

While all markers operate on a carrier frequency of 75 mc, the modulation frequencies, and whether keyed or not keyed, are adapted to the marker stations to classify them as to their type of service.

The *Z* zone marker transmitters, whose carriers are modulated continuously at 3000 cps, are used in conjunction with the radio range station and supplement the radio range *cone of silence*

The Cone of Silence

This *cone of silence* is in that area, directly over the station, where an absence of signal exists. While in this short paper no attempt will be made to explain the technique of range flying, a few important range facts will be analyzed. It must be remembered that in addition to the course guidance given by the radio range, the indication of *over-the-top* of the station, is of importance as a radio check point along the airways. This is first indicated by a gradual signal build-up as the station is approached. Then as we come near the station we have a signal surge. Then comes the *cone of silence* (*COS*), then a larger surge and finally a gradual decrease in signal. The *COS* should occur directly above the station.

One of the factors that affects the marker and *COS* is the type and the location on the aircraft of the antennae used with these receivers. The desired response is that the *COS* and *Z* marker occur simultaneously at the time that the plane passes over the top of the range station. This is relatively easy to accomplish at altitudes less than 4000 feet provided the ground station characteristics are normal and the proper type antennae is used on the aircraft. At higher altitudes great accuracy is not required. The graph shown in Figure 1 gives an example of the desired coordinated response of the range and marker over the station.

This graph represents a typical test that was made to determine the characteristics of the antenna system. An Esterline-Angus recording voltmeter is well suited for this test because it provides a record of the condition where rapid changes are taking place in a matter of seconds of time. To obtain the desired data it is necessary to correlate recorded voltages during this brief interval with reference to the exact time over the station. The time over the station during the radio test flight was recorded by actuating an auxillary pen that operates on the margin of the graph. The time over the station was observed through a port located in the bottom of the aircraft. When the ground station was lined up in the *sight*, the observer by remote control, operated the margin pin.

Fan Markers

The *FM* (fan marker) transmitters are located on the radio beacon course, usually 20 to 25 miles from the range station. This type of marker is generally used as a holding point pending clearance to proceed to the airport for a landing. It is also used as a check point in connection with the descent in preparing for an instrument approach to the airport.

The fan markers are identified by use of 3,000 cps modulation and keyed in accordance with its geographical relation to the radio range station. Beginning on the north leg of the radio range, the marker so located is keyed the letter *T*, east *M*, south *O* and west *CH*.

The fan marker major axis of the elliptically shaped (cross sectional) pattern in the horizontal plane is at right angles to the radio beacon course. The minor axis is in line with the course.

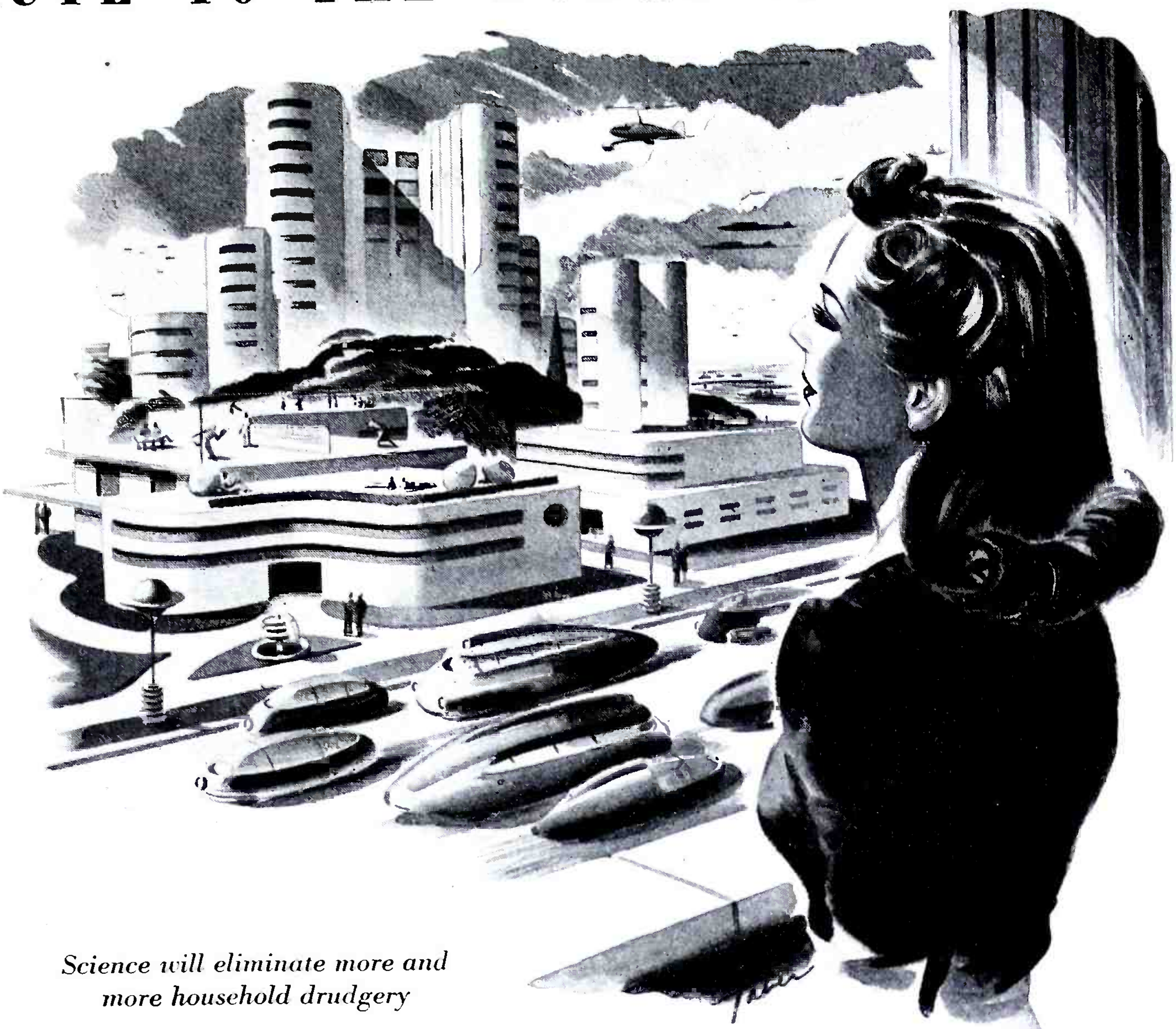
The Approach Marker

An approach marker is modulated continuously at 400 cps. It is used in connection with the *let-down* procedure that is used with an instrument approach to the airport.

The *inner* and outer markers are used with an instrument landing system. They are designated *I* and *O* respectively.

The outer (*O*) marker is modulated

SALUTE TO THE WOMEN OF TOMORROW!



Science will eliminate more and more household drudgery

RESEARCH AND INVENTION have been speeded up by the war — the tragedies of today will, in the not-too-far-distant future, be transformed into the blessings of peace.

The women of tomorrow will step out of the bondage of household chores into more zestful, more creative living. More and more, they will share with men in the re-making of this world.

Typical of the forward-looking companies which will translate the visions of today into the actualities of tomorrow is Small Electric Motors (Canada) Limited.

This virile, rapidly-expanding industrial organization, now engaged solely in war work, is planning an important post-war future. From its large, modern plant will come electrical equipment of revolutionary design — for ships and planes — for factories and homes!

DESIGNERS
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Gyros, etc.

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and its subsidiary

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2-43

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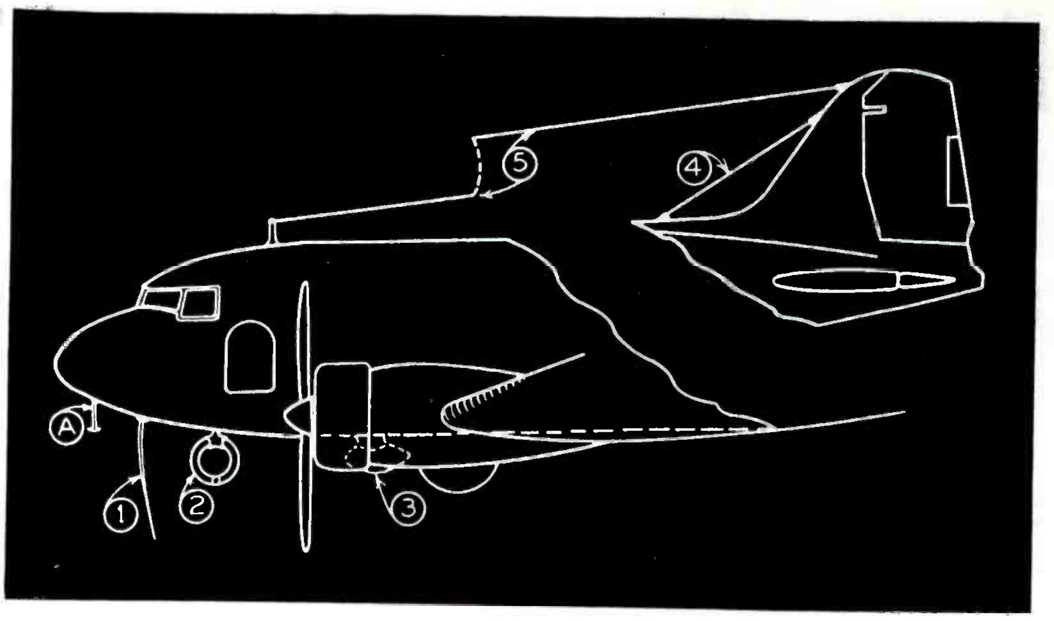

Figure 3
Position of antennae on aircraft. At *A* pilot tube support for wire antenna; *1*—whip antenna; *2*—electrostatic-shielded loop antenna; *3*—automatic radio compass loop antenna; *4*—inclined wire antenna, and *5*—high frequency communications antenna.

with 400 cps and keyed so as to produce equal length pulses at the rate of two per second.

The inner marker carrier is modulated with 1300 cps and keyed so as to produce equal length pulses at the rate of six per second.

One type of radio instrument landing system utilizes the marker receiver as a part of the aircraft instrument landing radio equipment. Four separate elements comprise the instrument landing system, viz., a localizer to furnish lateral guidance, a glide path to provide the path of descent and the inner-outer markers to indicate the progress along the course determined by the localizer and glide path.

Simultaneous Range Station

The simultaneous range station (*TL*) uses the modified Adcock antenna system, which supersedes the original type loop antenna range stations (*ML*). Loop type stations, as the name implies, employ a transmitting type loop antenna. This type station is now used at a few locations that require a low power directional radio beacon.

The marine radio beacon, while primarily intended for use by ships, are of *no* small service to the aircraft. They are used in connection with taking radio bearings with the aircraft radio direction finder (*DF*). Marine beacons are used in addition to the radio range station for *DF* purposes. The frequency of these stations is within the 200-400 kc range band. These marine beacon stations are usually operated in groups of three. Three stations of one group operate in sequence on one assigned frequency. This is an advantage, as three bearings can be taken in succession without retuning the receiver. The percentage of modulation is high compared with that of the range stations. However, the carrier is keyed in most cases and this feature is not entirely satisfactory for use with the aircraft automatic radio compass, but satisfactory aural null *DF* operation is obtained. Various frequencies for modulation are used. For identification purposes, the carrier is keyed continuously during the period of operation with a single letter. In some cases—and particularly the beacons located on light ships—a combination of two tones (modulation) is used in lieu of the identification letter system. This identifying characteristic is referred to as a high and a low; or two highs and a low, etc. In the latter method, it is a transmission of a modulated signal that consists of two dashes of a high audio frequency and one dash of a low frequency.

Antennae

Antennae play an important role in aircraft communications, too. And there are special types required for various services.

We have, for instance, the *whip* type antenna, a stainless steel tapered shaft with an approximate length of five feet. It is mounted in a rubber recepticle base. This type antenna is used with the marker receiver, range receiver and *sense* antenna for the radio compass. With the use of an antenna coupling unit the marker and the range receiver may be connected to the same receiver. Other type antennae suitable for this service is a horizontal wire *tee* antenna and a *vee* antena. Usually the forward support for these wire antennae is the pilot tube (A, Figure 3).

Electrostatic Shielded Loop

The electrostatic-shielded loop antenna is another important type. The shield is constructed of aluminum tubing. The somewhat standardized mean diameter is nine inches. This loop is used with associated equipment for a direction finding attachment in conjunction with the range receiver. A shielded loop affords an effective means of greatly reducing rain static.

A third type is the automatic radio compass loop antenna assembly which is inclosed in a streamlined housing.

An inclined wire antenna is still another type used. It is supported at a point on the vertical fin and on the top of the fuselage, and is satisfactory for use with the second range receiver.

For high frequency reception, an antenna mounted in the position, shown Figure 3 is used.

Future Developments

Future developments on larger and faster aircraft no doubt will make radical departures from the present type antenna. Antennae for u-h-f could be installed within plastic sections of the aircraft. One possible consideration is a location in the vertical fin. Another possible scheme is the retracting type where it would only be necessary to project the antenna in the slip-stream when the service of that particular unit is needed.

Retractable antennae possess certain advantages in that they could be replaced in case of failure during long flights. This refers particularly to loop antenna assemblies, since there is very little that does go wrong with simple types of antennae.

Other factors concerning aircraft antennae designs are their natural mechanical vibration periods, their susceptibility to ice collection and, of course, their electrical interaction. An example of the latter is an automatic radio compass loop antenna located near an antenna used with a superheterodyne receiver, where its oscillator may radiate a signal on or near the frequency of a station having its radio bearing taken.

Micro-Wave Transmission

In discussing future developments, the radio compass and the u-h-f marker must be considered. For both, serving so vital a function now, will be even more important as air traffic increases.

Accordingly, we can look for the use of micro-wave transmission with horn type radiators, for markers,

(*Continued on page* 87)


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JAMES KNIGHTS Co.
You...
will use James Knights Precision Crystals in your broadcast receivers of tomorrow! Today, new James Knights developments make it possible to supply large numbers of Crystals of many types for the Nation's needs. If you have a vital Crystal problem—we can help you.
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PRECISION CUTTERS OF QUARTZ
FOR RADIO AND OPTICAL USES
The JAMES KNIGHTS Co.
SANDWICH, ILLINOIS

NEWS BRIEFS OF THE MONTH . . . —

RCA LABS AWARDED "E"

The Army-Navy "E" has been awarded to RCA Laboratories, Princeton, New Jersey. This is the fourth "E" pennant to be won by the RCA organization. The presentation was made by James Forrestal, Under Secretary of the Navy.

* * *

FRISCHE NOW SPERRY CHIEF RESEARCH DIRECTOR

Carl A. Frische has been named Chief Research Director of The Sperry Gyroscope Co., Inc.

Mr. Frische succeeds Hugh Willis, who is now general sales manager.

In his new post, Mr. Frische assumes charge of the company's Garden City, L. I. laboratory.

* * *

MELLICK NOW GOAT METAL S-M

Carlton Mellick has been appointed sales manager of Goat Metal Stampings, Inc., Brooklyn, New York, as well as The Fred Goat Co., Inc., and Swing-O-Ring, Inc.

Mr. Mellick served in Washington as special WPB representative for the Tin Conservation Division.

Carlton Mellick

WARTIME TUBE SUBSTITUTION CHART

The sales engineering department of National Union Radio Corporation, Newark, New Jersey, has released a wartime tube substitution chart which includes a functional cross index.

The compilation indicates substitutions of approved Government types for 288 types available prior to the Government limitation order.

Preferred substitutions are shown in each instance and types are coded to indicate necessity of changes such as changing sockets, changing bias, using external shield, using filament shunt, rewiring sockets, etc.

In addition to the interchangeability listing, a functional cross index shows the replacement with regard to functional considerations versus heater considerations.

A copy of the chart may be obtained by recognized servicemen and technicians on request to National Union distributors in local areas.

* * *

ADMIRAL HOOPER NOW IN PRIVATE PRACTICE

Rear Admiral Stanford Caldwell Hooper USN (Ret.), has opened a New York office, as a consulting engineer.

Automatic Electric Company, Chicago, will be one of his clients.

* * *

TRANSMITTING TUBE CONSERVATION RECOMMENDATIONS

The NAB Engineering Department recently asked vacuum tube manufacturers to submit recommendations covering the stand-by operating conditions that would assure the maximum life from transmitting tubes. Differences of opinion existed among the manufacturers and the problem was further complicated by the variety of tube types to be considered. The manufacturers coordinating with the RMA Transmitting Tube Committee have, however, now provided a series of recommendations that have just been released. These data appear below.

FRANKLIN MEDAL TO GEORGE WASHINGTON PIERCE

George Washington Pierce, noted communications inventor, has been awarded the Franklin Medal at the Franklin Institute, Philadelphia, Pennsylvania.

Professor Pierce is the author of two standard works, *Principles of Wireless Telegraphy* and *Electric Oscillations and Electric Waves.* Professor Pierce developed the mercury vapor detector and amplifier, the equivalent to the *thyratron* developed later by G. E. He is also known for his development of the famous Pierce oscillator circuit.

* * *

JESTER, ELLMORE AND HUDSON NEW UTAH VICE PRESIDENTS

Oden F. Jester, Austin Ellmore and Remy Hudson have been elected vice-presidents of Utah Radio Products Company, Chicago, Ill.

Mr. Jester now vice president in charge of sales, has been with Utah for

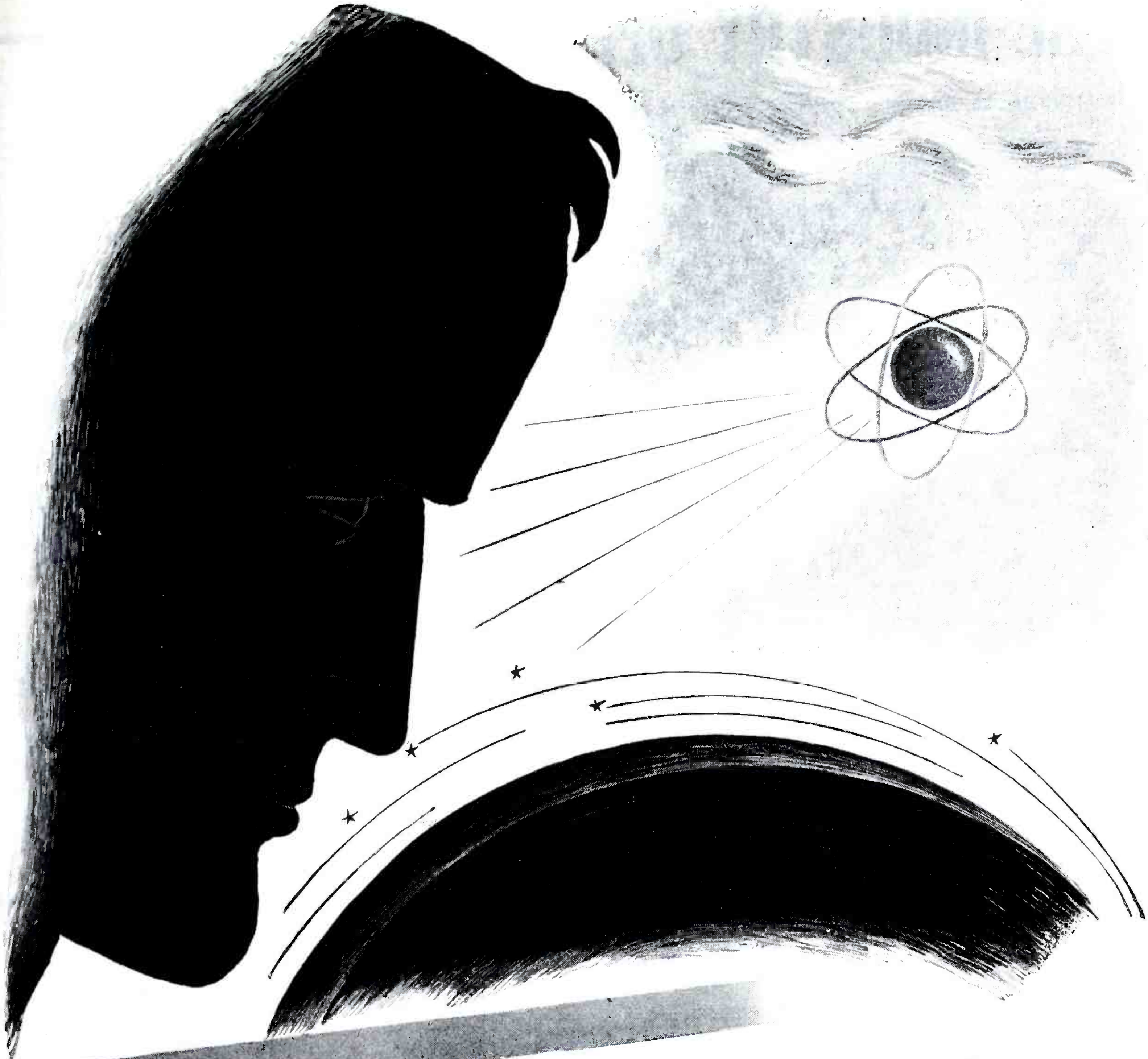
(*Continued on page* 71)

Oden F. Jester

Tube Type by Kind of Filament or Cathode	**Operating Conditions** *Normal Load Operation*	*Light Load; May-Increase Life*	**Recommended Stand-by Conditions (% of Normal Operating Voltage)** *Under 15 Minutes*	*15 Min. to 2 Hours*	*2 to 12 Hours*	*Over 12 Hours*	*Typical Tube Types*
1. Pure Tungsten filament.......... (small and medium types)	100*	Reduce	80	80	off	off	207, 891R
2. Pure Tungsten filament........... (large types)	100*	Reduce	80	80	80	off	895, 899A, 898
3. Thoriated Tungsten filament...... (small and medium types)	100	95-100	80	off	off	off	211, 803, 851
4. Thoriated-Tungsten filament...... (large types)	100	95-100	80	80	off	off	827R, 861
5. Oxide-coated filament............ (small and medium-gas, vapor)..	100	100	100	100	off	off	866A, 872A
6. Oxide-coated filaments or cathodes (large-gas, vapor)	100	100	100	100	100	off	857B, 870A
7. Oxide-coated cathodes........... (high vacuum)	100	95-100	100	off	off	off	807, 837
8. Oxide-coated filaments........... (high vacuum, quick heating)	100	95-100	80	off	off	off	1616, 1619, 1624

Percentages of rated normal filament voltages to be used under various operating and stand-by conditions to give maximum filament life.

**Normal load operation may be less than 100% as recommended in instructions.*



NOSE TO THE GRINDSTONE

"Our noses are held to the grindstone of war production . . . but our eyes are fixed on the future." This is how one Stancor engineer described our present operating policy.

War problems are urgent, challenging, and stimulating. To solve them calls for midnight oil; but the lessons learned and discoveries made apply also to the problems of peace. When the war is won, industry will be confronted by a revolutionary development of electronic engineering . . . and Stancor engineers, seasoned by war demands, will be ready to serve you.

STANCOR

STANDARD TRANSFORMER CORPORATION
1500 NORTH HALSTED STREET · CHICAGO

THE INDUSTRY OFFERS

WESTINGHOUSE HIPERSIL CORES

Hipersil cores which are said to offer 1/3 more flux-carrying capacity, with less size and weight, are described in a new 12-page Westinghouse booklet.

Hipersil cores are designed for radio transformers, chokes, relays, reactors and loading coils. Construction of a type C core, according to the new boklet, consists of (1) in winding the Hipersil strip continuously on a mandrel of desired dimensions. After the core is wound, it is annealed at high temperature (2). The core is then vacuum impregnated with a plastic compound to make it a solid unit (3). The impregnated core is then cut in two segments, the ends of which are machined and worked in such manner to produce coinciding surfaces when reassembled (4). In step (5) a check test is made for fidelity of performance. Cores are assembled on coils by means of metal bands, tightened with a special tool to insure correct tension at all times (6).

Also contained in the booklet are charts of recommended Hipersil applications, performance curves which compare Hipersil and ordinary silicon steels, tables showing complete range of core sizes available, and diagrams of the type *C* core assembly.

* * *

KULKA LAMP SOCKETS

A variety of special type lamp sockets are now being made by the Kulka Electric Manufacturing Company, Inc., 30 South Street, Mount Vernon, New York. The types include bayonet and screw base candelabra types. Also being made are terminal blocks, weatherproof sockets, wire cable thimbles, fluorescent lamp holders, etc.

* * *

NEW MAGNETIC CORE MATERIAL

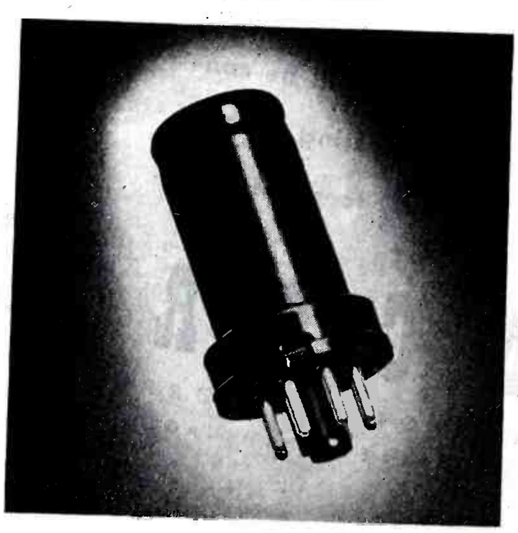
Advance Solvents and Chemical Corporation, 245 5th Ave., New York City, has recently announced a new magnetic core material called Advance 500 A. It is said to be especially well suited for Hi-Q and ultra-high frequency applications.

* * *

MECK TUBE TYPE CRYSTALS

Quartz crystals housed in conventional metal tube cases are now being produced by John Meck Industries, Plymouth, Indiana.

By means of this mounting, freedom from moisture and atmospheric pressure changes are said to be secured.

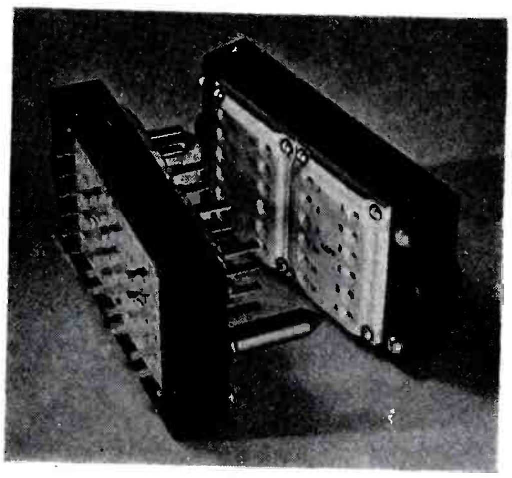


LAPP PLUG-RECEPTACLE

A new type of plug-receptacle assembly has been announced by Lapp Insulator Co., Inc., LeRoy, N. Y. It is for use with panel-rack type of radio equipment. It has full-floating contacts. Because of the fact that steatite is used as the insulation, it has a particular high order of resistance to flashover and surface tracking.

In construction, each plug and receptacle consists of a zinc die-casting on which are mounted four ceramic plates, which hold the metal contacts in full floating position. At the ends of the male plug are accurately machined steel pins, which engage corresponding holes in the female receptable. This is said to afford positive and accurate alignment.

As now produced, the design provides 24 contacts. Considerable freedom in circuit design is permitted, as contacts can be chosen so that high-voltage conductors are relatively isolated one from another.



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INDUSTRIAL AMPERITE BALLAST

A voltage regulator tube, decreasing 40% voltage variations experienced on railway signal systems to 5%, has been developed by the Amperite Company, 561 Broadway, New York City, New York. It is said that this new device is not affected by temperature or humidity conditions. A standard screw base is available for this type. However, similar regulators can be furnished with a standard radio octal base. A four page illustrated folder is available.

* * *

PRINTLOID'S PLASTICERAMIC

A new insulating material, Plasticeramic, is now being offered by Printloid, Inc., 93 Mercer Street, New York City. Its color is black and after machining it resembles in texture unglazed porcelain. The comparison of machinability would be similar to the difference between ordinary brass and "free turning" brass used in screw-machine work.

The average dissipation factor of plasticeramic at 1 mc is said to be .00036. At 100 mc, it is said to be .00088.

These characteristics are said to compare favorably with polystyrene which has a constant dissipation factor of .0003 at frequencies ranging from 1 mc to above 200 mc.

* * *

EMBY HALF-WAVE RECTIFIER

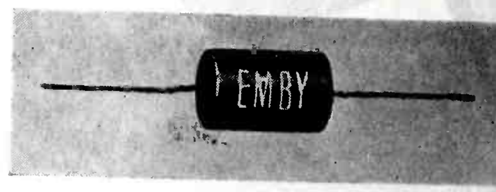
A selenium rectifier of the half-wave type hermetically sealed and known as type N, has been added to the instrument and relay selenium rectifier line manufactured by the Selenium Corporation of America, 1800 West Pico, Los Angeles, California.

Working temperature range extends from —70° C to +75° C, with a negative temperature coefficient, exhibited. All associated equipment, such as meters, relays, etc., have positive temperature coefficients with resulting compensation, when used with selenium rectifiers.

There are two rectifying elements 5/32" in diameter assembled in a tubular plastic case 15/64" in the N-2. It is rated at 10 volts a-c.

The d-c current rating for a continuous load is said to be 1 ma, for instantaneous load, 3 ma.

Impedance in the forward direction is 1,000 ohms. Impedance in reverse direction is 1 megohm per plate.

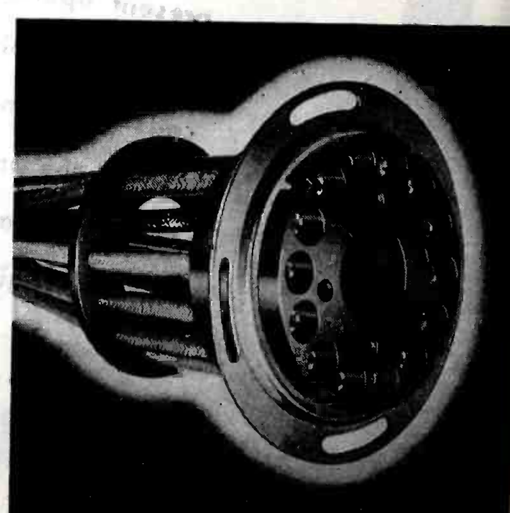


* * *

FRANKLIN CATHODE-RAY SOCKET

One piece moulded construction cathode-ray tube sockets, designed to completely enclose and seal the contacts against temperature and humidity conditions are now being made by Franklin Manufacturing Company, 175 Varick Street, New York

(*Continued on page* 60)



THE INDUSTRY OFFERS . . . —

(*Continued from page* 58)

City. This one piece socket is said to provide a high voltage flashover at high altitudes and high resistance between adjacent pins. The socket also has a strain relief ring that is said to protect the soldered joints against vibration pull or twist of the wires.

Sockets are supplied in either assembled units complete with cable or ready for assembly.

* * *

ANDREW COAXIAL ANTENNA

A half-wave vertical coaxial radiator for from 30 to 200 mc has been developed by the Victor J. Andrew Company, 363 East 75th Street, Chicago, Ill.

The upper half of the antenna is a whip of conventional design. The lower half, or skirt, is a 2½" tube. The entire assembly is supported by a 1 5/16" support pipe 12 feet long, which is attached to a mast with a clamp that is provided. Overall length including support pipe is about 20 feet and weight is 48 pounds.

No impedance matching devices are said to be required. The whip and skirt are cut to length at the factory for the exact operating frequency. The unit is designed to be fed from a 70-ohm coaxial transmission line. Fourteen feet of ⅞" coaxial cable are provided with the antenna.

* * *

AUTOMATIC ELECTRIC TINY RELAYS

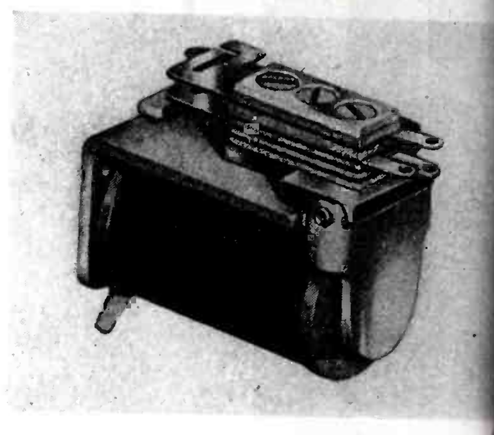
A line of tiny relays, providing twin contacts, *built-in* vibration resistance, and a wide range of operate and release speeds has been announced by Automatic Electric Company, Chicago. Developed primarily for use in aircraft, these relays, known as class *S*, are being adopted also for electrical control applications in many other fields.

Typical assemblies, having a maximum of six contact springs, are ¾" x 1½" x 1⅜" in size and weigh 1 2/3 ounces. Assemblies with maximum capacity of 12 springs are slightly larger, and weigh about 2 ounces. Relays can be supplied with any number of springs up to the maximum and with any combination of *make, break* and *break-make* contact arrangements.

Vibration resistance is provided by torsion. This is said to insure against false operation or release of contacts at up to 10.5 G.

Operate speeds range from 2 to 16 ms.; release speeds from 5 to 85 ms.; coils are available from 150 to 3,500 ohms, for operation at up to 48 volts, d.c.

Mounting and operating data will be sent on request.



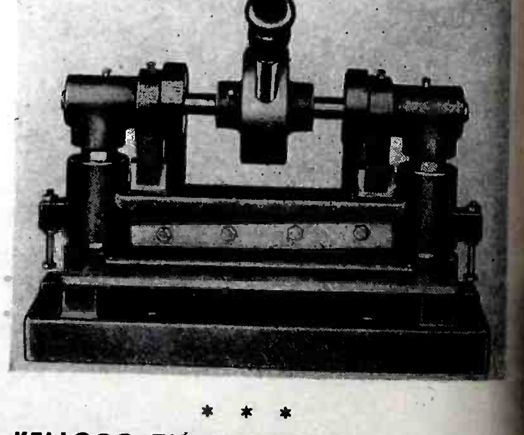
* * *

NINE INCH DI-ACRO SHEAR

A Di-Acro shear, No. 2 type with a maximum shearing width of nine inches, has been produced by the O'Neil-Irwin Manufacturing Company, Minneapolis, Minnesota.

The maximum shearing capacity, full width, of this new device is said to be 22 gauge steel plate. The blades are reversible.

The unit is said to be suitable for precision work on light and medium weight metals and materials that cannot otherwise be rapidly worked to accurate tolerances with a hand operated *scissors* shear or with a heavy operated floor type shear. It can be arranged for shearing, slitting, squaring, stripping or notching. Ductile and pliable metals and materials including light weight tissues, can be cut with this shear.



* * *

KELLOGG THROAT MIKES

Throat microphones, that fit snugly

(*Continued on page* 62)

To tyrants not will I bow my head
Nor sell my soul for the sake of bread
Willingly I bear sacrifice and pain
Willingly I serve in democracy's name
Until my debt to humanity has been paid
Will I face the dawn unafraid

From the Atlantic to the Pacific; from the great cities to the tiny hamlets; from the mighty and the humble — come tangible evidences of America's payment to humanity.

Giving of our sons and our resources and our dollars . . . to free the world from dictators and tyrants. We of Kenyon know that building a better transformer is but a small accomplishment when you consider the whole of the war effort. However, that is our part, and we're giving it our best . . . and when the dawn of peace-day breaks, we'll be tremendously thankful that we did. Come on—everybody—faster, better—better, faster!

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

YOUR PINT OF BLOOD CAN SAVE A SOLDIER'S LIFE... VISIT YOUR LOCAL RED CROSS BLOOD BANK TODAY!

THE INDUSTRY OFFERS . . . —

(*Continued from page* 60)

against the throat, are being manufactured for the U. S. Army Signal Corps

by the Kellogg Switchboard and Supply Company, Chicago, Ill.

* * *

G. E. OUTDOOR PHOTOELECTRIC RELAY

A general-purpose photoelectric relay for outdoor use has been announced by the electronic control section of G.E. Designated as the type CR7505-K108, it is for applications requiring rapid and accurate counting, controlling, sorting, or limiting operations. Its contacts control 2 amperes at 115 volts, 25- to 60-cycles, alternating current, or 0.5 ampere at 115 volts, direct current.

A GL-930 phototube and a 117P7GT pliotron tube are used in this new relay. This amplifier tube is said to provide two features. Its filament operates on full line voltage, eliminating the need for a filament transformer; and it incorpo ates a diode rectifier which functio when a-c power supply is used.

The relay has a weatherproof ca equipped with a sun shield and a lar directional lens system to minimize t effect of slanting run rays. In additio the lens system increases the relay sensitivity.

The relay can be mounted in any pos tion and can be adjusted under actu operating conditions, without removir the cover.

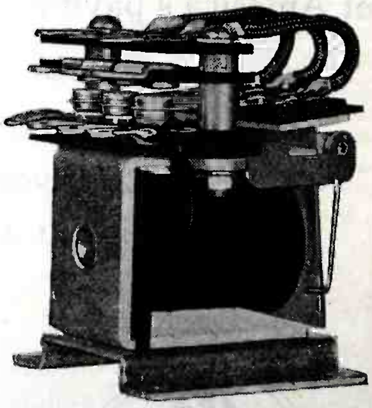
* * *

GUARDIAN AIRCRAFT RELAY

A relay for aircraft applications, serie 345, has been designed by Guardian Elec tric, 1623 West Walnut Street, Chicago Ill. It is available in contact combina tions from single pole, single throw, u to three pole, double throw. Dimension are 2⅜" x 2 1/32" x 1 11/16". Contacts rated 12 amperes at 24 volts d-c, are sai to be arranged to resist over 10 G. ac celeration and vibration in all positions

Coil resistances range from .01 ohm t 15,000 ohms in a varnish impregnate and baked coil. Standard voltages are 1 to 32. Other values are available. Bear ing is pin type, of hardened, non-mag netic, stainless steel and staked to th armature hinge. Armature return spring is torsion type to maintain an even spring pressure.

Relay parts are plated to resist de terioration under conditions of high hu midity. Circular 345 with full details i available from the manufacturer.



* * *

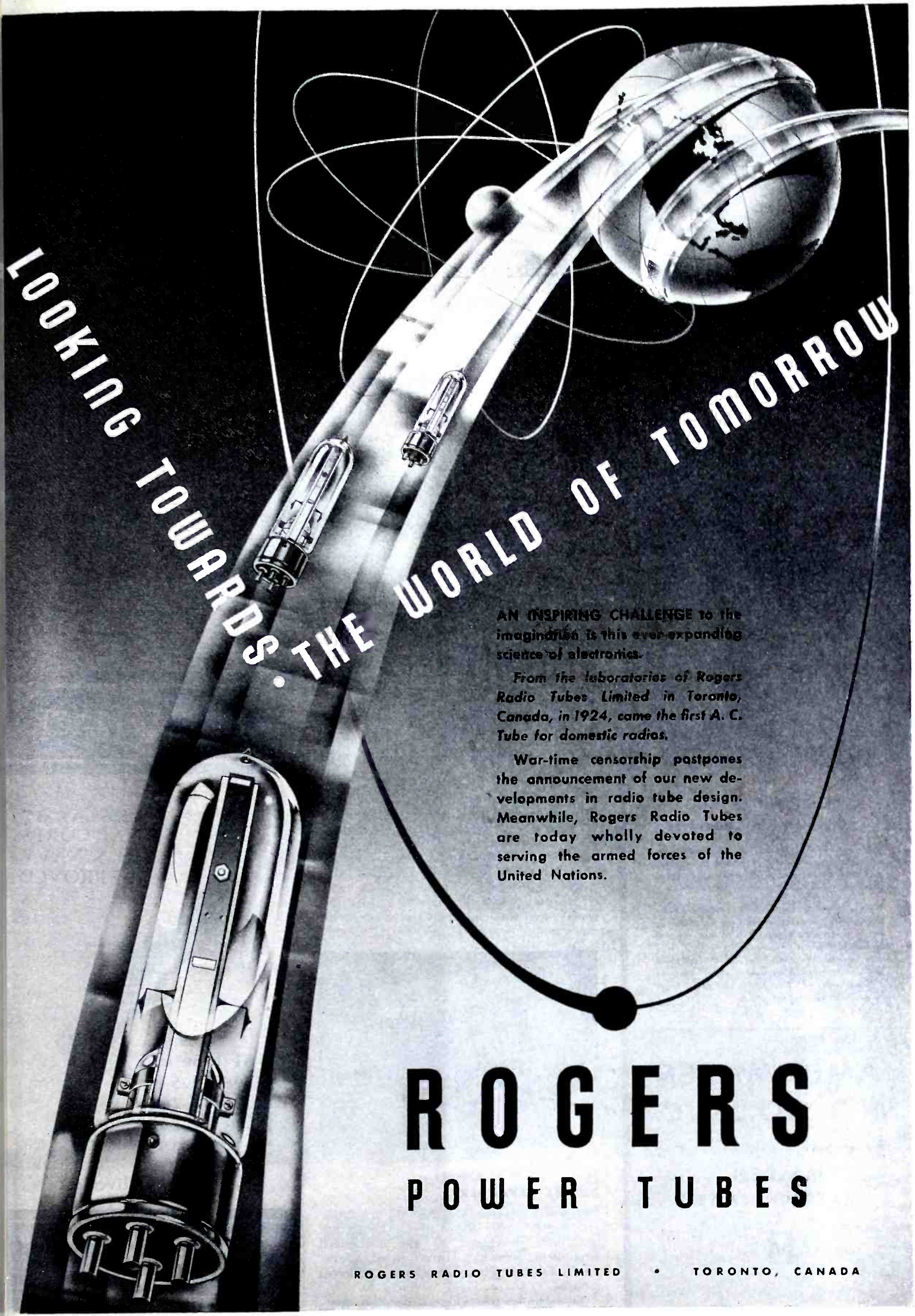
NON-RUBBER, WATERPROOF SEALING TAPE

A waterproof, pressure-sensitive cloth tape, which is made without the use of rubber is now being produced by the Mystik Tape Division of Chicago Show Printing Company, Chicago, Ill.

It is non-toxic and therefore available for sealing packages of medicine, blood plasma, foods of all sorts, surgical dressings and similar products.

The manufacturer claims that this tape

(*Continued on page* 64)


LOOKING TOWARDS THE WORLD OF TOMORROW
AN INSPIRING CHALLENGE to the imagination is this ever-expanding science of electronics.
From the laboratories of Rogers Radio Tubes Limited in Toronto, Canada, in 1924, came the first A. C. Tube for domestic radios.
War-time censorship postpones the announcement of our new developments in radio tube design. Meanwhile, Rogers Radio Tubes are today wholly devoted to serving the armed forces of the United Nations.
ROGERS
POWER TUBES
ROGERS RADIO TUBES LIMITED • TORONTO, CANADA

t-1-43

THE INDUSTRY OFFERS . . . —

(*Continued from page* 62)

may be stripped off and relocated in spite of the fact that its adhesive power is far greater than that of ordinary sealing tapes. Its tensile strength is said to be very high. The cloth stock is so woven that it tears evenly at right angles to either edge. It is packed in rolls of any width up to 36 inches. Standard rolls are 60 yards in length.

The manufacturer offers a liberal free test sample to all who have a bona fide war product interest.

* * *

CODE TAPE PERFORATOR

A device that permits the preparation of perforated code tape rapidly, has been developed by the McElroy Manufacturing Corporation, 82 Brookline Avenue, Boston, Massachusetts.

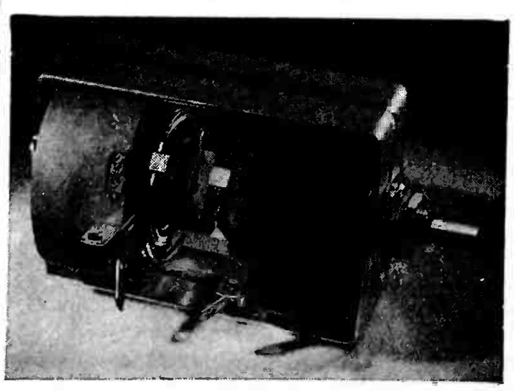
The perforator is operated with the index and middle finger and thumb of the right hand. The touch on the dot and dash contacts and space bar is featherlight. They close electrical contacts and a punch and die mechanism driven by a solenoid perforates the tape and advances it through the machine.

Dots are perforated by touching the contact under the index finger. Dashes are perforated by touching the middle finger contact. A touch on the space bar with the thumb separates completed signals and words. Thus, the signal V is perforated by three touches with the index finger, a touch with the middle finger, and a touch with the thumb. It is actuated by 110 volts a-c or d-c.

* * *

CLAROSTAT TANDEM POWER RHEOSTATS

Tandem power rheostat assemblies of two or more sections have been announced by Clarostat Mfg. Co., Inc., 285-7 North 6th St., Brooklyn, N. Y. These assemblies are made up of two 25-watt or two 50-watt rheostats, coupled together and held in a metal cradle. The usual one-hole mounting and locking-projection features are retained. Individual rheostats can be of any standard resistance value, taper, tap and hop-off, and all units go through the same degree of rotation as the single shaft is turned. Units are fully insulated from each other and from ground. Because of the wide choice of resistance values and other factors, such assemblies are necessarily made only on special order.

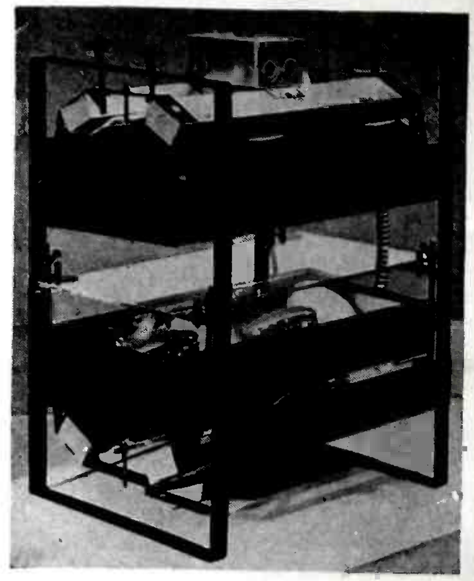


* * *

DUPLEX EXPANDER

For many heating applications, an infrared heater unit, the Duplex Expander, has been developed by the Infra-Red Engineers, Inc., 812 Huron Road, Cleveland, Ohio. There are six different models.

The Duplex Expanders develop temperatures from plus 100° to plus 350°F., and are being used for instrument parts heating, coil drying, heating parts for expansion fits, heating plastic sheet prior to punch press operations or forming, and for plastic powder preheating. It may also be used for baking paint, enamel and lacquer on small parts.

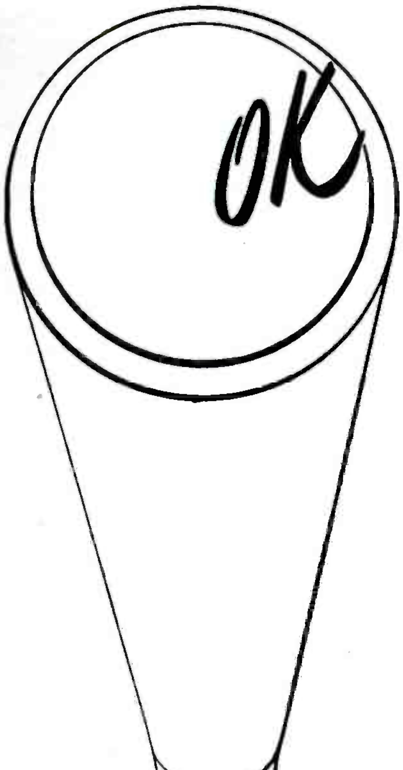


* * *

ANDREW AIR DRYING DEVICE

A hand operated air pump combined with a chemical drying tube to provide dry air has been announced by the Victor J. Andrew Co., 363 E. 75th Street, Chicago, Illinois. The drying agent is in a transparent container, mounted concentric with

(*Continued on page* 68)



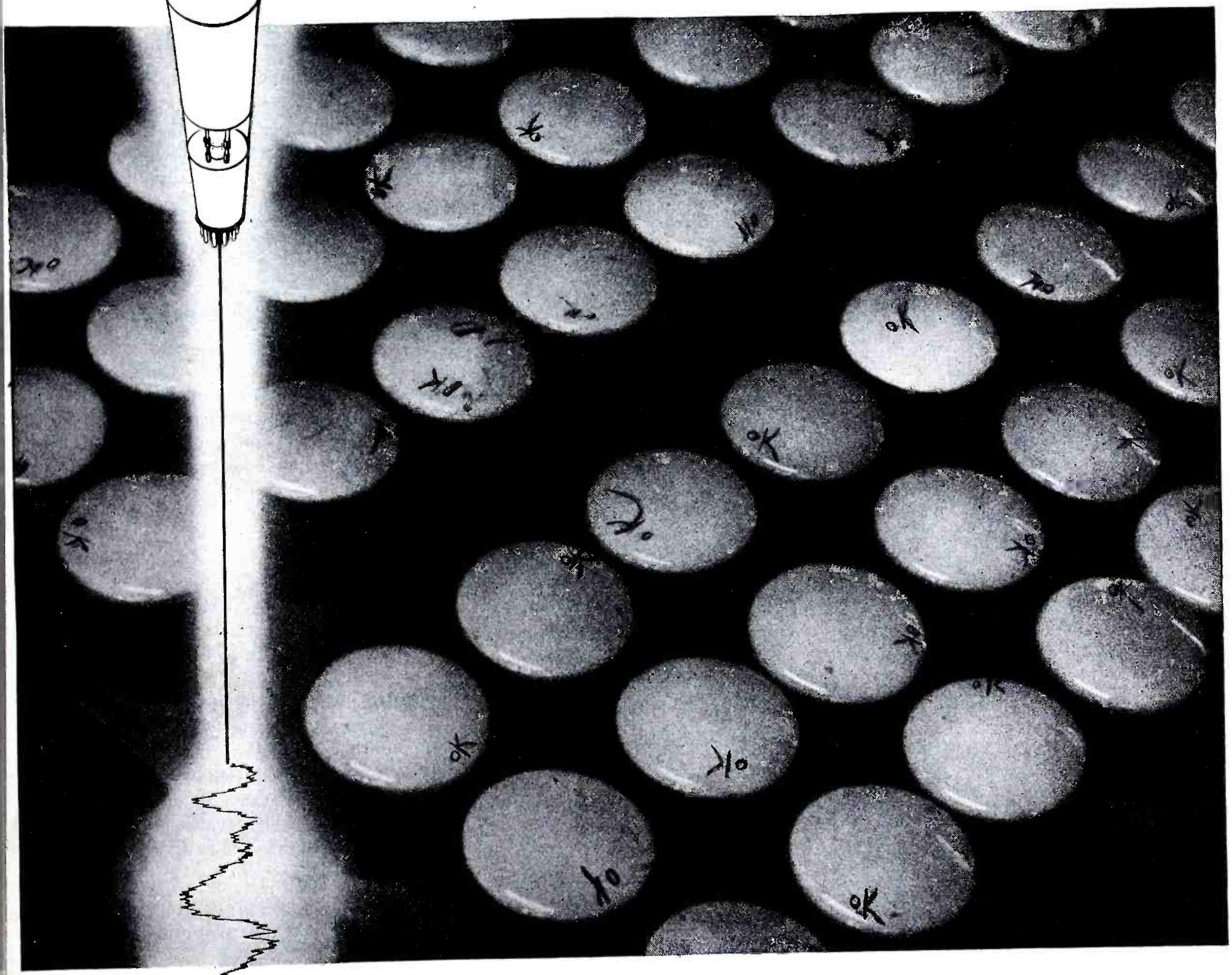
FOR THE BIGGEST JOB IN THE WORLD!

WHETHER it's a simple strand of wire or a cathode ray tube, we at Philips have only one standard that merits the O. K. of our electronics engineering experts. That standard is perfection.

Today, our O. K.'s contribute towards the biggest job in the world. Today, Victory is our primary and exclusive concern.

Manufacturers for Victory — Cathode Ray Tubes; Amplifier Tubes; Rectifier Tubes; Transmitting Tubes; Electronic Test Equipment; Oscillator Plates; Tungsten and Molybdenum in powder, rod, wire and sheet form; Tungsten Alloys; Fine Wire of all drawable metals: bare, plated and enameled; Diamond Dies.

X-Ray Apparatus for industrial, research and medical applications. (Philips Metalix Corporation.)



NORTH AMERICAN PHILIPS COMPANY, INC.

Electronic Research and Development

Factories in Dobbs Ferry, N.Y.; Mount Vernon, N.Y. (Philips Metalix Corp.); Lewiston, Maine (Elmet Division)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

ONE of radio's pioneer inventors, John Stone Stone, died May 21, at his home in San Diego, Calif. He was a prolific inventor, holding over 120 U. S. patents on radio and telephony, and an equal number abroad.

He worked in the early days as a research engineer for the American Telephone Company. He then developed his own company, the Stone Telegraph and Telephone Co., Boston, Mass. He spent his later years with the Bell Company.

He was one of radio's greatest mathematicians. Dr. F. A. Kolster, and VWOA Secretary G. H. Clark were initiated into the mysteries of wireless under Mr. Stone's direction.

He founded the first wireless society in the United States, the Society of Wireless Telegraph Engineers, which later merged with the Wireless Institute, to form the present Institute of Radio Engineers. Many members of the VWOA date back to membership in the *Swatties,* as the pioneer society was called.

THE *First Lady of Radio,* Vaughn de Leath, who sang at the annual VWOA Cruise in 1939, passed away on May 28. Her first singing broadcast was from the New York World Tower in December, 1919, during experimental work being carried on by Dr. de Forest.

Personals

DOUBLE congratulations to Karl Baarslag. He was recently promoted to the post of Lieut. Commander in the Navy, and he became the father of a son, Karel Herman, on May 6, 1943. . . . Our sincere condolences to William Sherman Gill, our association's first president and presently serving as a Captain in Army intelligence, on the recent death of his wife. . . . "Ted" McElroy is now busy sending out the attractive McElroy *Chart of Codes* and *Signals,* to schools and services engaged in the use of the telegraph and other codes. The original of the chart was unveiled at the Eighteenth Anniversary Dinner-Cruise. Interested organizations should communicate with "Ted" at the McElroy Manufacturing Corporation, 82 Brookline Avenue, Boston, Mass. . . . Our 'prexy' now devotes several nights a week teaching theory in the Commercial Radio Operating course at RCA Institutes in New York. . . . Remember, on August 26, 1943, Dr. Lee de Forest, *Father of Radio* and honorary president of VWOA celebrates his seventieth birthday. Send him a message of congratulations. . . R. V. Howley has become president of the Tropical Radio Telegraph Company. He succeeds W. E. Beakes, who now becomes chairman of the board.

R. V. Howley, newly elected president of Tropical Radio Company.

William E. Beakes, familiarly known to thousands as plain "Bill" Beakes is one of radio's pioneers. He holds the Marconi Wireless Pioneer Medal presented by the VWOA.

His radio career began in the United States Signal Corps in 1902. Upon his honorable discharge from Army Service in 1904, he became associated with Professor Fessenden during the latter's early experiments at his Washington laboratory, at Brant Rock in Massachusetts, and Macrihanish in Scotland. Bill Beakes personally handled many of the dispatches from the Brant Rock Station covering the San Francisco fire of 1906. These were the first press dispatches ever sent across the Atlantic by radio.

He was loaned to the United Fruit Company by Fessenden in 1910, to investigate radio conditions in the Tropics. This led to his definite association with United Fruit Company as chief engineer. Upon the creation of the United Fruit Company's radio subsidiary, the Tropical Radio Telegraph Company, he carried his new title and activities to Tropical Radio.

Bill Beakes supervised the construction and design of Tropical's network of high-power stations throughout Central America and Panama and its complementary stations at New Orleans, Miami and Boston in the United States.

To the early pioneer work in long-wave transmission of Bill Beakes, can be added his similarly effective and pioneering work in the introduction of high-frequency transmission in the tropical areas.

He holds several patents covering early methods of spark synchronous transmitters on crystals, and antenna forms. He designed and built the first successful and really efficient synchronous spark gap of high power . . . 50 kw.

GILSON WILLETS, one of our founders, is having a vacation for himself while writing a book on *Boys Town,* Nebraska. A story he had written about this famous community came to the attention of Father Flanagan. As a result brother Willets was invited to be the house guest of Father Flanagan, to write the book. All royalties will go to the support of *Boys Town.*

WE are proud to have so many VWOA men among those who contributed to Radar, that mighty communications weapon of aircraft warfare. Unfortunately secrecy still prohibits the publishing of the names of those directly involved in Radar design, development and operation. We hope, however, that soon these restrictions will be lifted, and we'll be able to tell their story.

Louder than the HURRICANE

IN the old days of wooden ships and iron men, a sea captain's voice had to be louder than the hurricane, to carry over the roar of wind and waves. Today the miracle of radio flashes the spoken word around the world in a fraction of a second, but even radio must contend with problems of interference – natural and man-made static that disrupts communications. Breeze engineers have specialized in the solution of such problems for many years, have pioneered and developed Breeze Radio Ignition Shielding to guard electrical circuits against radiation or absorption of the high-frequency impulses which cause interference. Produced in a wide range of types and sizes, this equipment is designed to meet the requirements of any shielding problem, is in service today on world-wide battlefronts with our armed forces of land, sea, and air.

Breeze CORPORATIONS INC. BREEZE MARK NEWARK, NEW JERSEY

SOUND EFFECTS DEVICE

(*Continued from page* 28)

radio-telegraph station, and as the percentage of listeners who can read this speed is small, the intelligence communicated by the keyed oscillator has little importance. Anything from a simple repetition of the letter *V* to a full message can be used if the space on the keying wheel permits. After the speed in words per minute is settled, the speed of the motor shaft determines the number of letters that can be used on the disc; the slower the speed the smaller the number of letters that can be used.

For our machine a 78 rpm phonograph motor of old but sturdy design was obtained. Since it operates continuously for 20 hours per day, oil pipes were installed to each bearing so that it could be oiled easily once a week. The speed was higher than we wished, but was reduced somewhat by a series resistor and the addition of a fan on the motor shaft, which also served as a cooling aid. This reduced the speed to about 50 revolutions per minute. It was logical to pick the station call letters to put on the disc, since this kept the speed to about 50 words per minute.

The disc design did not prove difficult, and by laying out the necessary dot and dash notches on paper they were spaced properly to nearly fill the circumference, leaving a little longer space after the *C* to indicate the starting point. This disc when finished was mounted where the phonograph turntable had been and a small bakelite brush or brake installed to bear against the side. This was necessary because the slight play in the drive gears allowed the disc to jerk and jump ahead under the action of the roller cam. The keying contact was designed to be operated by a roller rather than a simple shoe to minimize wear, and the result has been highly satisfactory. Under continuous operation for 20 hours per day, neither the disc nor the roller has shown serious wear after five months of use.

In the design of the keying disc, several factors must be considered. The material used should be heavy enough to run for long periods without noticeable wear, even though this makes the filing of the notches somewhat more laborious. We used a piece of scrap 3/16 inch aluminum panel. In may occur to the builder to make the disc easily removable so that others bearing different letters could be substituted. But as mentioned above, few people can read the "message" so we felt this was not worth while. Our experiments showed that though it is possible to scale the notches down and use a rather delicate keying mechanism, for rugged mechanical design it was found best to use the size shown with a roller-operated contact that would be free from trouble for long periods. Actually no attention is required beyond oiling once a week and cleaning the attenuator during regular maintenance periods.

The method of feeding the keyed signal into the program circuit may be varied. It could even be switched into an existing microphone or turntable channel, but rather than apply this limitation to its use we used the arrangement shown, with no switching at all. This has the advantage of leaving existing channels unchanged so that the signal may be used with any combination of microphones or other sources of program. The only limitation imposed is that no provision is made for using the signal on other than the regular program circuit. This could be remedied by bringing the output to jacks on the patch panel to make it available for other uses.

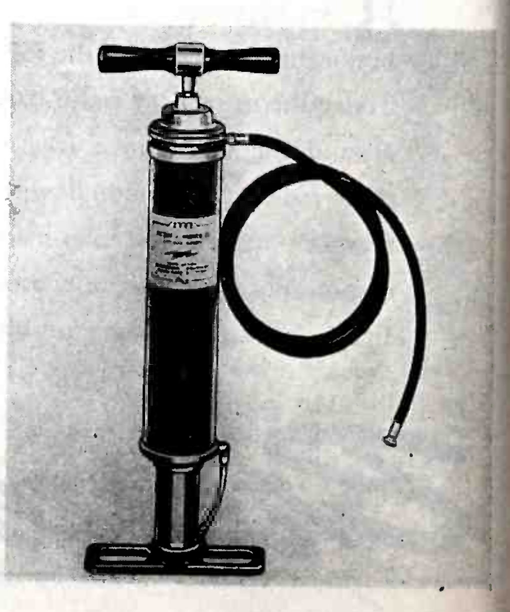
The output circuit uses a 500-ohm-to-grid transformer which happened to be available, with the 500-ohm side facing the attenuator. The resistor combination on the input side of the transformer was selected by experiment to provide the best loading on the oscillator and the desired level.

THE INDUSTRY OFFERS . . . —

(*Continued from page* 64)

the pump barrel. The drying agent contains a color index which is blue when the chemical is active, and turns pink when it becomes saturated. The drying chemical may be replaced when saturated, or may be removed from the tube and reactivated by heating in an open pan.

This device, first developed for use with coaxial cables in radio transmitting stations, is equally applicable to many other purposes.



U-H-F DESIGN FACTORS

(*Continued from page* 26)

lationships at u-h-f. For example, selectivity at u-h-f is comparable to that at lower frequencies, in terms of percentage, although poor in terms of kc. This is important when considering the relationship of modulation to frequency. If an oscillator is not sharply resonant, serious frequency modulation will occur when amplitude modulated. This frequency modulation will be due to changes in frequency due to variations in the plate voltage. The problem is further accentuated with increases in resonant frequency because of the relationship of audio to resonant frequency. Frequency modulation, or f-m presents a similar problem. Since the amplitude of the modulation represents the frequency swing, unless sharply tuned receivers are used, very wide-band widths would be necessary for proper operation.

The tuning methods discussed, while adequate to fixed frequency operation do not answer the needs of wide-band coverage. Also, a possible solution for high Q circuit components may be found in some simpler adaptation of resonant and concentric lines.

These methods described do not lend themselves to quantity production. The methods outlined, are in the majority, developments of the Radio Laboratory of the New York Fire Department.

PRODUCTION AIDS

(*Continued from page* 40)

diameter of the tubular section is just slightly larger than the diameter of the ball bearings so that they will pass through it in line and without congestion.

A lever arrangement pivots from the frame holding the hopper in a manner that pushes two pins through the walls of the tube alternately at two locations. In this particular application, the pinholes have been located so that between them there is room for 9 ball bearings in the tube. An upward movement of the lever withdraws the lower pin from the inside of the tube allowing the 9 bearings to drop into the contact wheel assembly. The same movement injects the upper pin into the tube preventing more than 9 bearings from entering the assembly. Spring return of the lever to its lower, normal position simultaneously reverses the position of the pins, automatically permitting another 9 bearings to fall into the space in the tube between them.

A vertical slot in the side of the tube permits a visual check of the bearings during the operation of the device.

Signal Selector Switch

By suggesting a fixture for electrically and mechanically testing a signal selector switch used in radio transmitters in production at one of General Electric's works, Mrs. Catherine Marchewka has eliminated the possibility of a defective switch going into the final assembly before being detected.

The test fixture is said to be simple and foolproof. The switch is mounted on a vertical backboard and is coupled to an extended shaft from a model switchboard. By turning the switchboard selector to each of its three po-

(*Continued on page* 86)

NEWS BRIEFS

(*Continued from page 56*)

the past six years as general sales manager.

Austin Ellmore, vice president in charge of engineering, has been chief engineer of Utah since 1938.

Remy Hudson will, in his new post, be in charge of post-war planning.

* * *

SPRING DESIGN AND ENGINEERING MANUAL

A 40-page manual 4" x 9", with formulas of spring design and engineering for compression, extension, torsion, flat spiral or motor, flat springs, wire forms, etc., and illustrations, diagrams, and tables, has been issued by Mid-West Spring Manufacturing Company, 4262 S. Western Avenue, Chicago, Ill.

To assist in making out specifications, detachable extension sheets following "blue-print" diagrams, with spaces for details, and inquirer's sketches if desired, are included.

* * *

RALPH MERKLE NOW CAPTAIN

Ralph Merkle, who was Technical Editor of *Sylvania News*, has been promoted to the post of Captain in the United States Army. For the past several months Captain Merkle has been in the office of the Chief Signal Officer, Washington, D. C.

He received a leave of absence in June 1942, from Sylvania Electric Products, Inc.

* * *

UNITIZED RADIO FOLDER

The system of *unitized* radio assembly is explained and illustrated in a folder recently published by the Harvey Machine Co., Inc,. 6200 Avalon Boulevard, Los Angeles. In the *unitized* system there are three basic cells . . . r-f, i-f, and a-f, each assembled in a standardized protective metal case. Cell components are so arranged that 75% less hook-up wire is said to be required.

* * *

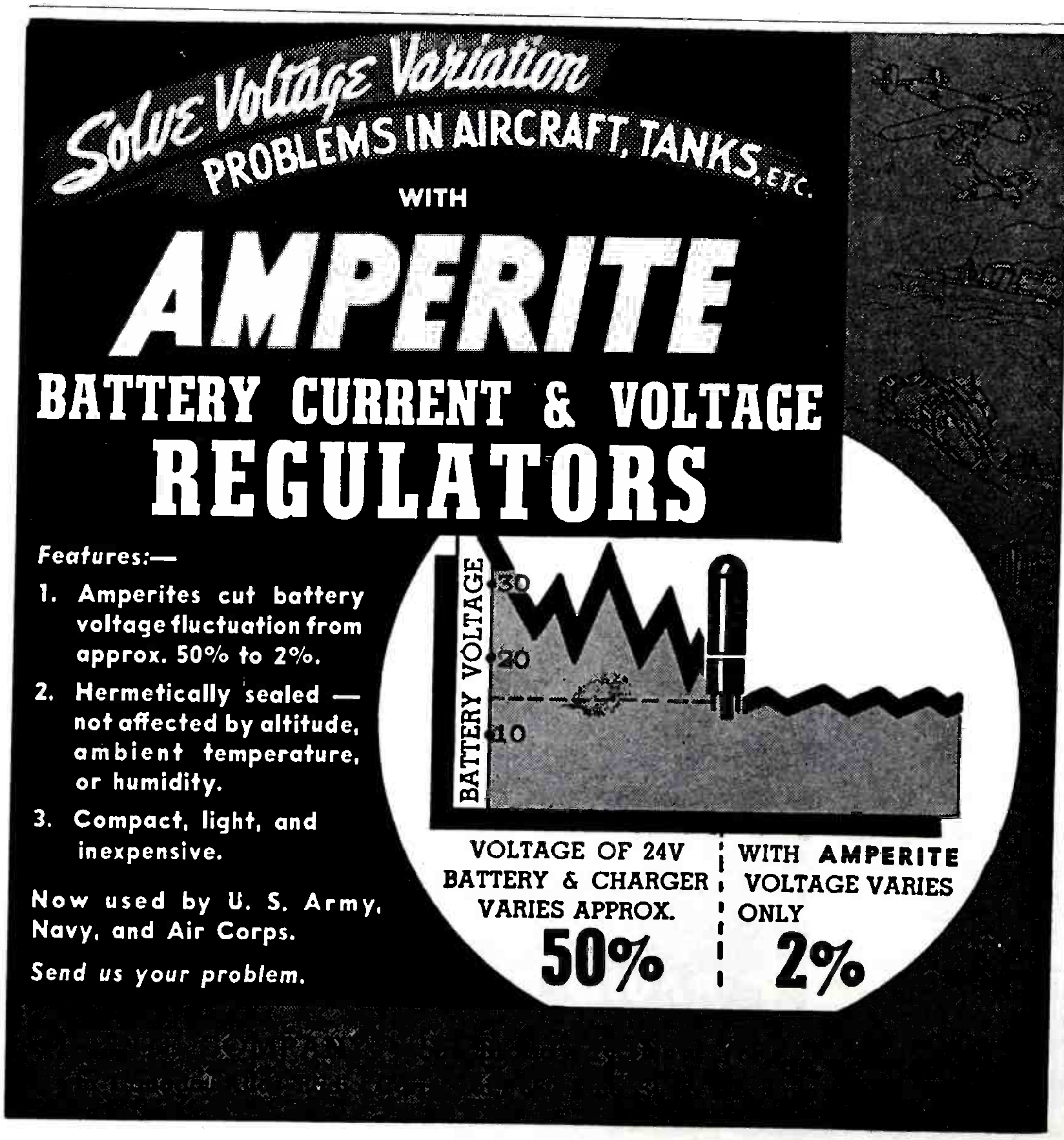
"HAM" OPERATORS' LICENSES EXTENDED

The Federal Communications Commission has announced adoption of General Order 115 reinstating all amateur radio *operator* licenses which have expired since December 7, 1941, and extending such *operator* licenses for a period of three years from the date of expiration shown on each. In the same order, the Commission provided that all amateur *operator* licenses, expiring between May 25, 1943, and December 7, 1944, inclusive, are hereby extended for a period of three years beyond the expiration date on each license.

In the interests of national security, the Federal Communications Commission halted all amateur radio *station* operations, and then discontinued the issuance of all amateur *station* licenses. The Commission, however, at the request of the military, has continued its policy of issuing new or renewed amateur *operator* licenses.

Since present conditions make it difficult for amateur radio operators who are in the armed services or engaged in war work at locations distant from their homes to make timely applications for license renewals, the reinstatement of amateur operator licenses which have ex-

(*Continued on page 72*)



NEWS BRIEFS

(*Continued from page 71*)

pired since December 7, 1941, and extension of such operator licenses expiring not later than December 7, 1944, were authorized by the Commission.

Provisions of the order do not apply to any amateur radio operator license which has been voluntarily surrendered by the licensee or which has been, or may hereafter be, finally suspended by Commission order. Nor does the order apply to any amateur radio operator licensee who has failed to comply with the FCC order regarding citizenship.

* * *

GHIRARDI TROUBLESHOOTER HANDBOOK FOLDER

Ghirardi's newly revised 3rd edition *Radio Troubleshooter's Handbook* containing 744 manual-size pages of data covering all phases of radio service work is described and a detailed listing of its 75 topic section titles given, in a new 4-page folder just issued by the Radio & Technical Publishing Co., 45 Astor Place, New York City.

Copies of this new folder are available from local radio supply houses, radio dealers and bookshops, or direct from the publishers.

* * *

SYNTHETIC RUBBER BOOKLET

A 24-page booklet, *The Five Commercial Types of Synthetic Rubber*, has been released by the United States Rubber Company, 1230 Sixth Avenue, New York City.

The booklet traces the development of synthetic rubber from its laboratory beginnings, describes the properties of the commercial synthetic rubbers.

The publication includes photographs of synthetic rubber manufacture, many diagrams, and a chart compiled from the experience of plants and laboratories of the company, giving the relative physical and chemical properties of natural rubber and of the five types of synthetic rubber.

The booklet, which has had a limited distribution to government agencies and allied industry, has been cited for study by several of the foremost technical schools and colleges of the country, and is now made available free upon application.

* * *

LEWYT CORPORATION STAGES SPRING OFFENSIVE

Using the recent drives by our land, sea and air forces as a keynote, Lewyt Corporation, Brooklyn, New York, recently organized a plant-wide production drive to increase the output of the vital war goods they are making.

These reports were dramatized via the plant's public address system with talks by Alex M. Lewyt, department heads and workers.

Every event in this production drive was geared to the military motif. A bugle call began the daily events. New events mentioned in newspaper headlines were used as the texts which pointed up the need for even greater production. Military music was played over the address system during the morning and afternoon rest periods.

* * *

THOMAS ELECTED VICE PRESIDENT OF IRC

Leslie G. Thomas has been elected vice-president in charge of production of Inernational Resistance Company, Philadelphia, Penn.

* * *

GOLENPAUL PRAISES L-265 ORDER

Commenting on the recent WPB Limitation Order L-265, Charles Golenpaul of Aerovox Corporation, said that for the first time the radio serviceman can really buy those replacements he needs in his work.

"Previous restrictions are swept aside," he said:

"I like this new order. It's simple. It reduces paper work to a minimum. And yet it safeguards the use of our strategic materials as it should.

"This new order should work wonders in wartime servicing. Until now, unfortunately, many jobbers have held up on the release of their merchandise. They have held out for better odds, working under the false impression that they could not replace their stock, although they could have replaced whatever they sold by filing the PD-1X form. However, the present part-for-part routine now clears up all doubts as to stock replenishment within the production scope of the manufacturers.

"The WPB is certainly proving its intention of keeping American radio sets functioning, to the end that the American people can be kept informed and guided and encouraged at every stage in the winning of the war."

* * *

RCA BOOKLET ON FACILITIES

In a fifty-two page booklet, the facilities of the Radio Corporation of America and its subsidiaries, are described.

The role of RCA in this war and the last one, is effectively told.

Broadcasting, television, manufacturing, communications, marine radio and technical training are some of the phases of RCA activities described in this new presentation.

* * *

C-D EMPLOYEE BROCHURE

A forty-four page booklet describing the growth of the Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey, has just been issued. Many interesting illustrations showing the early plants of C-D appear among the pages.

The uses to which C-D capacitors are put in war today are effectively told and illustrated.

Data concerning employee relationships and facilities are also presented.

* * *

WHEELCO CONTROL DATA

A sixteen-page condensed catalog describing temperature control instruments, and lead wire, radiation heads, remote control equipment, etc., has been issued by the Wheelco Instruments Company, Harrison and Peoria Streets, Chicago, Illinois.

The company has also released a

(*Continued on page* 74)

NEWS BRIEFS

(*Continued from page 73*)

twelve-page bulletin on thermometers and a thirty-two-page booklet on thermocouples.

These three bulletins are available gratis.

* * *

GUARDIAN ELECTRIC OFFICES IN NEW LOCATION

The general offices of the Guardian Electric Manufacturing Company are now located at 1400 West Washington Boulevard, Chicago, Illinois.

* * *

LIFEBOAT RADIO SAVES 84

The contacting of four potential rescue vessels by men in a lifeboat with a combination radiotelegraph-telephone unit, powered by a hand-cranked generator, saved the lives of 84, whose ship, the SS. *Stag Hound*, had been torpedoed.

Communication between two lifeboats which were so far separated that they were out of sight even in the daytime, was possible.

* * *

COL. WILLIAM F. REPP DEAD

Colonel William F. Repp, vice president and director of the International Telephone and Telegraph Corporation, died recently.

Colonel Repp was in the Signal Corps of the U. S. Army during the First World War. As head of the South American branch, Colonel Repp was active in the building of a transcontinental telephone line which interconnected the telephone systems of Argentina, Uruguay and Chile.

* * *

NEW NAVAL POST TO LT. COMDR. BRENGLE

Lt. Commander Ralph T. Brengle, formerly head of Radio Procurement Section, Bureau of Ships, has been appointed Assistant Head of Radio Division, Bureau of Ships.

Before entering the service, Lt. Com-

nder Brengle was head of the Ralph
Brengle Sales Company, Chicago.

* * *

AN & SONS WINS "E"

W. Onan and Sons, Minneapolis, nnesota, has won the coveted Army-vy "E" production award. A plant er, the *Onan Current News,* contains interesting assortment of news about award and other plant activities.

* * *

NUM-VITAE DATA

e characteristics, uses and development Lignum-Vitae are described in a lve-page report, issued by the Lig-n-Vitae Products Corporation, 96-100 yd Avenue, Jersey City, N. J.

Lignum-Vitae is a very hard resinous od and is now being used for a vari- of applications including bearings, hings, rollers, etc.

* * *

ARD BROCHURE DESCRIBES ODUCTION FACILITIES

twenty-four page brochure outlining radio, electronic and mechanical en-eering production facilities and equip-nt has been issued by the Ward Prod-s Corporation, 1523 East 45th Street, veland, Ohio. Copies of the brochure available, gratis.

* * *

RCRAFT ACCESSORIES NEW OFFICE

e Aircraft Accessories Corporation of nsas City, Kansas, and Burbank, Cali-nia, has opened an office at 732 17th reet, N. W., Washington, D. C. Emery Johnson is in charge.

* * *

RESIDENT OF BOLIVIA ONORED BY I. T. & T.

n informal luncheon in honor of Gen-al Enrique Penaranda, President of livia and his official party, was given the International Telephone and Tele-aph Corporation, 67 Broad Street, New ork City. Colonel Sosthenes Behn, esident of I. T. & T., acted as host for e company.

* * *

ESTINGHOUSE APPOINTS LECTRONIC AIDES

rederick S. Rowe has been appointed anager of electronic tube production d stocks at Westinghouse Lamp Divi-on, Bloomfield, New Jersey.

William J. Knochel has been named sistant superintendent of electronics anufacturing at the Bloomfield plant.

* * *

OHN K. HILLIARD OES TO ALTEC LANSING

ohn K. Hilliard, formerly chief trans-ission engineer of the M-G-M sound epartment, and more recently consultant the Radiation Laboratories of Massa-husetts Institute of Technology, has oined the war production staff of Altec ansing Corporation, Los Angeles, as hief engineer of the Radar and Motion Picture Division.

Mr. Hilliard is chairman of the The-ter Standards Committee of the Research Council of the Academy of Motion Pic-ure Arts and Sciences. He is also a member of the Motion Picture Standards Committee of the Royal Scientific So-ciety of Great Britain.

* * *

UNITED ELECTRONICS COMMENDED FOR WAR BOND EFFORT

The Secretary of the Treasury has

(*Continued on page* 76)

NEWS BRIEFS

(*Continued from page* 75)

acknowledged the excellent War Bond record of the United Electronics Company, Newark, New Jersey.

* * *

RADIO TRAINING KITS BROCHURE

Lafayette Radio Corporation, 901 W. Jackson Blvd., Chicago, Illinois, has prepared a new brochure to aid schools in government training courses. The kits mentioned in this folder have been designed to fit present training programs. Starting with fundamentals and progressing to basic receiver and transmitter operation, a progressive training program may be built around these kits.

* * *

MUSIC AND PRODUCTION

A twenty-four page booklet entitled *Music and Manpower* has been released by Operadio Manufacturing Company, St. Charles, Illinois. The importance of music to production today is analyzed in a very effective manner. Production charts and other statistical information are provided. In addition, equipment used for voice paging is also discussed.

A limited edition has been printed and is available to executives.

* * *

AIR COOLED TRANSFORMER CATALOG

A six-page bulletin entitled *Power Where You Need It* has been issued by the Acme Electric and Manufacturing Company, Cuba, New York. The bulletin shows various types of air cooled transformers, with characteristic operating data on auto type, two-winding type, three-winding type and four-winding type transformers up to 50 kva.

* * *

BURCHAM TO STANDARD TRANSFORMER

Don H. Burcham, 917 S. W. Oak Street, Portland, Oregon, has been appointed by the Standard Transformer Corporation, Chicago, to cover jobber and industrial sales in the states of Idaho, Montana, Oregon and Washington.

* * *

GLASS STRING CARRIES RADIO ANTENNA

A kite string of glass yarn is now being used with a box kite that carries aloft the antenna of the portable, hand-generator, radio transmitter developed by the Army Air Forces to summon help for fliers forced to make crash landings at sea.

The box kite has an ordinary cloth and wood frame with an antenna consisting of very fine copper wire wound around the glass kite string. Two balloons and capsules of compressed hydrogen are also carried in the boat. The balloons, inflated with the hydrogen, can be used to

ːry the antenna aloft in the event of a ɪm.

Glass yarn can be used as the kite ɪing because of its strength in propor-n to its weight, and because it does not r. or otherwise deteriorate from the ects of salt water, tropic sunlight, rain dampness. The yarn is twisted and ed from continuous filament glass ers which can be drawn to indefinite ıgth, measurable in miles.

* * *

ɪYTHEON PRODUCTION ONTROL DEPARTMENT

Production Control Department has en organized at the Raytheon Produc-n Corporation, 55 Chapel Street, New-ı, Massachusetts.

Kenneth R. Johnson will direct this w department which will include a heduling section to be headed by Ly-an W. Robbins; a materials section to headed by Leo Barsam, and a finished ock control section to be handled by ank Fenwick.

Previous to joining the Raytheon or-nization, Mr. Johnson was production anager and assistant publisher of the ɔston *Evening Transcript.*

* * *

ENITH APPOINTS MERICAN STEEL EXPORT

merican Steel Export Co., Inc., has en appointed exclusive export sales presentative of Zenith Radio Corpora-on, Chicago, Ill.

H. W. McAteer, president of Amer-an Steel Export Co., Inc., has also an-ounced his resignation from the board f directors of Philco International Cor-oration.

* * *

R. COOLIDGE CITED BY CHILE

)r. William D. Coolidge, vice president nd director of research of G. E., has een awarded the *Order del Merito* (Order of Merit) of Chile for his *many ervices to civilization.*

* * *

METAL CLEANING LITERATURE

A bulletin, 11543-1 SUP, describing the ses of the four available types of cy-lodiene base hydrocarbon solvent de-reasers and cleaners for metals has been ssued by the Technical Processes Divi-ion, Colonial Alloys Company, 2154 E. Somerset St., Philadelphia, Pa.

A section deals with painting or lac-quering on the wet surfaces *immediately* after the work comes out of the bath, which is operated at room temperature.

Another paragraph tells of the pro-tective rust inhibitive film left on the surfaces of the work after being de-greased in cyclodiene.

* * *

MOT-O-TROL DRIVE BOOKLET

A 4-page illustrated booklet, B-3256, describing the operation of the Mot-O-Trol, has been issued by Westinghouse. Charts show motor-speed characteristics for a 20-to-1 speed range, 10-to-1 speed range, and constant speed.

Other features of the Mot-O-Trol listed and discussed in the booklet are its vibra-tion, stable operation with full torque at low speeds, constant torque-zero to base motor speed, and speed control.

* * *

FORMER SERVICEMAN WINS WPB AWARD

Lawrence Handler, former serviceman and amateur radio *ham,* has received a WPB suggestion award from the West-

(*Continued on page* 78)

NEWS BRIEFS

(Continued from page 77)

inghouse Lamp Division, Bloomfield, N. J.

His idea provided for a change in the design of a machine tool fixture that has prevented tube breakage and accordingly increases production.

The fixture is essentially a collar-like device which fits over the end of the tube mechanism to hold it in place while the glass bulb is sealed around it. In order to release this *collar* after each sealing operation, it formerly was necessary to hammer it back to its original position, thus sometimes damaging the fixture and cracking the tube glass.

In searching for some way to avoid this damage, Handler installed three metal *jaws* on the fixture which pulls the collar back to its original position and eliminates the need of hammering.

Ball bearings were also installed on the fixture to eliminate the motion caused by friction when the collar was released.

* * *

UNIVERSAL MAKING SWITCHBOARD JACK

Universal Microphone Co., Inglewood, Cal., has gone into mass production of the JK-37 jack, a telephone switchboard extension type, with coin silver contacts. It is a three-way, heavy duty three-prong unit with high impact phenolic body and steel bracket attachments.

* * *

MITCHELITE FLUORESCENT FIXTURE DATA

An 8-page catalog, No. 400, describing all-purpose Mitchelite fluorescent fixtures has been published by the Mitchell Manufacturing Company, 2525 N. Clybourn Avenue, Chicago, Ill.

Throughout the catalog are graphs, tables and charts covering many lighting problems.

A free copy of this new catalog can be obtained from Mitchell distributors or by writing to the company.

* * *

ZENITH WINS WHITE STAR

A White Star has been added the "E" flag of the Zenith Radio Corporation, Chicago.

* * *

DRESSEL PROMOTED BY STACKPOLE

Henry Dressel has been appointed supervisor of electronic components engineering at the Stackpole Carbon Company, St. Marys, Penn.

* * *

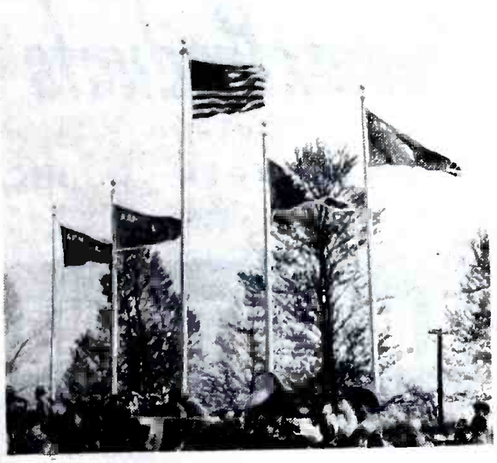
FOUR RAYTHEON PLANTS WIN "E"

The power-tube, small-tube, radar and equipment divisions of Raytheon Manufacturing Company of Newton and Waltham, Mass., were each awarded with the Army-Navy "E" recently. The awards were presented before employees and invited guests on the lawn of the estate of Governor Gore at Waltham, Mass. The ceremonies were in charge of David T. Schultz, vice-president and treasurer.

Presentation was made by Commander Lewis L. Strauss of the U. S. Navy. The speech of acceptance was made by Laurence K. Marshall, president of Raytheon. The "E" pins were presented by Colonel James H. Van Horn, U. S. Army.

Guests included Governor Leverett Saltonstall of Massachusetts, Mayor John F. Devane of Waltham, Mass., Mayor Paul M. Goddard of Newton, Mass., and many high ranking Navy and Army officials.

The entire program was rebroadcast by radio station WNAC.



* * *

SGT. BARNEY ROSS ADDRESSES SHURE BROTHERS WAR WORKERS

On his tour of war plants, Sgt. Barney Ross, with Lieut. Melvin F. Lanphar, USNR, Incentive Officer, recently visited Shure Brothers, Chicago.

In a stirring talk to hundreds of Shure war workers, Sgt. Ross told of some of his experiences on Guadalcanal and pointed out how important microphones were to the boys *out there*.

* * *

TYDINGS WITH R-9 CRYSTALS

Emmet Tydings has become president of the R-9 Crystal Company, Inc., 907 Penn Avenue, Pittsburgh, Penn.

STUDY OF IRON CORES

(*Continued from page* 48)

cal resistance in series, will often raise the Q 5% or more, while leaving the permeability unchanged.

There are many effects that occur when the core is heated. Since the domains are held together by crystal strains and since thermal agitation is always fighting to destroy the crystal structure and to increase the number of free electrons, we might be pessimistic about the possibility of extreme thermal stability of the core. Remember, we are living in a world four-hundred-odd degrees above absolute zero.

As we heat the core, the size of each particle must increase by its coefficient of thermal expansion, increasing each dimension of the core. The insulation film will also expand, change its dielectric constant with heat and be subject to mechanical stresses due to the particles expanding at a different rate than the insulation.

Since we are particularly interested in u-h-f iron which usually has some sort of internal structure of separate crystals, the boundary between these have thermal characteristics quite unknown to us at present.

We aren't surprised to find that an oxide core gives us a two-per cent drift in frequency through a range of 100° C, and it is very pleasant to find the carbonyl iron cores can be made to hold better than 20 kc at 125,000 kc. Why this miracle happens, the writer does not know. The losses in the core are also quite unaffected by temperatures up to and above 100° C, another miracle. It is of course necessary to design very high performance circuits to nurse along this characteristic. There is little or no balance of one effect in the core against another, since this thermal stability holds true for various insertions of the core.

Performance at 100 Megacycles

The performance of cores at 100 megacycles can be stated briefly. Certain magnetite cores perform well in regard to losses, giving a Q as high as 400. A typical tuning range would be 46% for a core ½" long in the coil we mentioned. But the thermal characteristics of the oxide particle are poor. For a temperature range of 200° F, the circuit drift due to the core may be over 2% and at 165° F the Q may be below 100. Even at room temperature this thermal drift shows up as a steady drift in the oscillator for an hour or so, after the set is turned on. This is caused by circulating current in the oscillator tank coil heating up the core, thus changing its permeability, which in turn shifts the frequency. These cores will afford a satisfactory Q at 400 mc.

Some carbonyl cores show about the same tuning range as the oxide core mentioned, but the Q is much lower, from 60 to 125. This characteristic depends, of course, on particle size, insulation, and particle internal structure. They have the inherent characteristic of being almost immune to heat, however. The writer has checked circuits to 325° F and found these cores to maintain Q. The particle, itself, has an exceptional low change of permeability with heat. But this must be nursed along by real work on the insulation.

As we mentioned earlier hydrogen iron is unusable at u-h-f, having a Q of 28. This is a mystery, since you can tune with a piece of drill rod and obtain a better Q.

The carbonyl and some oxide particles are very hard. If it is desired to reduce the diameter of a core by turning it down on the lathe a carboloy or equivalent tool must be used. An ordinary high speed steel tool will be dulled in making *one pass* over the core. As we know, these particles are widely used in powdered iron metallurgy, where they are molded under enormous pressure into valve seats for gasoline engines, gears, etc., sometimes being sintered into a solid mass after molding.

An oxide core can often be spoiled by turning on a lathe, since the heat of the operation will effect the core characteristics, for oxides are sensitive to heat. Sometimes their activity is restored in a few months, however. The hydrogen core, when machined, often has its outside soft particles smeared into a solid conductive sheath. Gently filing the outer layer off a carbonyl core will do no harm. This procedure can be safely employed when experimental diameters must be produced. Molds for these cores are quite expensive and it is easier to file a few cores down, than to make up a mold.

A good size hole can be used in the axis of a core with little loss in tuning range. This is not due to any skin effect, or to the flux being guided into the outer shell by the presence of the iron. It is due to the simple geometrical fact that about all of the mass of a cylinder is in its outer shell. There is a loss, but only by the amount of material removed, which is slight.

Tendency of the core to corrode can be handled by impregnation, or by etching the iron exposed on the sur-

(*Continued on page* 82)

STUDY OF IRON CORES

(*Continued from page* 81)

face, leaving a pure bakelite surface. The carbonyl cores are quite resistant to corrosion.

Tuning Ranges at 150 MC

Mention has been made of tuning ranges that are limited to about 50% at 150 mc when a core is inserted in the coil, with no external iron to complete the magnetic circuit. While improvements may be expected to increase this somewhat, still a core of infinite permeability used only inside the coil would obviously leave the return path for flux still in air, and the tuning range still limited. Placing iron outside is a help, but in u-h-f work all the wire is needed in the coil and none in the leads. The design is accordingly difficult.

The use of iron cores at 150 mc poses an interesting problem. The tuning range is small, cores are either low *Q* or lack thermal stability (at present), and the core movement is reciprocating and rather short. This places a real strain on the mechanical designer to devise a precision movement and dial for it. It doesn't seem prudent either to go to great pains to design a high frequency circuit assembly that only with great difficulty reaches the u-h-f, and then lower the hard-won upper frequency response of the circuit by inserting an iron core.

Highlights of Core Tuning

The arguments in favor of any type of core tuning include the ability to design circuits that mechanically are of the utmost compactness, with no sliding contacts. Such circuits, especially if all ceramic, have tremendous thermal and secular stability (immune to changes over a long period of time). All frequency determining elements occupy less than one cubic inch of space, including the tube, and can be made immune to vibration. The L/C ratio is constant, and band switching is fairly simple, while the Q without core can exceed 500.

Tuning Range Reduction

Another considerable difficulty with u-h-f core tuning is the requirement of substantially filling up the coil with a core to obtain even a 45% tuning range. This means a very thin-walled coil form with very small tolerance on wall thickness, ovality and camber. Since the inside of the form must be kept free for the passage of the core, the firm securing of the wire or strap forming the coil is also a real problem. One set of dimensions that have proven satisfactory is a ⅜" diameter core, ½" long, used with a coil having an i-d of 0.420" and a length of ⅜". Care must be taken that the core does not rub on the inside of the ceramic form, since iron particles will be rubbed off the core and deposited on the inside of the form, destroying the calibration.

Ceramic Rod Mounting

Another real design problem concerns the mounting of the core on a ceramic rod. Cements are subject to creepage with thermal cycling and in general have marked and non-cyclic changes of dielectric constant with temperature. Being in the field of the coil, this causes erratic frequency effects. Due to the enormous pressure it is necessary to use to mold the cores they cannot be molded directly on the mounting rods. Thus a spacer system is usually the best means of locating the core on the rod.

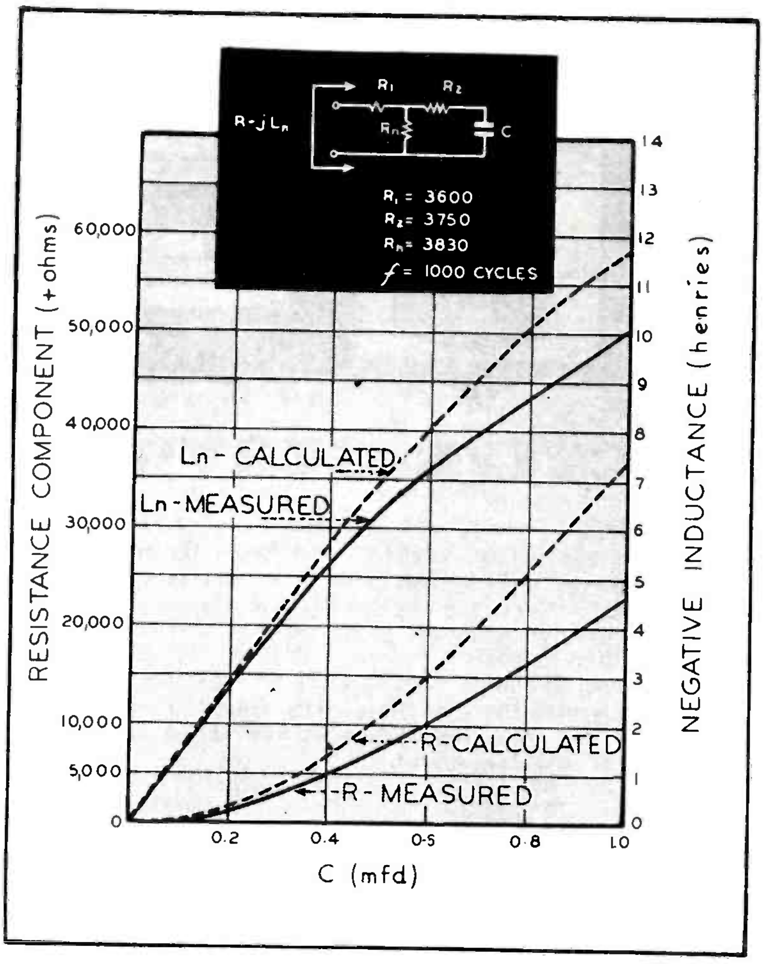
Copper and Silver Cores

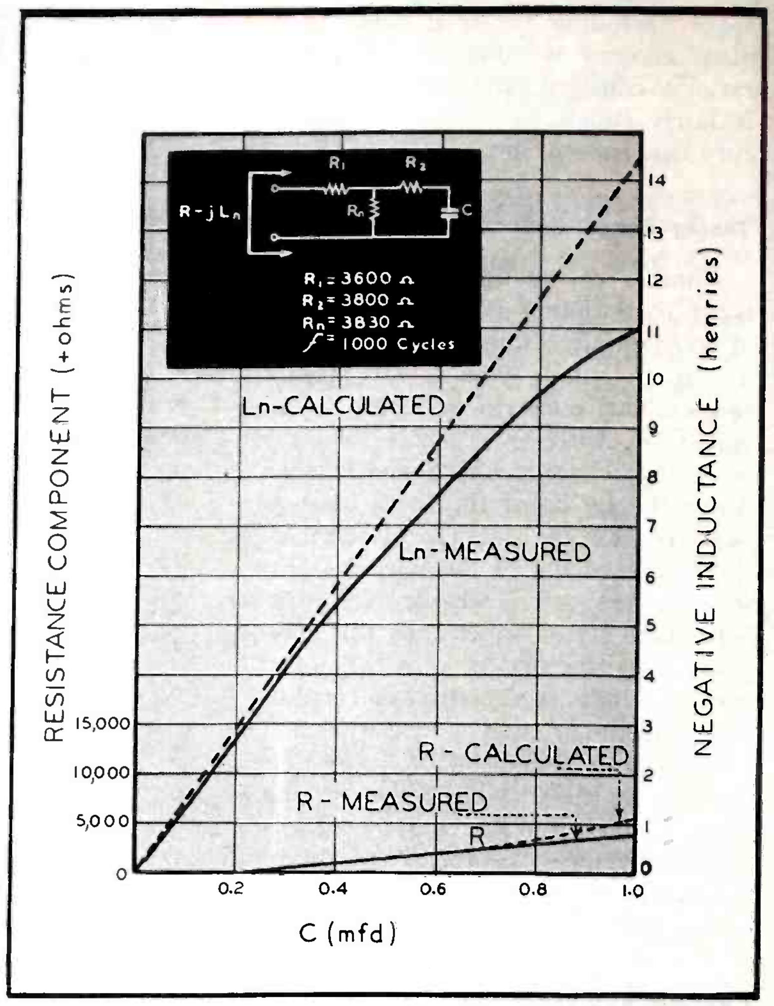
The use of copper or silver cores also presents an interesting phase of study. They will tune a circuit that is initially 100 mc up to 163 mc. The Q is lower than a thermally stable iron and the frequency change with temperature will be considerably higher. The Q may run 80 or so with the copper, and careful investigation shows that you cannot increase the Q by increasing the conductivity of a conductive core. This statement is rather unexpected, no doubt, but the Q of a brass core at 150 mc is about the same as the best annealed or electrolytic silver. Apparently the current penetrates deeper into the low conductivity metal and thus increases the thickness of the short circuited turn, thus maintaining a rather constant resistance.

[1]Bell Technical Journal, January, 1940.

NEGATIVE INDUCTANCE

(*Continued from page* 18)





Figures 14 (left) and 15 (top)
Figure 14 illustrates the resistive and negative inductive components of the impedance of the circuit of Figure 1 (page 14). Figure 15 shows the measured and calculated reduction of resistive component.

magnitude and variation of resistive and reactive components of the impedance, a bridge circuit was employed as shown in Figure 13. In using the bridge, two conditions must be observed which, in fact, must be observed in any circuit to which the negative inductance is connected. The conditions are that: The impedance external to, and therefore shunting the negative inductance must . . . *(1)*—be kept low and . . . *(2)*—provide a d-c path. When the bridge is balanced:

$$L_n = -j\frac{1}{wC_c}$$
$$R_{L_n} = R_c$$

The bridge circuit impedance in parallel with terminals *A-B* was kept low by making R_a and the impedance of the generator *G* small. A d-c path was provided through R_a and the generator. (C_x is used only when the unknown impedance has a negative resistance component.)

Figures 14 and 15 show the measurements of the reactive and resistive components of a circuit having the parameters indicated. In Figure 14 the values selected, namely $R_1 = 3{,}600$ ohms, $R_2 = 3{,}750$ ohms and $R_n = 3{,}830$ ohms, yield a large resistive component at the higher values of *C*.

Figure 15 shows the effect of using

(*Continued on page* 86)

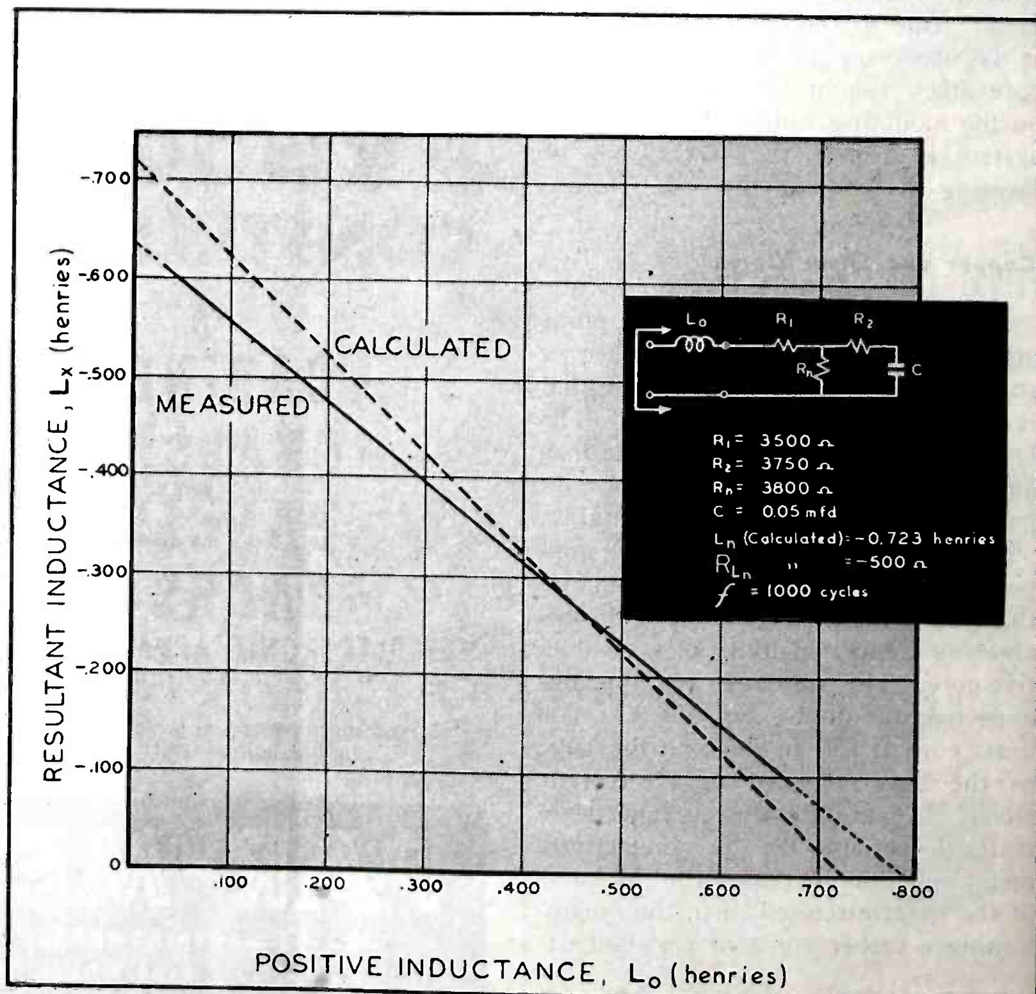


Figure 16
Neutralization of the negative inductance by a positive inductance.

NEGATIVE INDUCTANCE

(*Continued from page* 84)

more nearly equal values of R_1, R_2 and R_n. The resistive component is reduced considerably.

The ability of the negative inductance to function as such in a circuit may be illustrated by the fact that it can be neutralized by connecting a positive inductance in series with it. Figure 16 shows this effect. A fixed negative inductance was connected in series with a variable positive inductance and the resultant total inductance measured. The latter must remain negative for stable operation. The neutralizing effect is clearly apparent. The curve departs from a 45° line, apparently because of an unavoidable change in the value of the negative resistance, R_n, occurring during the measurement.

[1]L. C. Verman, *Negative Circuit Constants,* Proc. IRE Vol. 19, pp 676-681; April, 1931.
[2]Patent 1,903,160 issued to M. M. Dolmage, Washington, D. C.; April 11, 1933.
[3]A. T. Starr, *Electric Circuits and Wave Filters,* Pitman Publ. Co., New York.
[4]C. Brunetti, *The Transitron Oscillator,* Proc. IRE, Vol. 27, pp 88-90; Feb. 1939.
[5]H. Mouradian, *Long Distance Transmission Problems,* Jour. Frank. Inst., Vol. 207, No. 2; Feb. 1929.

PRODUCTION AIDS

(*Continued from page* 70)

sitions, the switch is checked electrically by observing proper combinations of six lights mounted on top of the backboard.

Switch Controls Contact Points

The switch controls a series of contact points in each position, and this arrangement permits all of them to be checked quickly and accurately. In the *tone* position of the selector, lamps 2, 3, 4 and 6 light; in the *cw* position, 3 and 5 light, and in the *voice* position, 1, 4 and 6 light. If one or more of the lights in a sequence fail to go on as they should, the switch is rejected. Mechanical action of the switch is also checked while it is in the fixture. Previously, this switch received no preliminary electrical test. Defective units that got by a visual test had to be removed later from the final assembly.

Soldering Iron as Soldering Pot

The use of standard soldering irons especially adapted as small soldering pots has facilitated the production of small instrument-type motors. Because they present only a very small area for oxidation, the irons are saving materials.

The improvised solder pot, which was developed by R. H. Bainbridge, a G.E. foreman, is easily built. A standard medium-size soldering iron tip is faced off flat and drilled with a ¼" diameter hole, ¾" deep. This tip is reassembled to the soldering iron. The iron is then mounted vertically in a hole in the bench so that the tip projects about two inches above the top. The mounting is made permanent by the use of a standard pipe nipple locked from the top with an electrician's conduit bushing and from the bottom with an electrician's lock nut. The iron is held in the bushing by three setscrews which clamp the body of the iron proper.

Only the insulation contained in the iron itself is required for efficient operation. A perforated sheet-metal guard which encircles the exposed tip permits free circulation of air about the tip, eliminating the possibility of overheating the solder, and at the same time assures complete operational safety by guarding against accidental contact with the heated tip.

AIRCRAFT COMMUNICATIONS

(*Continued from page* 54)

which would apparently give a well defined field pattern.

The use of an u-h-f radio compass would present relief from static, but this design is somewhat hampered due to the effects of reflected waves. A l-f compass operated on the range station, when these are on increased power and on clear channels, will be an improvement. Installation of the u-h-f ranges would, however, relieve the l-f range band, so that clear channels could be used.

SIGNAL CORPS TRAINING

In a recent NAB address, Brig. Gen. F. E. Stoner, Assistant Chief of the U. S. Signals Corp., discussed Signal Corps training. He pointed out that the greater the number of different sets in use, the more difficult will be the problems of training mechanics to service each one of them. In addition, maintaining in division and army depots a sufficient stock of repair parts for each one, is quite a project. Thus, standardization has become vital.

"The organization and activation of Signal Corps field units," he said, "and the selection and training of men who constitute them, is controlled by the Signal Operations Service

"The actual training of selectees is conducted in four major training centers devoted to the Signal Corps. Of these four, only one—Fort Monmouth—was in existence when the United States entered this war. Fort Monmouth, with its subposts, Camp Edison and Camp Wood, has extended over a large area comprising a number of communities. It may be regarded as the parent training center modern Signal Corps. However, the methods of training developed there are now used in other camps geographically dispersed throughout the nation.

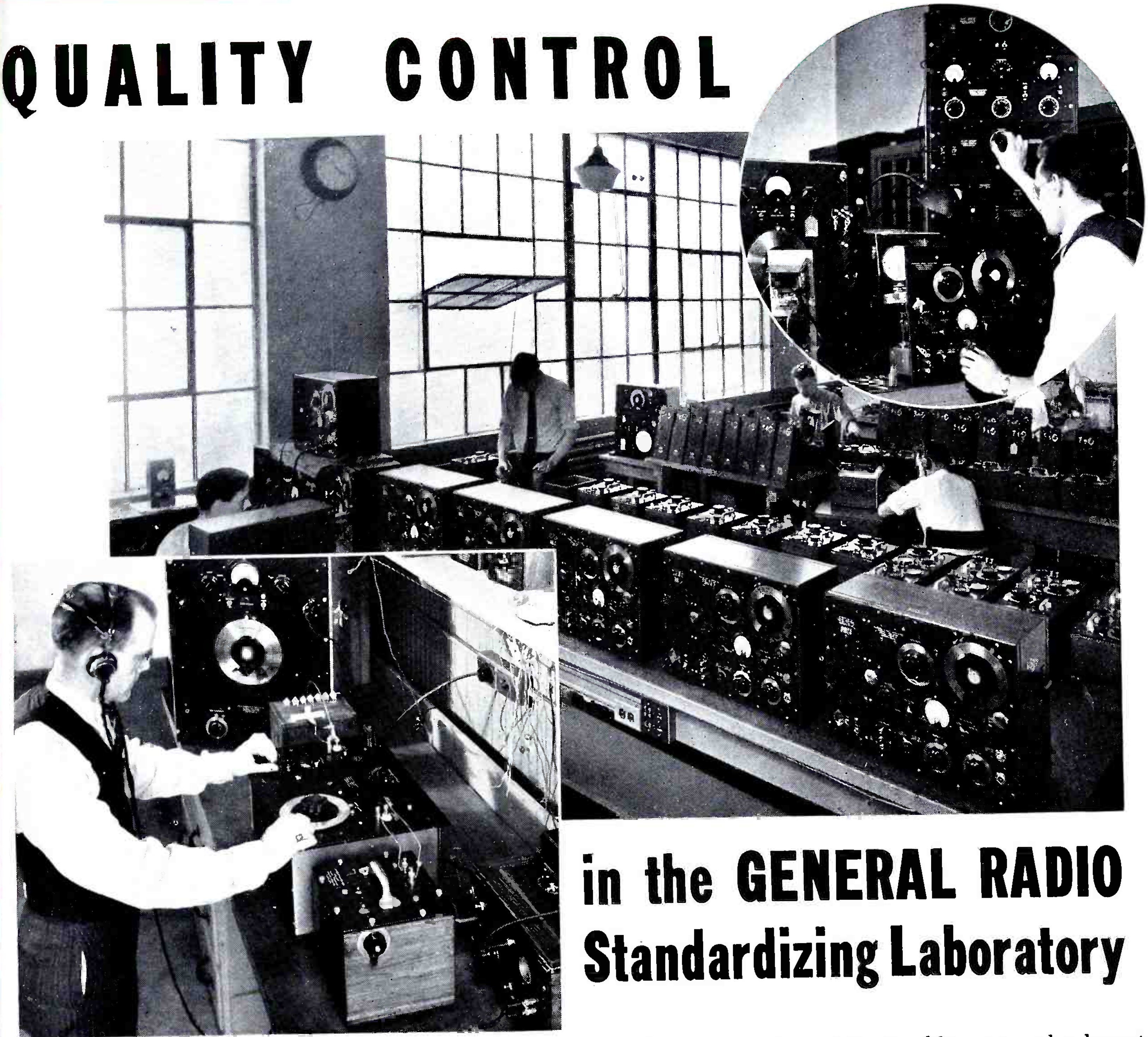
"The facilities of the Signal Corps training camps would permit an above average selectee to go through the following sequence of steps: (1)—Replacement training center for basic military and basic signal communication training—8 to 13 weeks; (2)—A specialty school in signal communication—8 weeks; (3)—Enlisted men's department of a Signal Corps school for specialized training in either radio or wire communications—12 weeks; (4)—An officer-candidate preparatory school—8 to 12 weeks; (5)—An officer candidate school, and finally, the officers' department of a Signal Corps school—3 months.

"Thus the Signal Corps is now thoroughly equipped to take a soldier with natural aptitude and leadership qualities through all the necessary stages required to turn out a capable, resolute, and technically skilled officer to whom may be entrusted an important role in maintaining the communications of the Army."

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS—JUNE, 1943

QUALITY CONTROL



in the GENERAL RADIO Standardizing Laboratory

HOWEVER well designed an instrument may be, accurate calibration and reliability in service determine its ultimate usefulness. Testing, therefore, has long been an important final step of our manufacturing; approximately 10% of the total man hours required to produce a General Radio instrument is spent in our standardizing laboratory. Here a carefully planned schedule of tests and measurements transforms an unadjusted, uncalibrated device into a precision instrument.

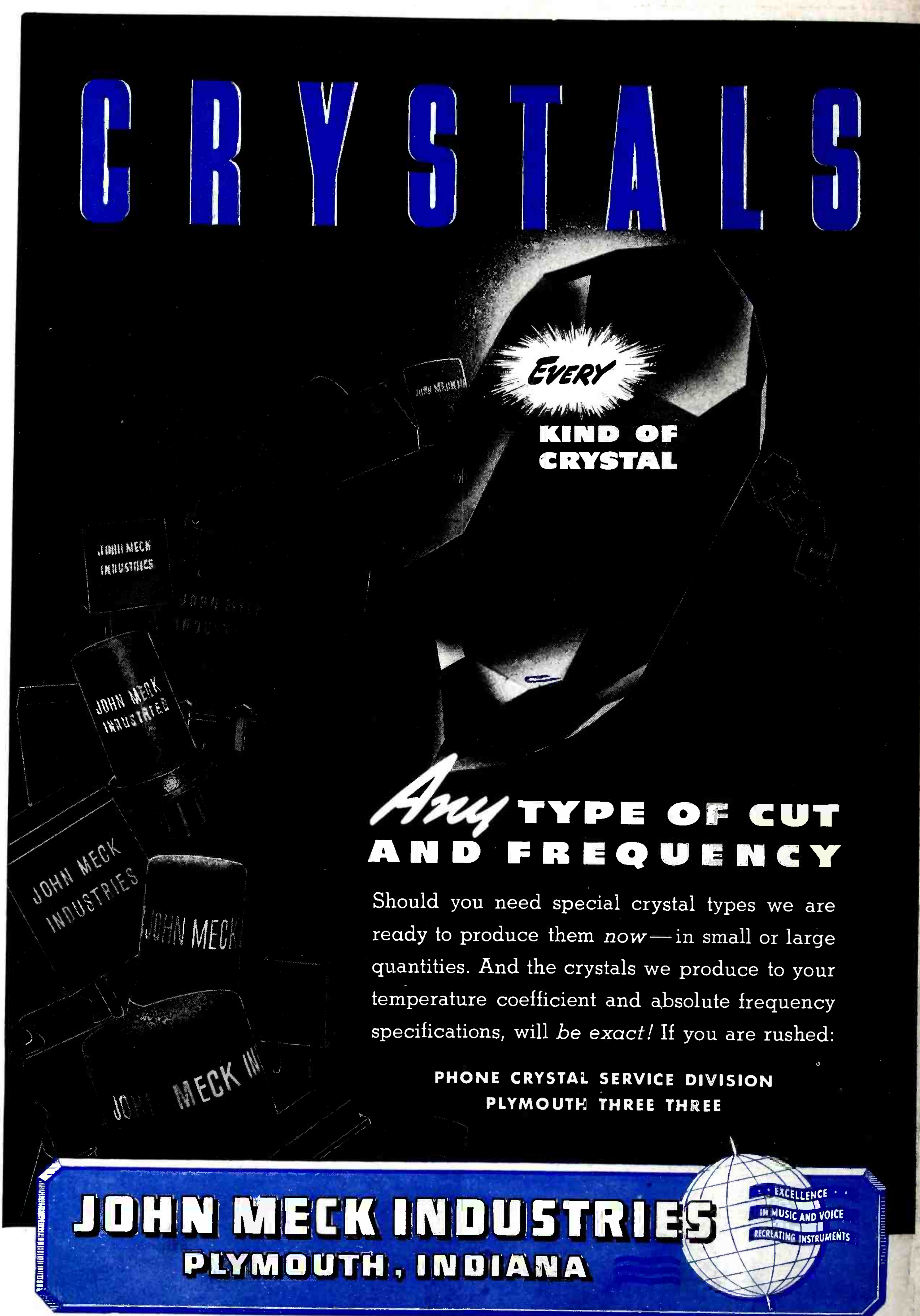
Testing specifications embody not only the rigid requirements imposed by the design objectives of the instrument, but also the field data collected in hundreds of case histories of similar instruments. Engineering test and calibration operations cover far more than meter reading and embrace a wide variety of precise electrical measurements.

To carry out these tests, capable personnel, adequate test equipment, and reliable standards are necessary. Many of the staff have engineering degrees or are graduates of engineering institutions. All are capable technicians. The laboratory equipment includes the entire line of General Radio instruments as well as those of many instrument manufacturers in other fields. As a basis for the measurements, the laboratory maintains precise, accurately-known standards of resistance, capacitance, inductance and voltage. Frequency measurements are based on the engineering department's primary standard.

Quality control in the General Radio Standardizing Laboratory is the result of years of experience in instrument manufacture; it is the customer's assurance of uniformly accurate and reliable instruments for his own testing department.

GENERAL RADIO COMPANY · Cambridge, Massachusetts

NEW YORK LOS ANGELES


CRYSTALS
EVERY KIND OF CRYSTAL
Any TYPE OF CUT AND FREQUENCY
Should you need special crystal types we are ready to produce them *now*—in small or large quantities. And the crystals we produce to your temperature coefficient and absolute frequency specifications, will *be exact!* If you are rushed:
PHONE CRYSTAL SERVICE DIVISION
PLYMOUTH THREE THREE
JOHN MECK INDUSTRIES
PLYMOUTH, INDIANA
EXCELLENCE IN MUSIC AND VOICE RECREATING INSTRUMENTS