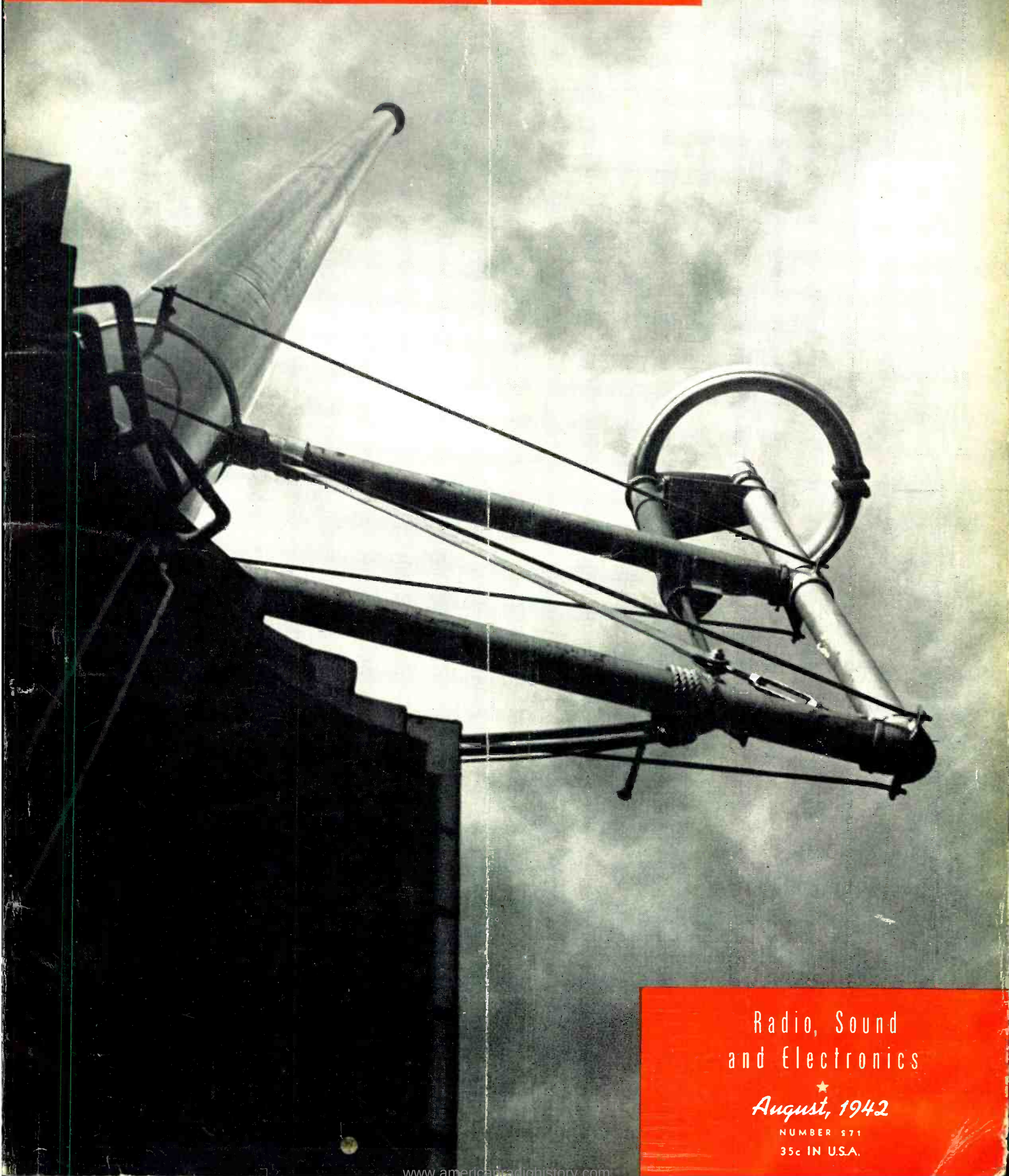
RADIO

ESTABLISHED 1917



Radio, Sound
and Electronics

★

August, 1942

NUMBER 271
35c IN U.S.A.

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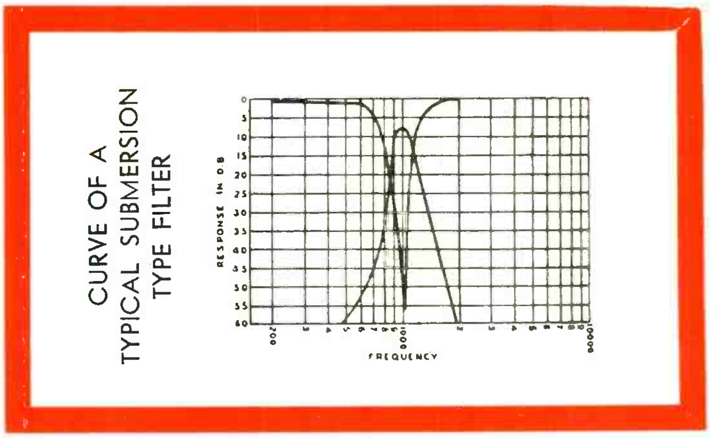

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EDITORIAL

RADIO SCRAP

◀ There is a critical scarcity of No. 1 and No. 2 copper wire scrap as well as other materials many of us have lying around. Our Government needs every bit of scrap we can provide. While each one's accumulation of scarce metals may not be large, the sum total of our accumulations would be an important factor in relieving the present situation.

Every amateur has surplus and damaged metal—especially copper wire—which he is not currently using. There are salvage committees in some 12,000 communities where he can turn it in, or be advised as to where he can dispose of it.

One amateur has made the excellent suggestion that antenna systems not now in use in conjunction with local defense units, might be voluntarily dismantled in order to provide an additional few pounds of copper, and other metals from the mast structure.

Remember—for want of a nail. . . . .

THE ENGINEER AND SOCIETY

◀ There is no escaping the fact that the world has become a bad taste in the mouth. When the stomach first turned is anyone's guess, but there is the rather good suspicion that the initial spasm turned up around the time when men of bad will (and no will) first discovered that the technological field was the world's newest and best racket. All one had to do was grab an udder, and the engineer gave milk without so much as a "please" from the taker. There was no question as to what the milk might be used for, or any concern over the possibility that it might sour if not handled properly. Or it might have been that the technological cow had a blind faith in all grasping hands—clean and otherwise.

Be that as it may, the innocent milk from the naive udder has turned to blood, has wrecked a continent and may yet ruin a world . . . . unless, of course, the cow takes off her pink glasses.

Though not in such terms, something of this sort is expressed by Arthur Van Dyke, President of the Institute of Radio Engineers, in his article "The Engineer in Modern Society," appearing in the July, 1942 *Proceedings*. Its importance cannot be overestimated, and we suggest it as the best reading of the month for every last man in the radio field—engineer or not.

Mr. Van Dyke feels that it is high time the engineer assumed some control over the use to which his brain children are put. It is also his thought that the engineer must have some voice in the society of the future if there is to be a future at all. At the very least he should be consulted on problems having to do with the sociological complexities of modern life.

This idea of assuming responsibility above and beyond their marriage to truth may be a new thought to some engineers, and possibly a distasteful one. But it is a responsibility that must be assumed if the bacillus is to be kept out of the new brew. And the first part of the responsibility is the irksome job of obtaining a broader view of humanity than the average engineer has. As a step in that direction we would suggest as required reading, "South Wind," by Norman Douglas, and "What Man Can Make of Man," by William E. Hocking. From these two books, the seeker after truth may find that truth itself plays but a small part in the ways of life. Humanity is a peculiar but lovely bit of rubbish that won't fit into a formula; and should the engineer make the mistake of thinking that life can be arranged to fit a plan derived from an ideal, then the reality of life as contradistinguished from the reality of pure truth will have escaped him, and the cause will have been lost.

POULSEN—1869-1942

◀ Word comes through from shackled Denmark of the death of Valdemar Poulsen, at the age of 73.

We cut our eye teeth on the Poulsen Arc, and tried, at the tender age of 14, to improve upon his Telegraphone. We did not succeed, and Poulsen continued to carry the honors.

But he lived to see others turn to the steel wire; and that which he invented in 1899 may still prove revolutionary before the century is out.

There will be other inventors, but never another Poulsen. —M.L.M.


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AUGUST 1942 — No. 271

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COVER

The "doughnut" antenna at Muzak's W47NY, the first to be installed in New York. Though a temporary set-up for the duration, it is 900 feet above sea level. The doughnut antenna is a development of the General Electric Co.

ARTICLES

MISCELLANEOUS

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with Temperature Controlled Characteristics

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Power Factor .05% does not increase with ageing. Voltage rating 5000 volts D.C. A.C. voltage rating varies with frequency.

Terminals available in two types; same as Type 840.

TYPE 840 High Capacity

Available in any temperature coefficient from zero to —.00075 mmf/mmf/C°.

(1) Zero Temperature Coefficient up to 1500 MMF.
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SIZE: .780" diameter Steatite tube — length varies with capacity and temperature coefficient.

500 MMF	NTC	approximately	¾" long.
1000 MMF	NTC	approximately	1" long.
500 MMF	ZTC	approximately	¾" long.
1000 MMF	ZTC	approximately	1½" long.

Power factor of .05% — does not increase with ageing.

Voltage rating — 1000 volts D.C. Leakage more than 10,000 megohms.

Terminals — two types available:

(1) Lug .030" thick threaded for 6-32 machine screw, or conventional soldering

(2) Axial mounting post with 6-32 machine screw thread.

CENTRALAB: Div. of Globe-Union Inc., Milwaukee, Wis., U. S. A.

HIGH-FREQUENCY TECHNIQUE

C. R. STOLL

◀ Radio gear for ultra-high frequencies has undergone considerable change during the past year, for which there are two reasons.

Circuits, tubes and component parts have either been improved so as to better serve the war program; or they have been made almost-as-good because of material priorities. Fortunately, the latter condition applies only to non-essential items.

With the coming of new amateur defense nets and a multitude of government set-ups, it becomes necessary to throw away some of our haywire and operate stable equipment. In many cases this means sacrificing last-ounce efficiency for practicability.

Antennas

The problem of antennas is always a primary consideration, especially in portable-mobile equipment. Depending on requirements, there are a multitude of systems from which to choose.

For simplicity and ease of handling, the antenna shown in *Fig. 1* has considerable merit. Actually, it is a coaxial type in new dress. The component parts instead of being rigid are flexible.

For receiving or low-power transmitting purposes, the construction need be nothing more than a section of good quality single conductor rubber-covered wire. A quarter wavelength of copper braid slipped over the rubber covering and connected to the cable braid comprises the bottom half of the antenna. The upper section consists of a flexible length of No. 14 wire of equal length as the lower braid. An insulator at this end provides a means of support for either vertical or horizontal polarization.

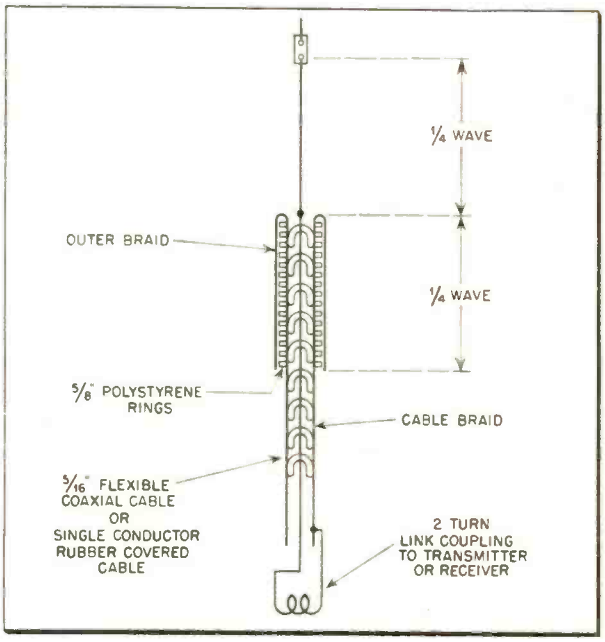


Fig. 1. Simplified coaxial antenna for portable use. Easy to erect, may be coiled and carried with any pack equipment.

A more efficient method of construction utilizes Amphenol or any similar polystyrene cable replacing the rubber type. Sections of polystyrene tubing approximately ½-inch long insulate the outer braid from the cable. With this method good results may be had with any conventional portable transmitter or receiver. Careful trimming of each quarter-wave element will naturally insure best results. The simplest method of doing this is to connect a 50 ma. bulb across a few inches of the upper element where it joins the cable. Adjust the length of each element for maximum brilliancy.

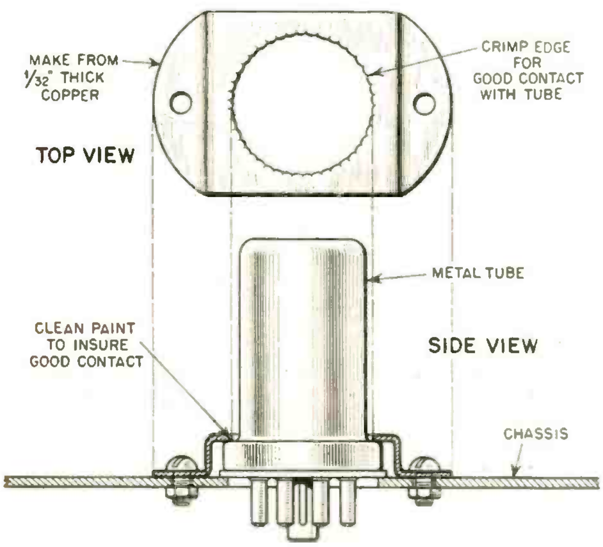


Fig. 2. One method of obtaining good contact between a metal tube shell and chassis.

Tubes

In many u.h.f. receivers, especially superhets using metal tubes, instability caused by regeneration often creates erratic operation. This can be traced directly to improper grounding of the metal shells of the tubes. In f.m. and a.m. receivers with 20-40 mc. i.f. stages of cascaded 1852's are especially prone to this condition. This is usually caused by lead inductance inside the tube and is the one failing of present-day metal tube construction.

The logical remedy is to provide some low-impedance path back to the chassis. Several types of tube clamps on the market do a good job of this providing the metal tube shell is cleaned of its protective paint. Lacking these, a simple clamp can be made by punching a large hole in a strip of copper, sliding this over the tube and fastening to the chassis (*Fig. 2*). A simpler version is to solder a heavy lug to the tube shoulder and bolt it under the socket screw.

This idea adapted to low-power metal tube transmitters often improves stability considerably and is always worth a try if regeneration, as evidenced by grid current kick when tuning through resonance, is present.

Loctal tubes are not subject to this trouble by virtue of their metal reference pin; but they likewise are not without sin. They are undoubtedly electrically superior to other types, since glass is the only insulation. However, even with the dozen or more types of sockets on the market, the contact between the tube prong and the socket could be better for u.h.f. use where a low-impedance path is desired.

Two independent reasons contribute to this difficulty. These are small prong diameter and hardness of the material of which the prong is made.

By combining the features of the Loctal tube with the base of the octal, an excellent compromise is reached. This can be done by force-fitting small sections of brass tubing, the diameter of an octal pin, over the pins of the Loctal tube and crimping in place. The Loctal tube may then be plugged into a standard octal socket. A good solid low-impedance contact is the result.

Although this method can be used only on experimental equipment, since it is a compromise and leaves the center pin to be grounded by other methods, it has proven valuable in certain cases. Possibly in the near future manufacturers will consider this change to cope with the greater responsibilities placed on tubes by high-frequency circuits.

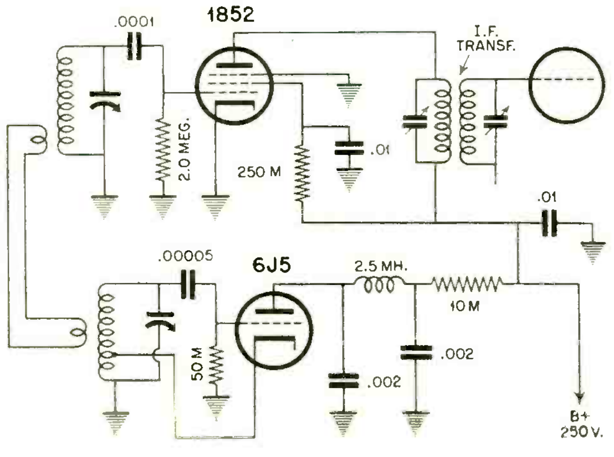


Fig. 3. An efficient and stable converter for use on frequencies up to 150 mc. If an r.f. amplifier is used preceding this, care should be taken to isolate input and output circuits.

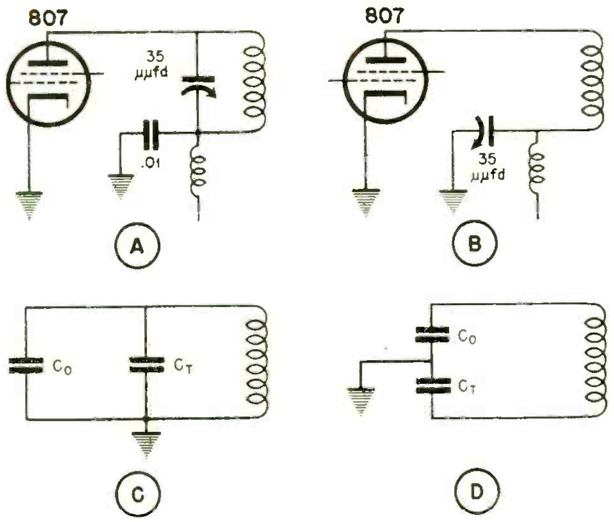


Fig. 4. Parallel tuning v.s. tuning in series with tube capacity. Advantages are greater output and increased tube life. Coupling to antenna or following stages may best be accomplished by two turn link.

Converters

In the average f.m. receiver the converter stage consists of a 6SA7 or equivalent. This usually does an excellent job. Considerably more gain can be had if this is replaced with an 1852 and a separate oscillator, as in *Fig. 3*. The circuit is conventional except for a few details.

Of interest is the lack of any cathode bias. This would normally be bad medicine for a tube of the 1852 type were it not for the fact that the screen voltage is held down to 20-30 volts by a large screen resistor. Without this the plate current would reach saturation, since the bias provided by the grid leak is small. By keeping the screen voltage low the signal-to-noise ratio is improved. If this voltage is too low, however, the gain of the tube will be sacrificed. The proper voltage will be indicated when the cathode current is at its normal value for 250 plate volts.

Coupling to the oscillator may best be accomplished by a one-turn link of push-back wire inserted in each coil. Too much or too little coupling will result in high signal to noise. Adjust the coupling at one end of the link while listening to a signal and comparing background hiss.

Transmitters

The output circuit of any conventionally tuned

[*Continued on page* 17]

An Improved

ELECTRONIC PHOTO TIMER

HOWARD A. BOWMAN, W6QIR

When Ham radio went into its—we hope—temporary hibernation, amateurs returned to former hobbies in droves, and many of them went to photography. It was inevitable that the one hobby should have influence upon the other.

Some time ago, there appeared in RADIO a description of an electronic time control device suitable for use as a timer for a contact printer or enlarger.[1] A copy of this device was built, but for several reasons was not considered satisfactory. For one thing, the time element was affected by the length of time the operator held down the push button used to start the timed period, and for another, the circuit and certain of the components seemed unnecessarily complicated.

With certain improvements in mind, a new circuit was designed around the familiar 117L7GT. This tube has a rectifier section and a beam power tetrode section. For our purposes the tetrode section is triode-connected—plate and screen tied together. The circuit developed, with most of its constants, is shown in *Fig. 1*.

Method of Operation

When the unit is turned on by throwing *SW1*, the main a.c. switch, the tube begins to warm up. The circuit to the output terminals is closed at this time, and the enlarger, or what have you, is turned on. Needless to say, there should be no sensitized paper lying around loose. When the tube draws sufficient plate-screen current to energize the relay *RL*, the armature pulls down, opening the output circuit. The unit is now ready to operate, but for the sake of stability, a warm-up period of at least fifteen minutes should be allowed.

An inspection of the circuit will show that at this time there is no negative voltage on the control grid, hence no charge in *C1*. When the push button is pressed, however, the rectifier section current flows through the resistor network, *R1* to *R5*, and *C1* is charged accordingly. This high negative bias, considerably past cut-off point, reduces plate-screen current to such a low value that the relay is de-energized, and the a.c. circuit is connected to the output terminals.

While the charge in *C1* is draining off through the resistor network, the relay remains open, but as the bias decreases due to discharge of *C1*, the plate-screen current increases, finally reaching a point where it is great enough to energize the relay, and thus open the output circuit.

It is important to note that when the push button is pressed and the relay opens, current flow through the resistor network stops. This means that the charge received by *C1* is determined by the total time that both the push button and the relay are closed. When either opens, the charging process is terminated automatically. In actual use, the relay always opens first, almost instantaneously when the button is pressed. Thus the charging time is independent of any human element, and the condenser receives exactly the same charge each time the button is pressed with the controls set at any given point.

Construction

Many different plans of construction may be used, in each case depending upon the parts the constructor

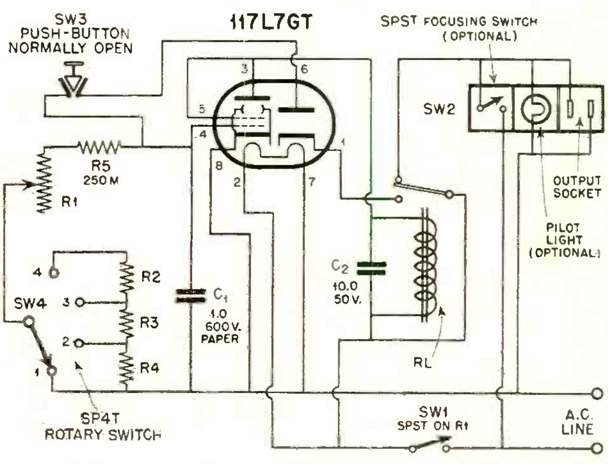


Fig. 1. Complete circuit of photo timer using a triode-connected 117L7GT.

[1]Norton, Leigh, "An Electronic Photo Timer," RADIO, March 1940, p. 23.

may have available in the junk box. The relay may be any d.c. single pole, double throw affair which has a sufficiently high resistance to operate on the plate current range of the tube. About 800 to 1500 ohms should do the trick. Several models have used relays taken from old Yaxley B eliminator-Trickle Charger units. The wire is stripped from the coil, and it is rewound with No. 38 or smaller enameled wire. These relays are d.p.d.t. and the contacts may be paralleled for greater capacity on the output side.

The condenser *C2* across the relay winding is necessary to prevent chatter. It is not critical as to capacity; anything from 10 μfd. up and of a rating of 50 volts or so is satisfactory.

Some of these units have been built in metal boxes of varying sizes; others have used only a panel of Tempered Masonite, or plywood, mounting all components on the back of the panel. If a metal box is used, care must be taken to insulate leads, connections, etc., carefully, so that the box is not hot with a.c.

The output socket with its associated pilot light and switch for focusing may be an integral part of the unit, or may be separate, with leads of almost any length. It is possible to purchase a standard assembly for a.c. use, consisting of a female outlet, pilot light, and switch. The light should preferably be red, but amber is satisfactory if only enlarging papers are used.

Time Control Circuit

The time control circuit is composed of *C1* and the resistors *R1* to *R5*. *C1 must* be a good, low leakage paper condenser of 1 μfd. or greater capacity. The minimum time of operation is controlled by *R5*. With 250,000 ohms at *R5*, the minimum time is about three seconds. If a shorter minimum time is desired, *R5* may be reduced in value, but should not be less than 50,000 ohms or thereabouts. Without *R5* the rectifier section of the tube would be shorted were the push button pressed with *SW4* and *R1* set for minimum value. Since this particular variety of tube is rather delicate, it would probably end its useful existence at that point.

The voltage rating of *C1* does not seem to have great effect upon the operation of the unit, so long as the leakage value of the insulation is very low. Obviously, a discharge circuit of 10 or 12 megohms would have little effect if the internal leakage resistance of the condenser amounted to but 1 or 2 megohms.

Resistors *R2, R3, R4* select the ranges of time delay, while *R5* enables the operator to select any time within each range. The four resistors must be equal in value, and may be of ½-watt rating. Experiments conducted with resistors of various value showed a considerable range of time delay available.

If the constructor needs something to control time up to, say, 15 seconds, these four resistors may be a half megohm each. For control up to better than a minute and a half they may be 3 megohms each. As pointed out earlier, however, a poor condenser will render the upper ranges almost inoperative. With 500,000-ohm resistors and a condenser of somewhat questionable antecedents, the following tabulation was made:

Range	*Minimum time*	*Maximum time*
1	3 seconds	8 seconds
2	8 seconds	11.4 seconds
3	11 seconds	13.3 seconds
4	13.4 seconds	15.1 seconds

This is the tabulation for the potentiometer used to make the sample scale, *Fig. 2*. It will be noted that most of the calibration points are crowded into the upper ranges of the scale. This is because an audio gain control was used as the potentiometer. For best results the control should have a linear variation.

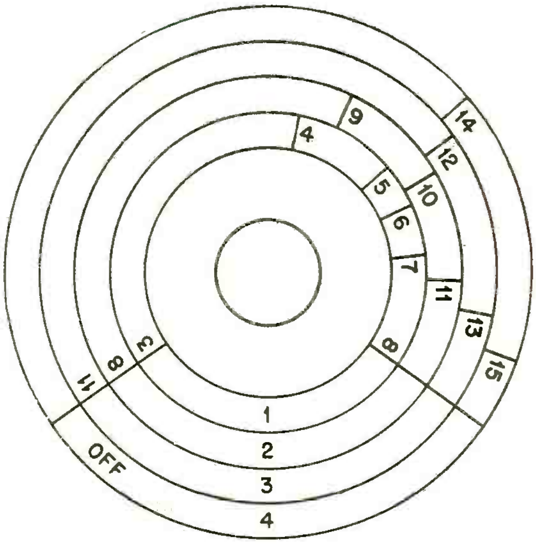


Fig. 2. Details of the calibration scale for potentiometer R1 in Fig. 1.

This will spread the calibration points more evenly throughout the range. Too, the two upper ranges show almost no variation in time throughout their length. This is because the resistors are approaching the internal resistance of the condenser, hence having less effect upon discharge time.

Calibration

When the unit is complete, a scale may be made for *R1* and calibrated for various time intervals. *Fig. 2*, a sample scale, gives an idea of how the scale may be made.

Calibration is a simple, but somewhat tedious, job. First, plug in a 7½- or 15-watt lamp at the output socket. A low power bulb is used because watching the light rapidly becomes tedious and considerable eye strain may result. A stop watch should be used for best results, but in a pinch an ordinary watch with a second hand, preferably of the sweep variety, may be used.

When the unit has thoroughly warmed up, check the minimum and maximum time for each of the four ranges. This is done by setting the range switch to point 1, turning *R1* to minimum resistance, pushing the button, and checking the time. Then, *R1* is set to maximum resistance and the time again checked. This procedure is repeated for each of the other ranges.

With this information tabulated, the user has a rough idea of the possibilities for calibration. Next the range switch is again set to point 1, and *R1* is given some arbitrary setting. A time check is then made. If the time is exactly on an even second, the user is lucky; usually it is not. However, by nudging *R1* one way or the other, and taking a few more checks, a point will be found at which the time will fall exactly upon the second. A point is then marked upon the scale. This process is repeated for the same range until each one second interval has been found and calibrated. Then the procedure carries on for each of the other ranges. When one range has been tabulated, the user will have some idea of the effect of taper upon the potentiometer's readings, and in the upper ranges the minimum and maximum readings will serve to indicate possible approach to the maximum range obtainable with the condenser used at *C1*.

Alternative Time Controls

Several alternative methods of time control suggested themselves, and a couple of the more promising are shown in *Fig. 3*. *Fig. 3A* shows a single potentiometer used as a control. It may be of 5 or 10 megohms, depending upon the range desired, and

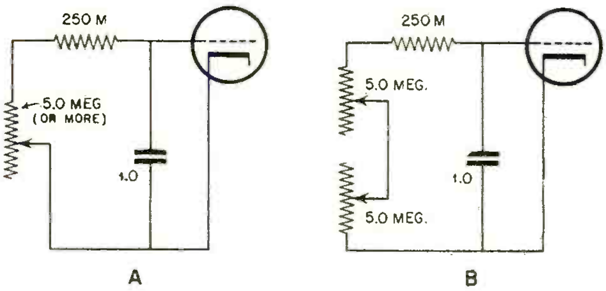


Fig. 3. Two optional timing circuits.

would be the only control, eliminating *SW4* and its associated resistors. Obviously it is not capable of as great an accuracy as the system shown in *Fig. 1*.

Fig. 3B shows a circuit employing two potentiometers, of about 5 megohms each. In this system, when the operator wishes any range covered by the lower control, the upper must be set at minimum resistance; if the desired range is covered by the upper control, the maximum resistance of the lower control must be in the circuit.

Another system, simpler in some ways, and more complicated in others, is diagrammed in *Fig. 4*. This circuit employs a type 2A4G Thyratron in a circuit that is capable of giving time control of great accuracy. It has been used successfully in a number

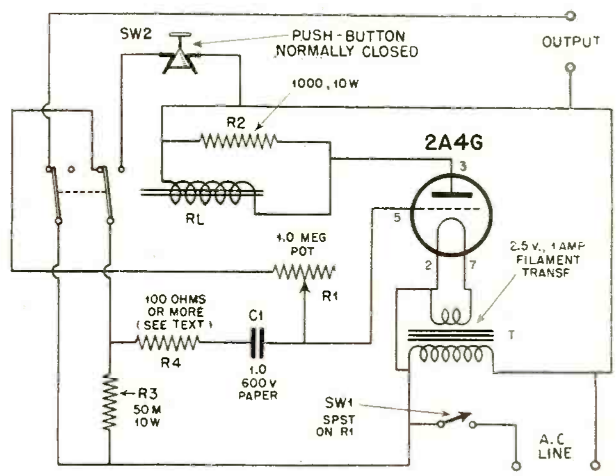


Fig. 4. A Thyratron timer that may also be used as a control for a spot welder.

of applications. Originally designed as a timer for photographic work, the circuit was later built up on a breadboard layout, and a relay with heavy output terminals substituted. In this shape it served to control a spot welder used to weld several thousand chassis turned out for local radio manufacturers. Chief objections to this circuit are the necessity of using a filament transformer, and a d.p.d.t. relay.

Method of Operation

Although the circuit is essentially simple as to components, it is a bit more difficult to understand than that diagrammed in *Fig. 1*. Referring to *Fig. 4*, the drawing shows the circuit as it is before *SW1* is closed. When this switch is closed, the 2A4G begins to heat up, and as soon as sufficient plate current is drawn, the relay *RL* closes.

Note that the push button used is normally closed, and that in this condition, current flows both through the tube and through the external circuit made up of the push button, the lower contact of the relay, and *R3*. *C1*, the time control condenser, immediately takes on a charge, but since the grid of the tube is on the same side of the a.c. circuit with respect to the cathode, the grid is not negative. When the push button is pressed, however, the a.c. circuit is broken. The side of *C1* which connects to cathode through *R4* and *R3* assumes cathode potential, but the grid side of the condenser is now negative by an amount approximating the peak line voltage. This cuts off plate

[*Continued on page* 17]

FROM BROADCAST TO TELEVISION

The Station Operator Is Confronted With New Problems and Duties When He Takes On a Television Transmitter. The New Operating Concepts Are Detailed Here.

EDWARD M. NOLL

PART I

◀ In the evolution of the broadcast operator to the television operator there are a number of new concepts of operation the new operator must acquire; moreover, he must retain those already mastered. Briefly they can be put under these general headings.

1. 550-1600 kc. to 50-200 mc. or from tank coils and condensers to transmission line sections and concentric lines.

2. 30-8000 cycles to 0-4 mc. linear frequency response.

3. 10-kc. bandwidth to 6 mc. bandwidth.

4. One source of information on one carrier to three sources of information on two carriers.

5. VU meters and sound monitors to picture tubes and various oscilloscopes.

6. AM to FM sound or 100% modulation to maximum deviation.

7. Resistor and transformer coupled stages to direct coupled and impedance transformation stages.

8. High-gain peaked circuits to low-gain damped circuits.

9. Low-voltage power supplies to voltage-regulated high-current supplies.

10. Quarter-wave verticals to stacked arrays and folded dipoles.

Construction of Signal

One of the initial requirements of the new television transmitter operator is to become familiar with the construction of the television signal. There are two types of information sent on the television carrier. One type is the actual picture information or variations in light and dark of the actual scene being televised, and the other type of information is the synchronization pulses and blanking signal. The synchronization pulses, both vertical and horizontal, keep the corresponding horizontal and vertical deflection circuits in receiving and transmitting circuits in synchronism so that the scanning beams in the picture tube and camera tube are at the same position on their respective surfaces. The blanking signal is transmitted to black out the picture tubes during the transmission of the synchronization pulses, and a short interval before and after each pulse. A composite television signal is shown in *Fig. 1.* This signal is in accordance with the standards decided upon by the Radio Manufacturer's Association Committee on Television, a group organized to standardize television practice throughout the United States.

The television signal is of one polarity in comparison to the audio signal as utilized in broadcast work. The voltage range of the television signal extends from zero to a finite positive voltage, or from zero cut-off to a maximum voltage represented by the tips of the synchronization pulses. There is always a constant voltage between the points marked "blanking level" and "synchronization tips," regardless of any changes in light and dark of the picture itself. This blanking level, which is maintained at 75%±2.5% of peak voltage, represents the voltage at which the picture tubes are blacked out. The volt-

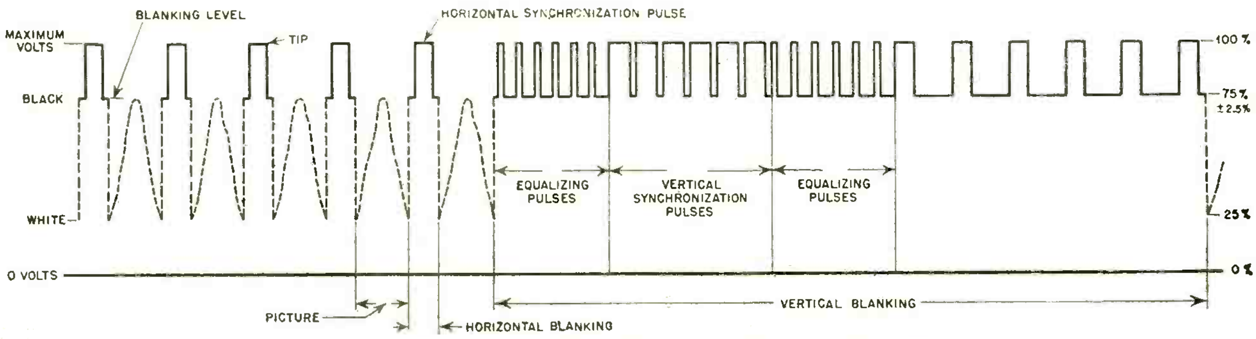


Fig. 1. A composite television signal following the standards set by the RMA.

ages over and above this level, called the blacker-than-black region, are those voltages depending upon their number and duration required to start the vertical or horizontal deflection circuits of the receiver. The portion of the signal below the blanking level contains the picture information; the darker regions of the picture being of the greater voltage extending up to the blanking level, while the whiter portions may be in the vicinity of the 25% level, and in brilliant scenes may drop below 25%, seriously approaching the cut-off value.

The region between 25% and 0° represents a buffer region in operation, to prevent too rapid a saturation of brilliant peaks. When this composite signal is applied as modulation, any increase in the darkness of a scene will increase the carrier output of the television transmitter. This is termed "negative modulation." On the camera tube itself, any increase in light will cause an increase in output. However, before the signal is sent to the transmitter it is properly phased, and blanking and synchronization pulses inserted at proper levels so that the signal reaching the transmitter is the standard RMA signal.

The generation of the composite television signal is beyond the scope of this article. It is not a necessity for the television transmitter operator to be well informed on the generation of the signal, although it is a definite advantage in localizing trouble not coming from the transmitter itself. The important duty of the operator is to maintain the signal at a two-to-one ratio (two portions of picture to one portion of synchronizaion) as the signal is amplified and finally applied as a modulating signal to the radio-frequency portion of the transmitter.

Response and Definition

The frequency response and definition of the television signal is determined by the number of lines per second, the velocity of the electron scanning beam, and the ability of the various circuit components to follow the rapid changes in current and voltage accurately and completely at the high speeds involved. The present system approved by RMA consists of 525 lines of interlaced scanning. These 525 horizontal lines determine the vertical definition of the picture and are visible when you are very near the picture tube—in the case of a ten inch tube, if you are within two feet they become visible. The interlaced scanning system is shown in *Fig. 2.*

The total of 525 lines are covered thirty times per second which means if the lines were covered in rotation the entire picture would have to be blacked out thirty times per second. This low frequency would produce an annoying flicker. In order to prevent this effect and to decrease somewhat the effect of any momentary distortion, the picture is blacked out sixty times per second by scanning first the odd number lines and returning again to cover the even number lines, thus doubling the number of times the entire picture is blacked out.

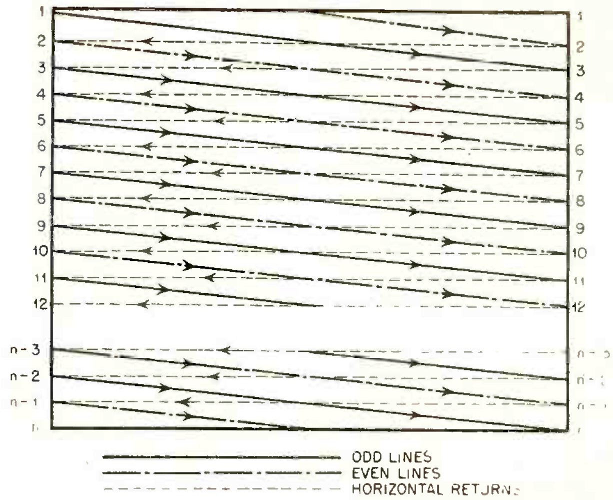


Fig. 2. Interlaced scanning system. The total of 525 lines are covered thirty times per second.

The entire 525 lines are not active picture lines as some lines are utilized on the vertical return. An earlier system utilized only 441 lines which made the lines more noticeable, but produced an equal definition in both the horizontal and vertical. However, at some sacrifice in horizontal definition and an increase in vertical definition, the number of horizontal lines were increased to 525. The loss in horizontal definition is not apparent to the televiewer as no lines are involved vertically. The horizontal definition of the picture is dependent on the scanning beam velocity and the ability of the following circuits to produce accurately the rapid changes in current and voltage. The very high frequency response required by video equipment can be shown by this simple example.

Beam Travel

The time required for the beam to travel from left to right on a ten inch tube is 57 microseconds, or to cover one inch requires 5.7 microseconds. Now if within this one inch there were twenty vertical black lines which the beam would have to cross on its trip across the camera tube, this would represent twenty complete cycles from white to black to white. Using this simple proportion the active frequency response as the beam covered that one inch distance would be 3.5 mc/second.

$$\frac{\text{time to cover 20 cycles}}{\text{frequency in cycles}} = \frac{\text{one second}}{\text{cycles/second}} = \frac{5.7 \times 10^{-6}}{20} = \frac{1}{x}$$

$$X = 3.5 \times 10^{6} \text{ cycles in one second}$$

Monitoring

The television signal can be monitored by an elaborate switching arrangement from the time it comes to the transmitter by line, through the video amplifiers, on the antenna feeders, and finally by means of a signal taken from the air at a remote receiver location which is sent by line back to the transmitter.

Both the actual picture is seen on a picture tube and the waveform on an oscilloscope for each switching position. In addition there is generally a permanent oscilloscope on the incoming line and one showing the radio-frequency output waveform of the television transmitter.

This versatile monitoring system is an ideal arrangement for immediately localizing transmitter trouble and the two permanent oscilloscopes on input and output are an immediate check on whether or not the transmitter is maintaining the proper ratio of picture to synchronization. The ratio can be controlled to take care of slight variations from the proper ratio by varying the bias of the final modulated stage. This method has a disadvantage, however, because varying the operating point of the modulated stage effects the power output of that stage. If the proper ratio of picture to synchronization is allowed to become greater than two to one, receivers at a point where the signal is relatively weak will not stay in synchronism and there will also be a tendency for the whites to saturate at all locations. If the overall ratio is allowed to become less than two to one, thus crowding the picture, the picture itself will lack variation and range.

Frequency Band

The frequency band assigned to television stations is only six megacycles wide and must accommodate both picture and sound carriers. The television signal itself contains frequencies up to four megacycles which, if double sideband transmission were used, would require a bandwidth of eight megacycles. However, television uses a variation of single sideband transmission in which the entire sideband is transmitted on one side of the carrier and a portion of the other sideband is transmitted. This method is called "vestigal sideband transmission."

The three main television channels are 44-50 megacycles, 50-56 mc., and 66-72 mc. Each one of these channels, each 6 megacycles wide, is divided in this manner:

0-.5 mc..........decaying sideband and guard band
.5-1.25 mc.....portion of low frequency sideband
1.25 mc..........carrier frequency television transmitter
1.25-5.25 mc...complete high frequency sideband
5.25-5.75 mc...decaying sideband
5.75 mc. ....carrier frequency sound transmitter
5.75-6 mc.......decaying sideband and guard band

The television transmitter operator must keep a constant watch on the picture monitor and waveform oscilloscopes—he must use his eyes continually. He must keep a close watch on the frequencies of both transmitters. He must keep a close watch on the deviation of the frequency-modulated sound transmitter. The television transmitter operator's work is fascinating, and his training as a broadcast operator is valuable in permitting him to concentrate more fully on his now added duties as a television operator.

(To be continued)

ELECTRONIC PHOTO TIMER

[*Continued from Page* 14]

current, allowing the relay to open, and applying the line voltage to the output terminals.

The discharge circuit, controlling the time element, is essentially the same as that used in the other model. A single potentiometer of 1 megohm gives highly accurate control up to 15 seconds. A second potentiometer of 10 megohms in series with the first gives control up to 3 minutes and 10 seconds.

R2 is used across the relay in place of a condenser because a condenser at this point might damage the tube by causing the flow of a high peak current. *R4* similarly acts to limit peak current. If *C1* is greater than 1 μfd., *R4* should be of higher resistance. A 4 μfd. condenser at *C1* needs about 2500 ohms at *R4*. *R4* may be a resistor of low wattage rating, but both *R2* and *R3* should be wire-wound.

HIGH-FREQUENCY TECHNIQUE

[*Continued from Page* 11]

oscillator-amplifier transmitter, *Fig. 4-A*, can be made to deliver several times more power by converting it as illustrated in *Fig. 4-B*.

At first glance it may appear that the circuit is series-resonant, but such is not the case. By examining the capacity diagrams, *Figs. 4-C* and *4-D*, it becomes evident why improved performance is to be expected.

Let us assume that the amplifier tube in question is an 807 with 7 μμfd. output capacity. In the conventional circuit the output capacity C_o is in parallel with the inductance, as is the minimum capacity C_T. This results in a total minimum circuit capacity of 14 μμfd. Examining the new circuit shows that the total circuit capacity is only 3.5 μμfd. This is an important gain since it permits using a larger L/C ratio. This resultant increase in inductance naturally increases the impedance of the circuit which in turn permits greater voltage to be developed and more output. A secondary but worthwhile result is that it increases tube life by reducing the on-resonance plate current.

In practice, however, the capacity constants of *Fig. 4-D* should not be used since they represent a balanced condenser. This puts equal voltage on each end of the coil and permits the tube to work into only half of the coil since it simulates a capacity centertap. The tuning condenser should be made at least four to five times larger than the tube capacity for frequencies above 50 mc. For lower frequencies it should be proportionally larger. This increases the total circuit capacity to five to six μμfd. but it is still a considerable improvement over parallel tuning.

Tests show that, for frequencies of 50 mc. and higher, it is possible to almost double the number of turns of any tank inductance by switching from parallel to series tuning. The r.f. output usually goes up approximately three times while resting plate current is halved.

Q. & A. STUDY GUIDE

—Theory and Practice

197. What is the approximate fully charged voltage of an Edison storage cell?

Approximately 1.45 to 1.52 volts open circuit value, which falls under normal discharge rate to about 1.14 volts.

198. A six volt storage battery has an internal resistance of 0.01 ohm. What current will flow when a 3 watt, 6 volt lamp is connected?

Solution: $I = \frac{E}{R + r}$

where I is the current, E the electromotive force of the battery, R the external resistance, and r the internal resistance of the battery.

$E = 6$ volts

$r = 0.1$ ohm

$R =$:

given a load of 3 watts at 6 volts

$$R = \frac{E^2}{W} = 12 \text{ ohms}$$

Thus. to find I, substitute, and

$$I = \frac{6}{12.01} = .499 + \text{amp.}$$

199. What is the approximate fully charged voltage of a lead-acid cell?

Approximately 2.1 volts.

200. Why is low internal resistance desirable in a storage cell?

The lower the internal resistance of a cell the greater its capacity to deliver current. The lower the resistance in the storage battery the longer the battery will be able to deliver steady current of a high amperage.

201. What is "local action" in a primary cell and how may its effects be counteracted?

Local action is where impurities in the zinc electrode of a primary cell act with adjacent zinc particles to form small cells. At such places zinc is always passing into solution, causing small currents of electricity which are wasted.

202. What is meant by the term "sulphation" as applied to a lead-acid storage cell?

Sulphation is the formation of lead sulphate on either the positive or negative plates of a storage cell when the cell is discharging or has been left idle for some time.

203. How may the condition of charge of an Edison cell best be determined?

Since the specific gravity of the electrolyte in an Edison cell is substantially constant, the best test is a voltage reading (connecting a voltmeter across the terminals when the current is flowing).

204. If the charging current through a storage battery is maintained at the normal rate, but its polarity is reversed, what will result?

The plates will become reversed in chemical character and the battery will be destroyed should the charging so continue for any great length of time.

205. What are the effects of sulphation?

The lead sulphate formed during sulphation will become hardened and gradually build up a greater deposit on the plates; the area of the plate which may be acted on by the electrolyte becomes smaller and the capacity of the battery is thus reduced. Also the hard crystals of lead sulphate are not readily converted back into lead peroxide when the battery is recharged.

206. How may the state of charge of a lead-acid storage cell be determined?

By testing the specific gravity of the electrolyte; by testing for the ampere-hour capacity, ampere-hour efficiency, watt-hour capacity and efficiency.

207. With respect to its use in connection with d.c. motors and generators, what is the meaning of the term "neutral position"?

When the rotator position is such that it is parallel to the flux lines of the magnetic field, and the induced voltage or electromotive force is zero.

208. Why is laminated iron or steel generally used in the construction of the field and armature cores of motors and generators instead of solid metal?

Eddy currents induced in a solid core that result when the armature is rotated in a strong magnetic field will heat the iron core and cause a power loss. A laminated core reduces the heating effect of the eddy currents by making the core non-conducting in the direction in which the current tends to flow.

209. What is meant by "regulation" of a generator?

The regulation of a generator refers to the voltage drop from no load to full load, and is stated generally as a percentage of the full-load voltage, expressed by the formula:

Per cent regulation equals

$$\left(\frac{E_o - E_f}{E_f}\right) \times 100$$

where E_o is the no-load voltage in volts

E_f is the full-load voltage in volts.

[Continued on page 33]

A Transitron

AUDIO OSCILLATOR

HOWARD H. ARNOLD

◂ There are many unusual oscillator designs in which only resistance and capacity are used as the tuning elements. Of these, one of the most stable types is the Transitron, or negative-transconductance oscillator. Using a minimum number of parts of standard type, it makes a splendid substitute at a time when other than stock parts are unobtainable.

Operating Principle

The Transitron is similar in some respects to the Dynatron oscillator, except that the negative-resistance characteristics are not obtained by means of secondary emission. Instead, the characteristics are obtained by the creation of a suppressor-screen negative transconductance.

Referring to the accompanying diagram, the 6J7 screen is operated at a higher potential than the plate. The suppressor grid is operated at a negative potential with respect to the cathode. In the absence of a strong positive potential on the plate, the accelerated electrons passing through the screen are diverted back to the screen by the negative voltage on the suppressor. The screen and suppressor grids are capacitively coupled, so that any voltage variation on the screen is transferred to the suppressor.

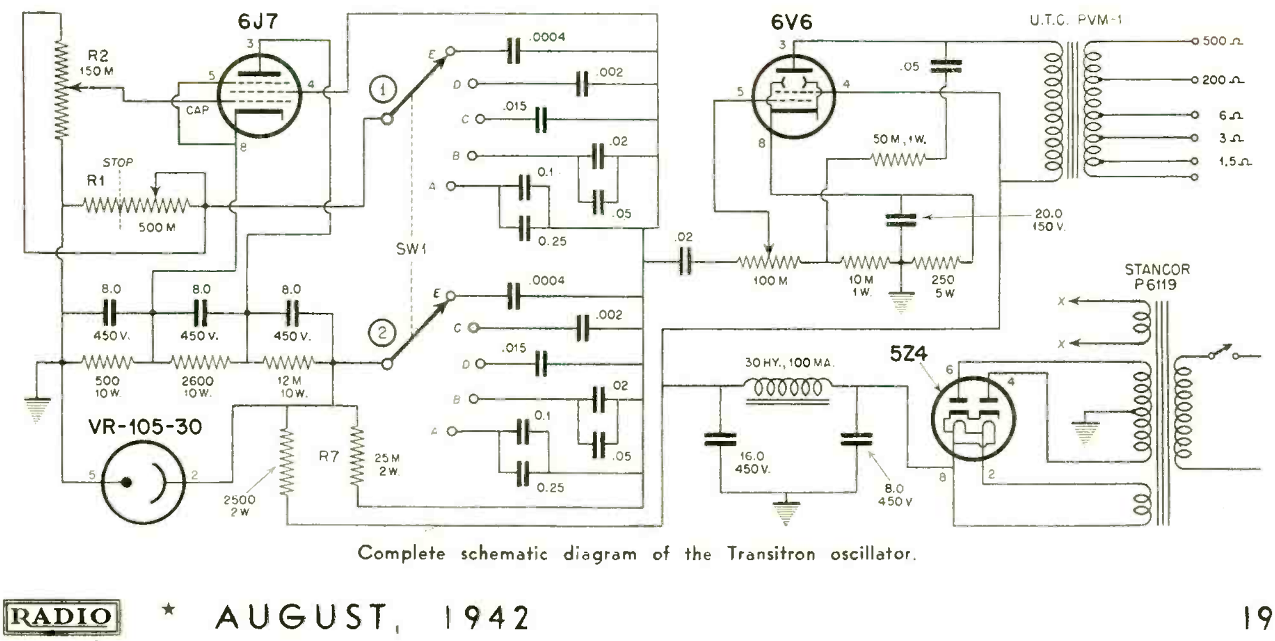
The tuned circuit consists of *R7* and one of the condensers common to switch arm (2). A small negative increment of voltage across this circuit is applied to the suppressor through one of the condensers common to switch arm (1), the value being proportional to the setting of *R2*. This further increase in the negative voltage applied to the suppressor increases the repulsion of electrons toward the screen, thus increasing the screen current. By properly proportioning the tuned circuit elements in the plate and grid circuits, a constant audio voltage of excellent waveform can be produced.

The oscillator section of the unit makes use of a regulated power supply, with a VR-105-30 tube as the regulator. Since the Transitron is stable to begin with, the use of a regulator provides constant audio frequencies under practically all conditions. Individual tube characteristics have little effect on frequency stability; therefore, with accurate calibration at the outset, the device will remain put over long periods.

Frequency Adjustments

The frequency ranges are covered by means of the ganged switch SW1, which alters the capacity values in the plate and grid circuits. The frequency ranges are, roughly, as follows: A — 12 to 100 cycles; B — 100 to 400; C — 400 to 2000; D — 2000

[*Continued on page* 30]



Complete schematic diagram of the Transitron oscillator.

Electrical Steel and MAGNETIC CIRCUITS

WILLARD MOODY

The subject of electrical steel is a fascinating one. The designing and building of iron-core devices using it, is now greatly accented as the war makes it necessary to conserve and improve existing products and to maintain old equipment in good order.

A grade of transformer steel widely used in communications apparatus in U.S.S. 72, a product of United States Steel Corporation, and this material serves well in those applications requiring good, low-density permeability. It has good punching properties. This grade is usually furnished in 26 and 29 gages, carrying the same core loss guarantee as U.S.S. Transformer 72, but with a higher flux density permeability. These transformer grades are termed "non-aging," with an assumed specific gravity of 7.5 and resistivities ranging from about 56 for U.S.S. Transformer 72 to 65 for U.S.S. Transformer 52.

Information which shows the relationship between the various grades of electrical sheet is given in the table at end of article.

Grade Characteristics

Viewing the whole series of grades in progression from Field grade up through the Transformer grades, the following generalized facts should be observed:

(1) The silicon content increases.

(2) The core loss decreases for a given sheet thickness.

(3) Eddy current and hysteresis losses decrease.

(4) The saturation flux density gradually decreases from about 21,500 to 19,000 gausses.

(5) The value of maximum permeability gradually increases, occurring at lower values of magnetizing force.

(6) The permeability increases for flux densities below maximum permeability.

(7) The high induction permeability, above approximately 12,000 gausses, gradually decreases.

(8) The sheets in general become stiffer, or harder; the Rockwell values gradually increasing and the Ericksen ductility values decreasing for the same gage and sheet finish.

There are a number of words that frequently crop up in any discussion of magnetic principles, which require definition to make their meaning clear or to refresh the memory. The maxwell is a line of electromagnetic force or "flux." A gauss is 1 maxwell per square centimeter. An erg is a unit of work, equal to the work done when a body is moved 1 cm. by a force of 1 dyne in the direction of original motion or from resting position. The magnetomotive force of a magnetic circuit is 1 gilbert if the work required to carry a unit magnetic pole once around the circuit is 1 *erg*. A magnetic circuit possesses a reluctance of 1 *oersted* if a magnetomotive force of 1 *gilbert* produces a flux of 1 maxwell.

A unit pole is one which, if placed 1 centimeter from an equal pole in a vacuum, will repel it with a force of 1 dyne.

Law of Magnetic Circuits

In a magnetic circuit, the total magnetic flux is equal to the magnetic force (F) divided by the reluctance of the circuit,

$$\phi = \frac{\text{mmf } (F)}{R}$$

where R is the reluctance in oersteds, ϕ flux in maxwells and F is the magnetomotive force in gilberts.

In practice, it is customary to deal with the magnetizing force per unit length of a magnetic circuit which, when the magnetic circuit is of non-magnetic material is equal to

$$H = \frac{4\phi NI}{10\ l} \text{ gausses}$$

where H is the field strength in gausses, NI is ampere-turns, and l is length (in centimeters) of the magnetic path. When the material is magnetic, the magnetic induction (gausses) is $B = kH$, where k is permeability, a constant which varies with the material and with B.

The reluctance R is proportional to the length l of the magnetic path and inversely to the area A. That is,

$$R = p\frac{l}{A} \text{ oersteds}$$

where p = a factor dependent upon the kind of material composing the magnetic circuit, l is the length and A is the area, dimensions in centimeters. For non-magnetic circuits, p is unity. For magnetic circuits, p depends upon the flux density and character of the material.

The average flux density at any point in the circuit is $\frac{\phi}{A} = B$ and if l is in centimeters and B in lines/cm.², the ampere-turns required to produce a specified flux density in non-magnetic materials is,

$$NI = .796\ B$$

For lengths in inches and the density in lines/in.² the formula is,

$$NI = .3132\ Bl$$

Putting an iron core inside of a coil greatly increases the flux and the magnetic induction is,

$$B = \frac{.4\pi\mu NI}{l},$$

where μ is the permeability of the magnetic circuit.

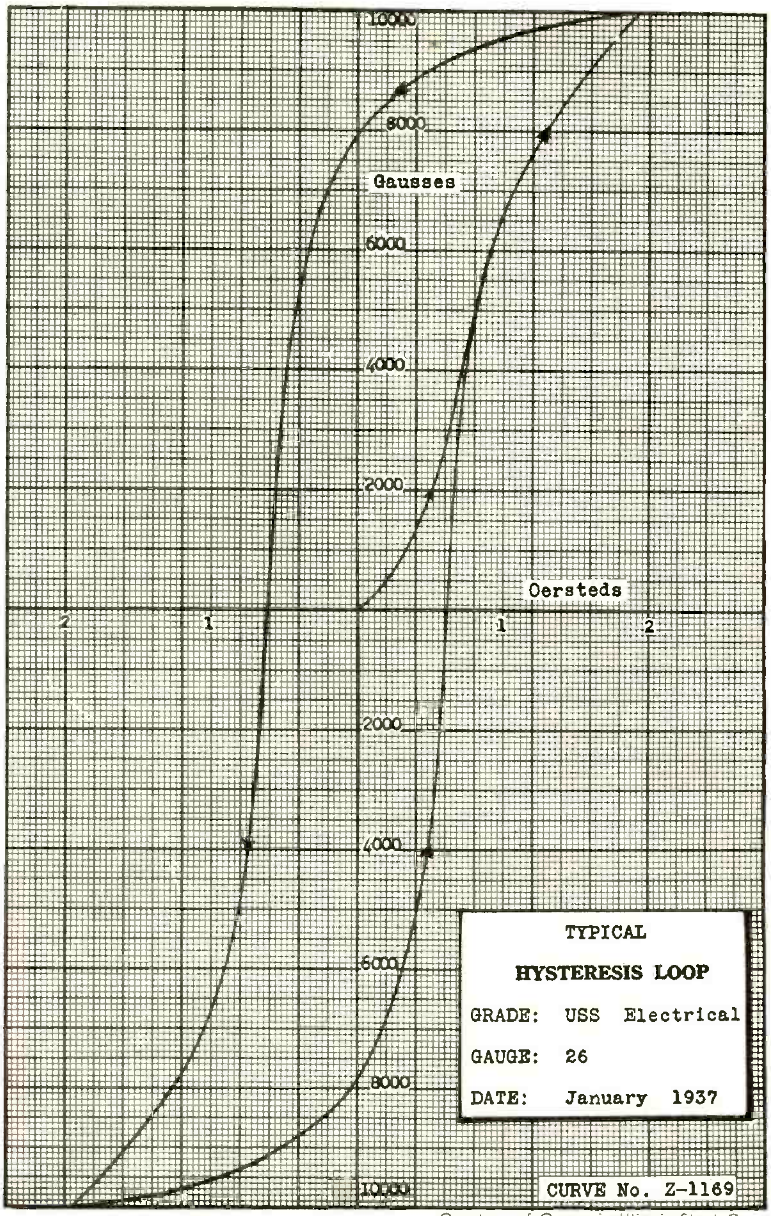
The permeability is,

$$\mu = \frac{B}{H}$$

where B is the normal induction (gausses) and H is the field strength (oersteds) of the magnetizing force.

Hysteresis

The changes which take place in iron when its magnetism is reversed were first thoroughly studied by Professor Ewing of Cambridge University. The hysteresis curve of *Fig. 1* shows the changes in the induction when the magnetizing force is changed from 0 to 10,000 gausses, starting at point 0 where the X and Y mathematical axes intersect.

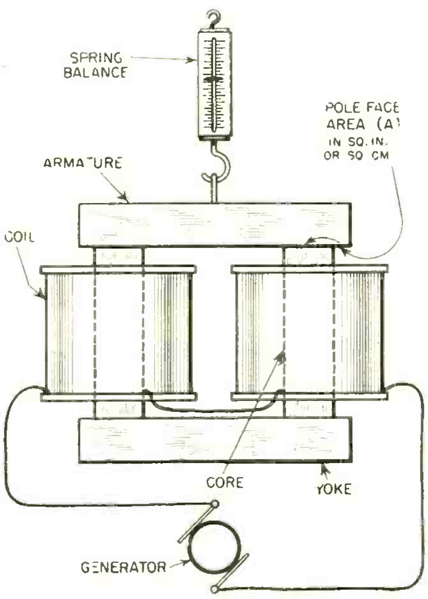


Courtesy of Carnegie-Illinois Steel Corp.

Fig. 1. Hysteresis curve showing the changes in induction when the magnetizing force is changed from 0 to 10,000 gausses, starting at point 0 where the X and Y mathematical axes intersect. The rise of induction when the iron is first magnetized, is shown by the line in the middle of the upper loop.

★

Fig. 2. The total pull on the armature of the electromagnet is 2F, and should the armature be separated a slight distance from the poles, the air gap produced in the magnetic circuit will greatly reduce the attraction force for a fixed number of ampere-turns in the magnetizing coils.



The rise of induction when the iron is first magnetized, is shown by the line in the middle of the upper loop.

The magnetizing force (oersteds) are X axis coordinates (horizontal axis) and the induction coordinates are on the Y (vertical axis).

On reducing the magnetizing force, the induction falls to 8000 gausses and by means of a steadily increasing reversed current, the magnetizing force is made negative until when H equals .5, the flux density is zero and there are no flux lines of force in the steel. As the force is made still more negative, the steel becomes oppositely magnetized, reaching the value $B = -10,000$ gausses when $H = -2$ oersteds. Then, as the force is again reduced to zero, the induction drops to —6000, following the lower curve or right-hand line of the lower loop, and does not become zero until H is $+ .5$ oersteds.

If the magnetizing force is carried up to the former maximum and then again is diminished, the curve rises and falls just exactly as it did before.

This lag of the induction in iron or steel behind the magnetizing force was named by Ewing *hysteresis*. In consequence of it, when a mass of steel is put through a magnetic cycle of reversal as described, more energy is spent in magnetizing than is given back when it is demagnetized, the difference being a certain amount dissipated in heat. The amount lost in this way per cubic centimeter of steel is proportional to the area of the loop of the hysteresis curve, and with a maximum induction of 5000, it may amount to as much as 2500 ergs per cubic centimeter in each cycle of magnetic change. Every time the magnetism in a mass of steel or iron is reversed (a.c. operation). hysteresis losses are encountered, so that soft iron is used where losses due to this action must be kept down. The loss of energy due to this cause may amount to 1% in a transformer made of fairly good iron.

Pull of Electromagnet

The pull of an electromagnet such as the one in *Fig. 2* is given by the equation,

$$F = \frac{B^2A}{8\pi} \text{ dynes}$$

where F is the attractive force in dynes, B represents the induction or number of lines per square centimeter, A equals the pole face area in square sentimeters and 8π is a constant (25.12).

If the force is in pounds,

$$F = \frac{B^2A}{7213 \times 10^4} \text{ pounds}$$

where B = induction in lines/in.^{2}, A = pole face area in inches^2.

In *Fig. 2*, the total pull on the armature is $2F$ and should the armature be separated a slight distance from the poles, the air gap produced in the magnetic circuit will greatly reduce the attraction force for a fixed number of ampere-turns in the magnetizing coils.

E.M.F. Equation

The following is the equation for the e.m.f. generated in a coil rotating in a magnetic field at a uniform speed, or for a coil which encloses a uniform magnetic flux varying in such a manner that a sine wave e.m.f is generated:

$$E = 4.44 \frac{N\phi f}{10^8}$$

where E = e.m.f., mean r.m.s. or effective value. N = number of complete turns in coil. ϕ = total magnetic flux (maximum instantaneous value if produced by alternating current) enclosed by the circuit. If the magnetic flux density is uniform (the usual case) throughout the space occupied by the coil, $\phi = BA$ where B equals flux density in lines per cm.^{2} and A = area enclosed by coil in cm.^{2} f = revolutions of coil/sec. or frequency in cycles/sec. of magnetizing current.

Eddy Current Losses

The iron or steel in the core is a fairly good conductor of electricity and acts like a great number of rings, each of which behaves like a short-circuited turn. The varying magnetic flux in the core induces a voltage in each ring, and the voltage makes current flow in the ring. This is the *eddy* current. It sets up a flux which tends to reduce the original flux and, as a result, the inductance of the iron-core coil is reduced. In the case of a transformer, excessive primary current then flows and considerable power is wasted in these eddy currents.

These eddy currents are generated in the iron core due to the flux increasing and decreasing in accordance with the electric current in the coil surrounding the core. If the core should be solid, such as cast steel, the eddy currents would not be restricted in their flow and could thus flow through all or any portion of the core. This would result in large currents, causing a high loss and heating of the iron. This is very serious on a.c. but not of much consequence on d.c. which does not vary periodically.

In order to reduce the path of eddy currents and also their value or size, the core is sectionalized by building it of electrical steel sheets which practically limits the eddy currents to their respective sheets or laminations. Thus, it is apparent why laminations are used for alternating core structures.

Silicon, when added to steel, causes the electrical resistance of the resulting silicon-iron alloy to increase in value. As the resistance increases with silicon content, the eddy currents will decrease, thus causing a reduction in the eddy loss. By decreasing the sheet thickness, as well as increasing the silicon content, a lower eddy loss will result.

These currents vary with the square of the frequency, as well as the square of the thickness of the sheet and the square of the flux density. The equation for the eddy current loss is:

$$W_e = K_2 d^2 f^2 B^2 \text{ watts}$$

where K_2 represents a constant, including among other factors the grade of the material, *d* is the thickness of the sheet (in centimeters) and *f* is the frequency of the magnetizing current in cycles per second. *B* is the flux density in the core, expressed in gausses.

The hysteresis loss is:

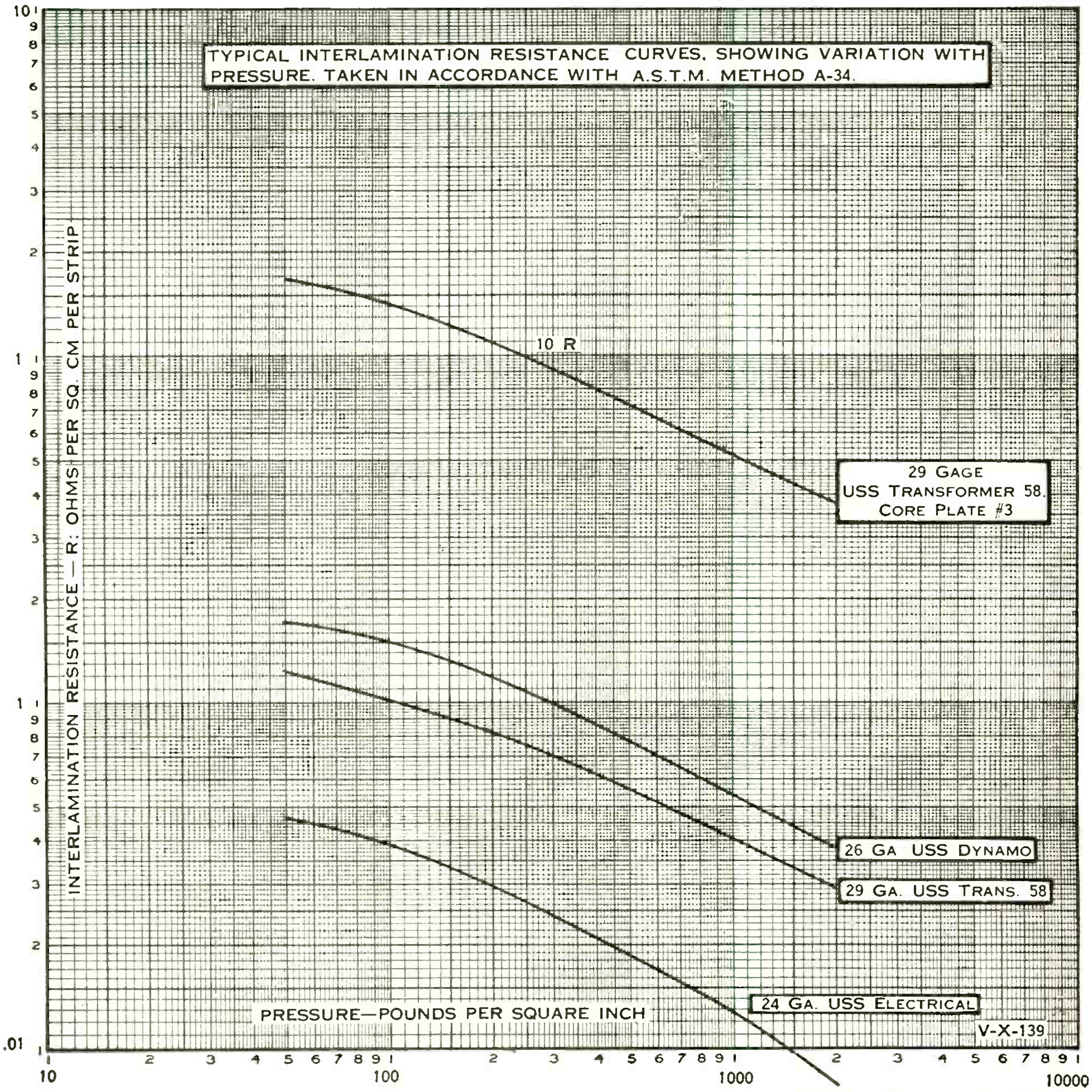
$$W_h = K_1 f B^{1.6} \text{ watts}$$

and the letters have the same meaning as in the previous formula. The exponent 1.6 is the Steinmetz exponent—an average value for silicon steel sheets.

To keep the eddy current loss low, electrical steel sheets are usually rolled in the thickness range of .031 to .014 inch, the thicker sheets usually being in the lower silicon grades and the thinner sheets in the higher grades. For frequencies above 400 cycles, steel sheets about .007 inch thick are used, and above 1000 cycles, sheet thicknesses of .005 and .003 inch are desirable in order to keep the eddy current loss to a reasonable value. U.S.S. Electrical Steel Sheets are available in this thickness in the Electrical Motor Dynamo and Transformer 72 grades.

Under modern annealing processes, a tightly adhering oxide coating is formed on laminations and this coating cuts eddy current losses since it insulates laminations. However, oxides cause manufacturing troubles—short life of dies and also increases core loss at high flux densities.

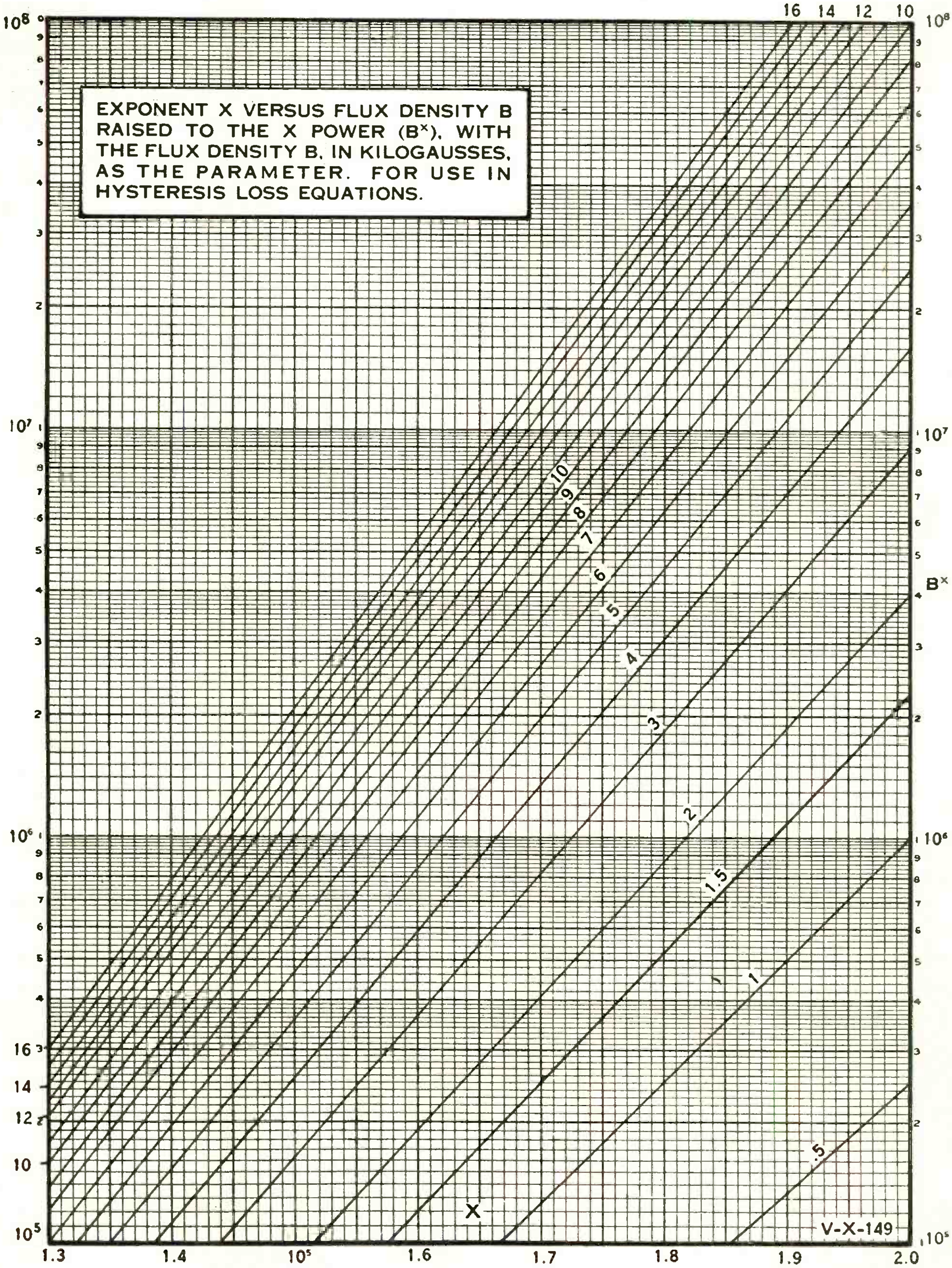
For the most widely used frequencies, 29 gage (.014 inch) steel laminations are probably the most economical thickness from practically all standpoints.



Courtesy of Carnegie-Illinois Steel Corp.

Fig. 3. Typical interlamination resistance curves.

CHART FOR USE IN HYSTERESIS LOSS EQUATIONS



Courtesy of Carnegie-Illinois Steel Corp.

Fig. 4. A handy chart for use in hysteresis loss equations. The values of the coefficients and hysteresis exponent for the gage and grade involved can be obtained by the simultaneous solution of three equations.

Interlamination resistance controls eddy current loss to a definite extent and is of importance in large transformers and rotating machines. Graphs showing this function are given in *Fig. 3*. This is shown only to indicate lamination resistances as a function of pressures.

A useful chart for use in hysteresis loss equations is given in *Fig. 4*. The values of the coefficients and hysteresis exponent for the gage and grade involved can be obtained by simultaneous solution of three equations with the flux density and frequency as variables. The hysteresis loss equation is:

$$P_h = \left(\frac{W}{D10^7}\right) f \eta B^x \text{ watts}$$

and the eddy loss equation is:

$$P_e = \left(\frac{1.645 d^2 W}{D10^{16}}\right) f^2 B^2 \lambda \text{ watts}$$

with the total loss $P_t = P_h + P_e$ watts, where W = weight of core in grams, f = frequency in cycles per second, d = thickness of core laminations in cm., B = flux density in gausses, D = density of core material, η = hysteresis loss coefficient, λ = eddy loss coefficient, X = hysteresis loss exponent for B.

$$\text{Let: } A = \left(\frac{W}{D\,10^7}\right) \text{ and } C = \frac{1.645\, d^2\, W}{D\ 10^{16}}$$

Thus, for two frequencies f_1 and f_2, and two flux densities B_1 and B_2, these three equations can be set up:

$$P_1 = A\,\eta\, f_1\, B_1^x + C\, f_1^2\, B_1^2\, \lambda$$

$$P_2 = A\,\eta\, f_2\, B_2^x + C\, f_2^2\, B_2^2\, \lambda$$

$$P_3 = A\,\eta\, f_1\, B_2^x + C\, f_1^2\, B_2^2\, \lambda$$

Solving equations with $A = f_2/f_1$,

$$X = \frac{\log\left[\dfrac{B_2^2\,(P_2 - a^2 P_3)}{B_2^2\, a\, P_1\,(1-a) + B_1^2\,(P_2 - aP_3)}\right]}{\log\,(B_2/B_1)}$$

$$\lambda = \frac{P_2\, B_1^x - a\, P_1\, B_2^x}{\dfrac{C\, f_2^2}{2}\,(a\, B_2^2\, B_1^x - B_1^2\, B_2^x)}$$

$$\eta = \frac{P_3 - f_1^2\,\lambda\, C\, B_2^2}{f_1\, A\, B_2^x}$$

These equations are limited in application to the flux range of about 2000 to 12,000 gausses. The chart in *Fig. 4* gives helpful assistance.

GUARANTEED MAXIMUM CORE LOSSES

Watts/LB. @ 60 c.p.s. and 10,000 gausses Epstein-Test,
A.S.T.M. Standard Method A-34

GRADE	Gage Number / Gage Thickness	29	28	27	26	25	24	23	22
		.0140	.0155	.0170	.0185				
U.S.S. Armature		1.30	1.38	1.46	1.55	1.75	1.98	2.23	2.50
U.S.S. Electrical		1.17	1.23	1.29	1.35	1.50	1.70	1.94	2.17
U.S.S. Motor		1.01	1.05	1.09	1.14	1.22	1.30		
U.S.S. Dynamo		.82	.86	.90	.94	1.02	1.10		
U.S.S. Radio Transformer 72		.72	.76	.80	.83	.90	.97		
U.S.S. Transformer 72*		.72	.76	.80	.83	.90	.97		
U.S.S. Transformer 65*		.65							
U.S.S. Transformer 58*		.58							
U.S.S. Transformer 52		.52							

*These grades are available in sheet thicknesses of .010, .007, .005 and .003 inch for use at higher than power frequencies.

POST-WAR POLICE RADIO

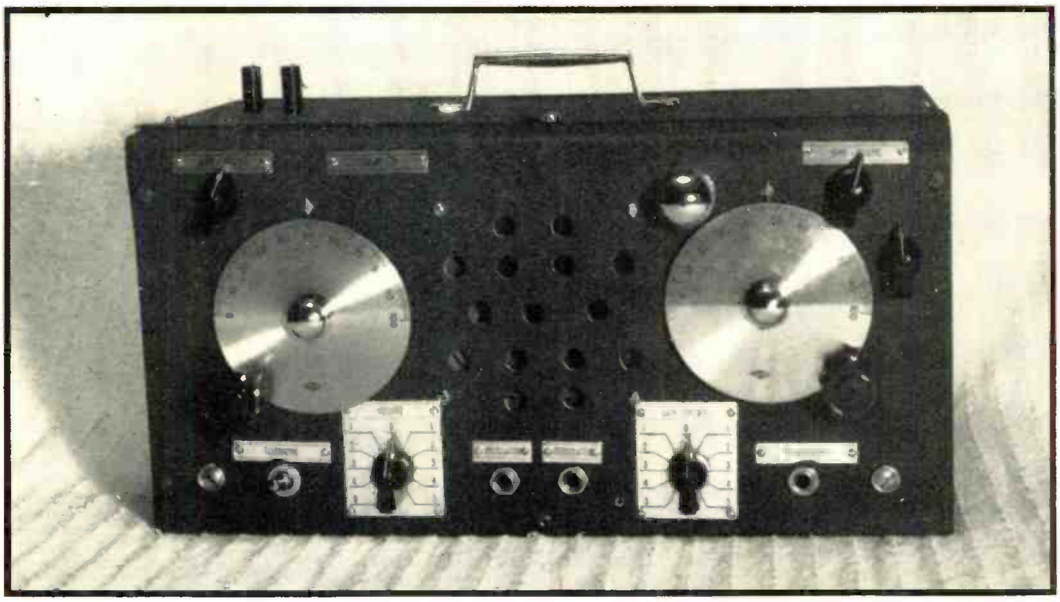
Vast developments being made in the radio industry as a result of the tremendous task which the industry has in equipping American and Allied armed forces with radio equipment "better than the enemy's" will make available many new electronic products for the police communication officer in the post-war period.

This was explained to police communication officers by Herbert DuVal, Jr., General Electric radio engineer, before the 9th Annual Conference of the Associated Police Communication Officers.

Resonant Inverter

Among such developments is a circular-type antenna which gives a higher field strength for a given transmitter power, both for station and mobile use, Mr. DuVal said. Another development is a resonant inverter to replace dynamotors and vibrators. "Present vibrators have to break the full-load current of the apparatus whereas the new resonont inverter has electrical and mechanical resonant circuits such that vibrator contacts break only during periods when the current through the contacts is zero," Mr. DuVal explained. "Such a unit requires very little maintenance and should give service longer than dynamotors or present vibrators, the latter being unsatisfactory for high-current interruption."

The most important job of the police communication operator at this time, Mr. DuVal pointed out, is in the care and maintenance of his apparatus. Now also is the time for police communication officers to help the radio industry and the F.C.C. by formulating plans to use super-high frequencies in the post-war period to relieve congestion now existing on police radio and other frequencies.



DEFENSE TRANSCEPTOR

F. BRUCE PARSONS, W2COT

◀ Under the guidance of the A.R.R.L. headquarters staff and given impetus by the needs of our local defense committees, a model type of Transmitter-Receiver combination is described in this article, using tubes and combinations heretofore presented. There is no claim for originality except possibly in the general layout, and no doubt many of our fellow Hams can improve on the set's performance. Suffice it to say, using the recommended voltages, the rig is sure-fire and amply able to perform within the limits of the average municipality. Cost will vary depending on the quality of the parts selected. Assuming new parts only, including tubes but less microphone, and the cost amounts to about $28.00.

Design Details

Having in mind that most cars have glove compartments which open up and will support a reasonable amount of weight, particularly if some additional support is made available, a receiving type of cabinet 8"x14" was selected, together with a 7"x13"x2" cadmium plated chassis. This cabinet has a three quarter closed back and a hinged lid. The panel is removable of course.

From the picture you will observe that the antenna leads are fed to the inside of the cabinet by banana type plugs. A conventional socket connection is provided on the back of the chassis to connect to any available source of 100-mil., 300-volt supply. The microphone battery is placed underneath the chassis to overcome the usual practice of trying to hold a poorly soldered battery to a microphone while operating.

The send-receive switches are ganged with a half-inch wide strip of bakelite for two reasons: one, to keep the transmitter r.f. away from circuit changes; and two, to enable your brother Ham to throw the send-receive switch while you are driving and talking. By using a three-way plug and jack in combination with a s.p.d.t. switch, it is possible to use either the 5-inch p.m. speaker or the "receiving" portion of the microphone handle. Due to its ample proportions, this set is not designed to become a fixture in your car, but was made to be used either at a fixed location or car so that local defense needs can utilize its usefulness in a hurry. Similar sets are being made by the amateurs in our town and we anticipate, by keeping them all alike, to be able to render service on a very efficient basis, when events make our contributions needed.

Antennas

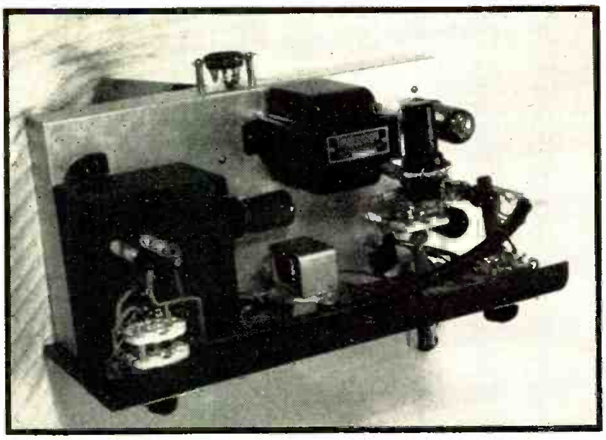
The stability of the Transceptor is remarkable, and by keeping the microphone voltage at 1½ volts, for the usual Ham mike, the fidelity is excellent.

We plan to use quarter-wave vertical antennas on the cars with a short length of coaxial cable, the ends of which will have permanent banana plug connections. For field work a quarter-wave rod with a banana plug soldered to its end can be used, with the other side grounded with a clip to the handle of the cabinet.

The question of whether or not it is necessary to use the shield can to mount the oscillator, in view of the general layout, is open to question, but we would recommend it, even though it then becomes necessary to mount the 6V6GT socket metal ring on the outside of the can, first making all the connections possible. It is very impractical to try and wire up the socket once it is in place. Having in mind the loading effects of different antennas and locations, we used the antenna pickup coil indicated by Mr. Grammer, but fastened it on a quarter-inch polystyrene rod which, at one end, inside the oscillator box, rests in a bearing made of bakelite with a 6-32 set screw, and at the other end protrudes sufficiently far out of the back of the box to accommodate a small pointer knob. Once you have selected the proper coupling, the set screw can be tightened with a long, thin screwdriver through a quarter-inch hole in the top of the shield can.

The purchase of a 100-100 μμfd. Hammarlund may present some difficulties in the present limited market, but this can be overcome by selecting, say, a 140-140 μμfd. of the same type and removing all but seven rotor and seven stator plates.

The antenna lead to the receiver 6J5 tank coil happens to be a short length of coaxial cable. The one-turn coil—or two turns if you prefer—feeding the detector tank is variable, with flexible leads, and mounted on a quarter-inch rod controlled from the right hand top portion of the panel. Tension on this rod is created by using a bent strip of bronze which bears on the rod at all times.



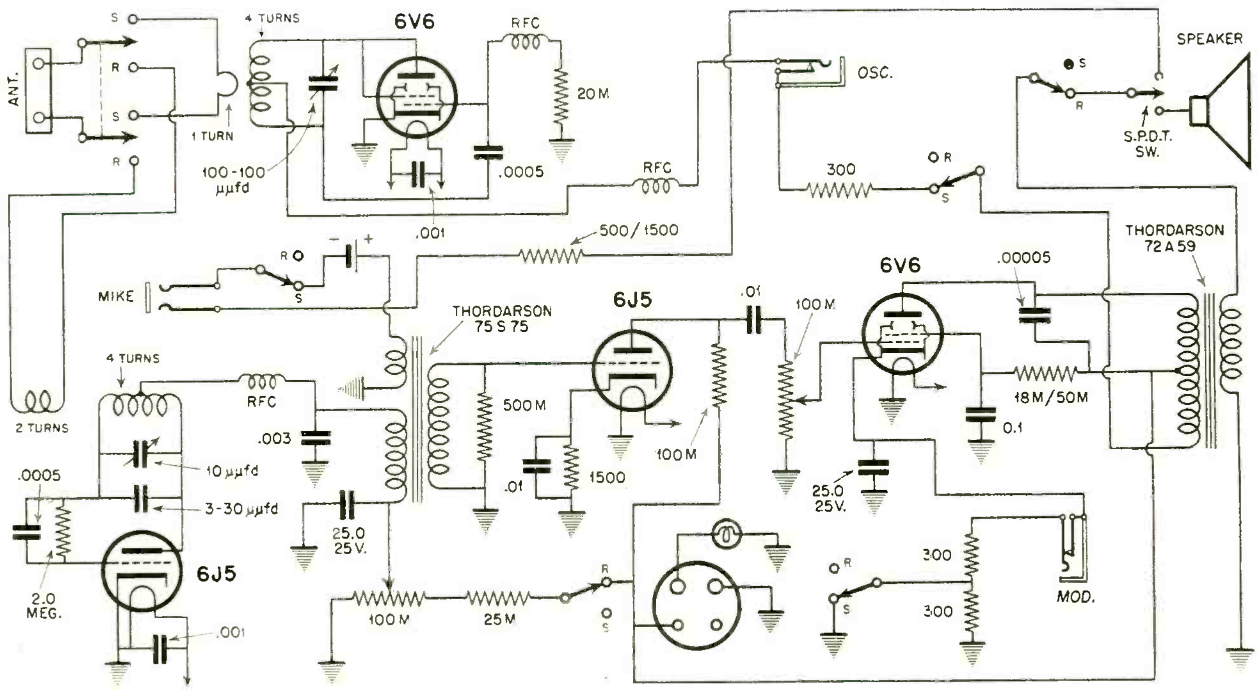
Interior view of the completed Defense Transceptor.

As can be seen from the photograph, the 6J5 detector is mounted in a horizontal position by using a two-inch, heavy-duty angle brace, preferably of brass. No shielding of the wiring underneath the chassis is necessary. The small transceiver type transformer should be mounted between the two socket holes underneath the chassis on the extreme right hand side.

Controls

In conclusion, it should be noted that, reading from left to right on the panel front, the first lower control is the telephone-speaker s.p.d.t. switch. Immediately above it is the four-inch National type K

[*Continued on page* 33]



Schematic diagram of the Defense Transceptor for u.h.f. work. All parts values and coil data are given here.

CATHODE-COUPLED AMPLIFIERS

C. F. NORDICA

The cathode-coupled amplifier, or cathode follower as it is sometimes called, is a degenerative amplifier in which the load may be at ground potential and in which all the advantages of inverse feedback may be realized. Coupling to coaxial cable is therefore simplified. Such a circuit has been used to advantage as the first stage of a video amplifier fed by an iconoscope. Many other uses are at once obvious, such as remote volume controls, etc.

The significance of the advantages of the cathode follower can be demonstrated by comparing it to a standard resistance-coupled amplifier. *Fig. 1* illustrates schematically the usual resistance coupled stage,

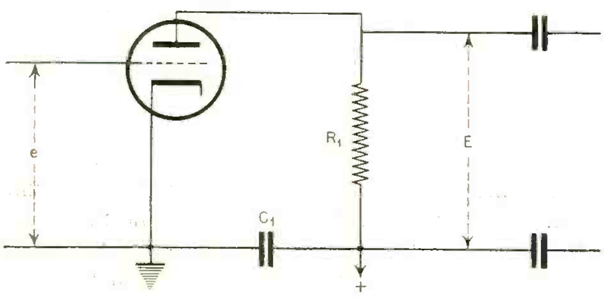


Fig. 1. Basic circuit of resistance-coupled amplifier.

in which R_p is the plate resistance of the tube and μ, its amplification factor. We have:

$$I_p = \frac{\mu_1 e}{R_p' + R_1}$$

$$E = I_p R_1 = \frac{\mu_1 e R_1}{R_p' + R_1}$$

$$\frac{E}{e} = \frac{\mu_1 R_1}{R_p' + R_1} = \text{stage gain (1)}$$

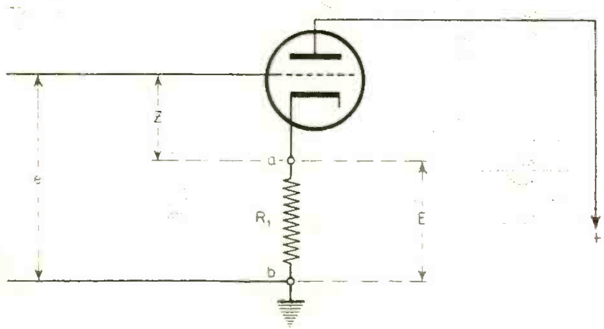


Fig. 2. Basic circuit of cathode follower. E = output voltage.

Fig. 2 shows schematically a cathode follower circuit. Here the output voltage E will be equal to the product of the plate current I_p and the cathode load resistor R_1. Hence:

$$I_p = \frac{\mu(e - I_pR)}{R_p R_1}$$

$$I_pR_p + I_pR_1 \quad \mu e - \mu I_pR_1$$

$$\text{Then: } I_p(R_p + R_1 + \mu R_1) = \mu e$$

$$\text{Whence: } I_p = \frac{\mu e}{R_p + R_1 + \mu R_1}$$

$$\text{And we have: } \frac{E}{e} = \frac{\mu R_1}{R_p + R_1(1+\mu)} = \text{stage gain (2)}$$

$$\text{Now assume that: } \mu_1 = \frac{\mu}{\mu + 1}$$

$$\text{and } R'_p = \frac{R_p}{\mu + 1}$$

Substituting in (1) we have:

$$\text{stage gain} = \frac{\mu}{(\mu+1)} \quad \frac{R_1}{\frac{R_p}{\mu+1} + R_1}$$

$$= \frac{\mu R_1}{R_p + R_1 \quad (1+\mu)}$$

which is identical to equation (2). From this we may conclude that the gain of the cathode follower is equivalent to the gain of a standard resistance coupled stage in which the amplification factor of the tube is:

$\frac{\mu}{\mu+1}$ and the plate resistance of the tube is: $\frac{R_p}{\mu+1}$

Let the stage gain be G. Now any impedance Z between grid and cathode of the cathode follower will appear higher because of degeneration. This apparent impedance then becomes:

$$Z' = \frac{Z}{(1-G)}$$

Whence it follows that a grid coupling resistance (if connected between grid and cathode of the cathode follower) can be made very low and yet appear quite high insofar as the effect on the signal is concerned. Obviously the same reasoning applies to grid-cathode capacitance. The grid-cathode capacitance C will therefore appear to be:

$$C' = C\,(1-G)$$

[*Continued on page 33*]

A.F. RESPONSE CURVES

With Oscilloscope

JAMES H. GREEN, Jr.

Department of Physics
University of Rochester

Recent improvements in the fidelity of recorded music and the advent of frequency-modulation have brought the engineer and technician face to face with many new problems involving the fidelity of audio amplifiers. Although many methods are known whereby the response curve of an audio amplifier may be obtained, they are, on the whole, tedious and require equipment which is not readily accessible.

One method, however, stands out above the rest from the standpoint of simplicity and universal applicability. When this system was originally described the complexity of the apparatus involved prohibited its general acceptance[1]. Now, however, since the frequency-modulated oscillator has become a standard piece of test equipment the scheme deserves the consideration of all those interested in the problems of high fidelity audio reproduction.

Method of Operation

The method is essentially that now employed in aligning superheterodyne receivers, where a frequency-modulated signal is applied to the input of the intermediate frequency amplifier and synchronized with an oscilloscope on the output so as to give the response curve of the stage or stages being examined.

For audio amplifiers a frequency-modulated audio note is fed into the amplifier and an oscilloscope connected to the output. The 'scope is set to sweep at the same rate as that at which the frequency of the f.m. oscillator is changing, and the two are synchronized through the external synchronization circuit of the oscilloscope. The oscillogram in *Fig. 1* shows the resulting pattern. The width of the envelope at any point indicates the amplifier gain at that frequency.

The frequency-modulated audio note used is obtained in the following fashion: An ordinary frequency-modulated test oscillator[2] is set so that when the carrier is undeviated, it is at some common r.f. frequency; 1000 kc. for example. An external oscillator is then coupled to this and adjusted to give zero beat at this frequency. When frequency modulation is now applied to the first oscillator there results an audio frequency beat note which varies from zero to the maximum difference between the two signals (20,000 cycles maximum for the oscillator mentioned above) then back to zero and out again to maximum as the oscillator frequency is deviated in the opposite sense. A block diagram of the arrangement is shown in *Fig. 2.*

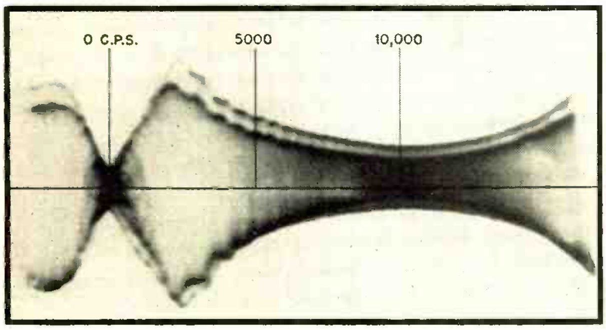


Fig. 1. Oscilloscopic response curve of a peaked audio-frequency amplifier.

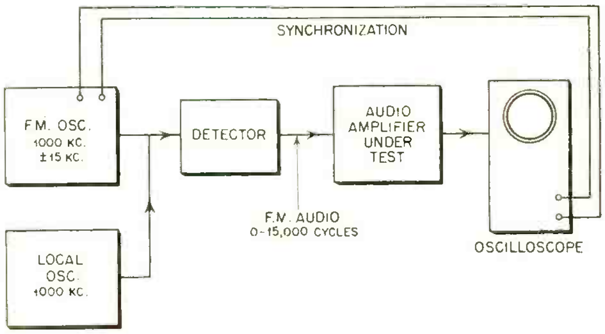


Fig. 2. Block diagram of set-up for obtaining frequency response curve of audio-frequency amplifier by means of a cathode-ray oscilloscope.

[1]Diamond and Webb, Proc. I.R.E., Sept. 1927.

[2]In this case the RCA Electronic Sweep Oscillator No. 150.

If we refer to the oscillogram we see these traces can all be identified. The zero beat position appears, as indicated, at the left of the photograph. Normally this would appear in the center of the screen, but due to a fault in the synchronizing circuit of the oscilloscope used it was found to be impossible to realize this condition. The trace which should appear running to the left from zero beat is continued at the extreme right of the photo.

To the right of the zero beat position are marked the 5000 and 10,000 (maximum) cycle positions. The outward bound and return traces are distinguishable in spots, although under ideal conditions they would not.

As may be seen, the amplifier being tested here was an extremely poor one in the ordinary sense of the word, having poor low-frequency response, a sharp maximum around 2000 cycles and a poor high-frequency response. This was to be expected, however, since the amplifier contained a .01 μfd. condenser to eliminate high frequencies and other filter components as well.

When it is desirable to make the conventional plot of response against log of frequency it is necessary to limit the maximum frequency deviation when the low-frequency end of the spectrum is being considered. With the oscillator used the maximum beat-note frequency can be adjusted to values as low as 500 cycles by using the sweep control provided on the unit. It is then possible to obtain values of the amplifier gain for frequencies as low as 50 or 100 cycles. This is not the case when the maximum beat note frequency is of the order of 10,000 cycles.

In connection with the use of this method at low frequencies it must be further noted that the rate of change of frequency of the f.m. oscillator places a lower limit on the range over which the response curve is valid. For instance, if the f.m. oscillator frequency is being swept at 60 cycles (standard for most test oscillators) the curve will have no meaning for frequencies below about 600 cycles since only a small portion of these waves will be generated before the frequency is changed. This difficulty can obviously be overcome by lowering the sweep frequency of the f.m. oscillator, even to as low a value as one cycle per second. Visual observation of the 'scope is seriously impaired by this modification, but satisfactory results may still be obtained by photographing the screen.

It is also necessary to examine carefully the "flatness" of the output vs. frequency curve of the generated beat note and to compensate for any falling off of this curve at very high or very low frequencies. In the apparatus described here very little difficulty was experienced from this cause.

Undoubtedly this method can be applied to other allied problems. It could, for instance, be used to give the response curves for various tuned audio-frequency circuits and a rough evaluation of their Q's.

Another use for the system was found in its ability to picture the overall operation of a superheterodyne receiver. When the signal produced by the two oscillators is introduced into the i.f. circuit of the receiver, the trace on an oscilloscope in the output shows the audio response envelope superimposed on the familiar response curve of the i.f. stages, thus enabling the operator to determine if the highest frequencies are being severely attenuated by the sharpness of the tuned circuits of the i.f. amplifier.

A TRANSITRON AUDIO OSCILLATOR

[*Continued from Page* 19]

to 10,000; E — 10,000 to 20,000 cycles. The finer adjustments are made by means of *R1*, which should be calibrated.

It will be noted that the frequency range of each switch position is not very extensive. The reason for this is the necessity for keeping the resistance in the grid circuit of the oscillator above a predetermined value. Since this resistance is the frequency-adjusting device, a stop is provided to maintain sufficient resistance in the grid circuit to prevent wave distortion.

The stopping of *R1* at the proper point was accomplished in the original model by the use of a National ACN dial, which is designed for 180° rotation, and consequently limits the use of the control to the lower part of its range. If desired, a fixed resistor of 150,000 ohms in series with a 350,000-ohm control for *R1*, may be substituted, thus using the full 270° of rotation.

The 150,000-ohm potentiometer *R2* is used for the purpose of adjusting the oscillator to the proper operating point, so as to obtain a true sine wave output. This point is found to be the adjustment which just barely keeps the circuit oscillating on all ranges. Advancing the control too far will result in over-excitation of the grid circuit, and produce a high number of harmonics of various orders. Once this control is adjusted, it is left alone, unless a change in tubes or circuit constants requires a readjustment. The control may therefore be mounted in an out-of-the-way spot on the chassis and equipped with some sort of screw-driver or wrench controlled shaft, so that an accidental disturbance cannot occur.

The condensers used in the frequency changing bank need not be of close tolerence, but they should be of high quality to prevent leakage from developing.

The output transformer used in this ocsillator is an excellent quality p.a. unit. If the oscillator is to perform a particular function, and the multiple-impedance output factor is not needed, a standard output transformer may be used. However, if the oscillator is to be employed for general test work, the transformer specified is recommended.

CATHODE-COUPLED AMPLIFIERS

[*Continued from Page 28*]

However a grid to ground capacitance will be unaffected as will grid to plate capacity.

If a coaxial line (which is usually of low impedance) is to be connected to terminals *a* and *b*, *Fig. 2;* that is, across the cathode load resistance *R*, the impedance looking into terminals *a* and *b* must match the iterative impedance of the line. This impedance is equal to R_l and $\frac{R_p}{1+\mu}$ in parallel. Since R_l may be larger in the cathode follower circuit than in a standard resistance-coupled stage, the voltage applied to the input of the cable is about the same in either case. The other advantages of the cathode follower, however, make this circuit preferable to the standard resistance-coupled amplifier for this use. The omission of coupling condensers in the case of the cathode follower is also a matter of importance.

Iconoscope Amplifier

Fig. 3 shows one application of the cathode follower circuit used as the first video stage in an iconoscope amplifier. This arrangement is quite effective in that the effective input capacitance is appreciably reduced. The proper bias for the iconoscope is obtained by tapping the cathode load resistor. Such an arrangement materially improves operation and can be followed by sufficient stages of conventional video circuits to build up the necessary gain in the iconoscope amplifier.

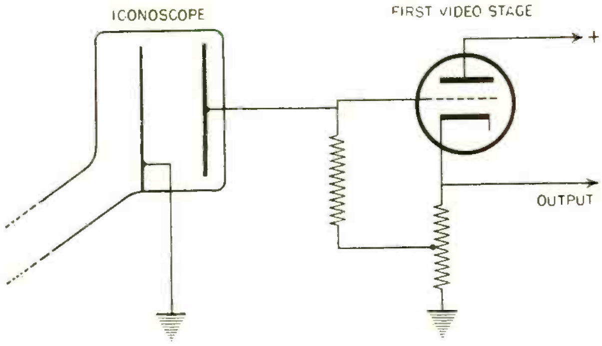


Fig. 3. Application of follower to iconoscope amplifier.

Q. & A. STUDY GUIDE

[*Continued from Page 18*]

210. What is the purpose of "commutating poles" or "interpoles" in a d.c. motor?

"Commutating poles" or "interpoles" are additional field poles connected in series with the armature, and placed between the main field poles in order to eliminate sparking caused by a shift of the neutral position of the armature of a motor when there is no corresponding shift of the brush position.

211. How may the output voltage of a separately excited a.c. generator, at constant output frequency, be varied?

The voltage may be varied or controlled by varying the field current. A field rheostat is used, and also controls the power factor at which the generator is operating.

212. If the field of a shunt wound d.c. motor were opened while the machine was running under no load, what would be the probable result(s)?

The motor will attain an excessive speed which may cause damage to the motor, and will cause sparking at the commutator.

213. Name four causes of excessive sparking at the brushes of a d.c. motor or generator.

Rough commutator; sticky or broken brushes; armature winding may be damaged; the motor may be overloaded or have poor ventilation.

214. What is the purpose of a commutator on a d.c. motor? On a d.c. generator?

The commutator on a d.c. motor reverses the current through the armature "loops" just as the loop reaches neutral position, causing rotation. Otherwise, the loop may rotate from its position to vertical position where it would be opposed to further rotation by the action of the combined magnetic fields.

In a d.c. generator the commutator converts the alternating current to direct current. When the direction of the induced voltage changes, the segments of the commutator change from one brush to another at the same instant, maintaining the external circuit current in one direction.

DEFENSE TRANSCEPTOR

[*Continued from Page 27*]

transmitter dial. Below this dial is the volume control. To the left of this are the oscillator and modulator jacks for reading the current. Above the jacks is the five-inch p.m. speaker mounted behind fifteen 3/8" holes. Next, at the bottom, is the regeneration control, and to the extreme right the microphone three-way jack. The other four-inch dial controls the receiver tuning, aided by a Mallory type 330 panel light. The description of the panel front ends with the two small pointer knobs, one at each end of the panel and ganged, as aforesaid, for convenience.

The Cathode-Ray
OSCILLOSCOPE

JAY BOYD

PART V—LISSAJOUS FIGURES AND RECEIVER ALIGNMENT

◀ In last month's issue we showed how audio waveforms were plotted against bases representing "time." But if we wish to illustrate the response of a tuned circuit we must plot its response against a "frequency" base, as in *Fig. 1*.

To draw such a curve "by hand" we would set up our instruments as in *Fig. 2*. With each change in frequency the vacuum-tube voltmeter reading would be noted by a point on the ruled paper. With a sufficient number of points established, a curve running through these points is then drawn.

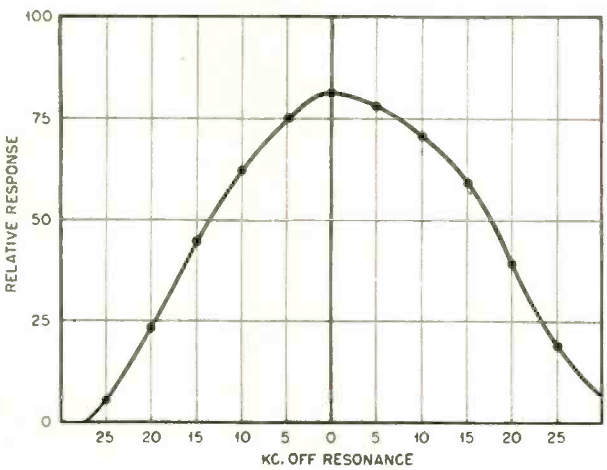


Fig. 1. A resonance curve plotted "by hand," with separate readings taken at a number of points.

This method is fairly simple for plotting the curve of a single tuned circuit, but much too slow when a number of cascade circuits are to be aligned, such as the intermediate frequency channel of a modern receiver. Since each i.f. trimmer adjustment alters the selectivity response curve, many graphs would have to be drawn before a job would be completed.

But substitute a cathode-ray oscilloscope for the v.t.v.m. (or usual output meter) and "wobble" the frequency of the signal generator. Synchronize this wobble with the oscilloscope's sweep oscillator and the desired frequency resonance curves will appear on the c.r. screen.

There are several ways of accomplishing this. But let's get a clear understanding of the principles involved first and examine the various methods later.

A simple set-up meant only for explanation, is shown in *Fig. 3*. A handle has been mounted on the signal generator to permit manual wobbling of its frequency. A potentiometer across a "B" battery places either a positive or negative potential on the free horizontal plate, swinging the beam across the screen in synchronization with the frequency changes of the signal generator.

As the beam is swept across the screen, the signal generator frequency will pass through the resonant frequency of the intermediate channel, producing a rectified a.c. voltage across the second detector divider load (when that type detection is used). This voltage is applied to the free vertical plate, usually through the oscilloscope's vertical amplifier, raising the beam in proportion to the i.f. amplifier response.

Note that a single movement of the handle makes one complete trace upon the screen. Returning the handle to its starting position, completing the cycle, makes another trace. But each trace lies over the preceding one, whether the response curve is symmetrical or not.

Such a simple mechanical arrangement is never used, although it would work if we could wobble the handle rapidly and used a long-persistence c.r. screen.

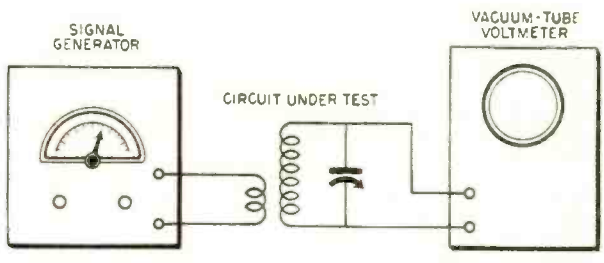


Fig. 2. The resonance curve of Fig. 1 could be plotted by means of the set-up shown above.

Motor-Driven Frequency Wobblers

In practice we find two methods for wobbling the signal-generator frequency. The first type uses a small motor for rotating a midget condenser, in parallel to the main condenser. Mounted on the same shaft will be found either a commutator or a tiny electrical impulse generator. Either of these will be found tied in to the sweep circuit, thereby locking the sweep frequency with the wobble frequency.*

The other method, or rather group of methods, produces this desired wobble by electronic means,

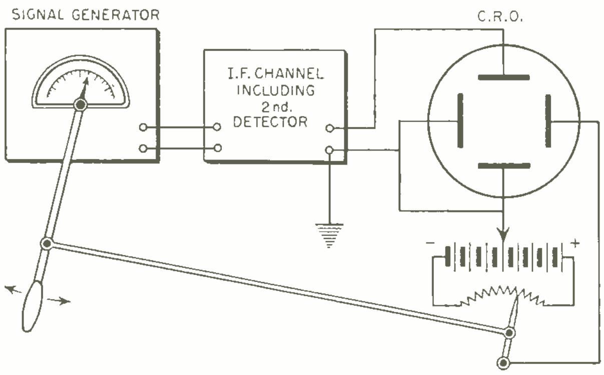


Fig. 3. A set-up by means of which the frequency of the signal generator can be wobbled. Potential on horizontal plate is synchronized with the frequency by means of a connecting arm.

thereby eliminating all moving mechanical apparatus. While the electronic sweep systems seem to be gaining in popularity it should be noted that the final result; that is, the resonance curve traces, will be essentially the same for either method. Also, it is quite practical to attach a motor-driven wobbler to any existing signal generator by the simple addition of a phone jack.

The motor-driven type is easier to understand. Two specific makes will be described; first, because of their popularity and secondly, because they are representative of all other manufacturer's types.

The RCA Frequency Modulator

This is a small motor-driven unit designed to wobble the frequency of any signal generator. The diagram is shown in *Fig. 4*. On the shaft of the small motor is a two-section rotating condenser of 35 $\mu\mu$fd. per section. A 14-inch low-capacity cable connects this rotating condenser in parallel to the main tuning condenser of the test oscillator. The motor turns at 1550 r.p.m., rotating the condenser about 25 times per second. The condenser goes from open to closed and back from closed to open once each revolution, thereby producing 25 double frequency wobbles per second.

*The term "wobble frequency" denotes the number of times per second which the signal generator is wobbled. It should not be confused with the mean or extreme i.f. frequencies produced by the signal generator.

With this system, the saw-tooth oscillator in the oscilloscope is used for horizontal deflection, forming the "base" of the graph being traced. The s.t.o. may be operated at either 25 or 50 c.p.s. but must be synchronized with the rotation of the revolving condenser.

Note the miniature a.c. generator on the right end of the motor shaft. Its output of a couple of volts connects to the "external sync." binding post of the oscilloscope. With the s.t.o. frequency controls set for approximately 25 or 50 c.p.s., the small impulses from this little generator positively lock the sweep frequency to that of the wobbulator.

If a single a.c. voltage is placed on both sets of plates simultaneously the pattern will be a *single straight line* as shown in *Fig. 5-A*.

Two separate a.c. voltages placed on the respective sets of plates will cause a similar pattern, provided these voltages are *similar in character and in phase*. They may differ in amplitude, however, this being indicated by a different angle than shown.

If the two voltages are similar in character but differ by 90° in phase the pattern will be nearly a perfect circle, as in *Fig. 5-B*. It would be an exact circle if both sets of plates were equally sensitive.

Other phase differences will cause an ellipse which broadens as the phase difference increases, up to 90°. If the breadth is one-half its length, as sketched in *Fig. 5-C*, a phase angle of 45° is indicated.

Lissajous Figures

In the 1800's a French physicist, in his experiments, connected two pendulums so their motions would act upon a single stylus. Setting these pendulums in motion at different frequencies produced patterns which now bear his name.

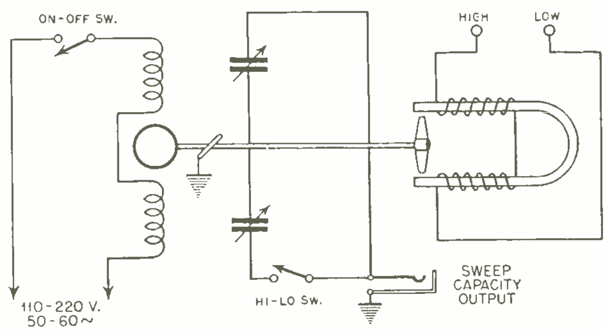
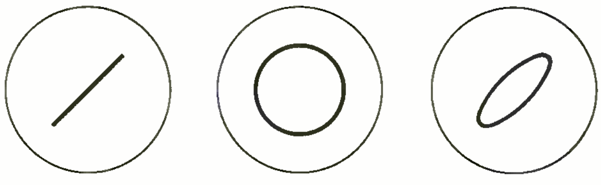


Fig. 4. The RCA Frequency Modulator, consisting of a rotary condenser and tiny synchronizing voltage generator.

Similar patterns may be traced on the c.r.o. screen by application of a-c. voltages of different frequencies to the two sets of plates. If the ratio of these frequencies is equal to the ratio of two integers, and if their ratios are not too complex, an interesting series of Lissajous figures will be produced. These are valuable for frequency comparison.

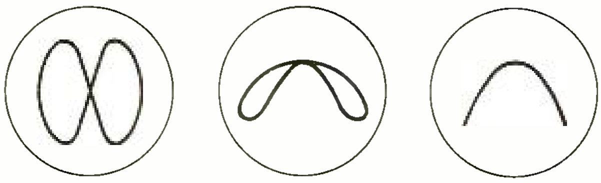
It should be noted that the three preceding patterns, *Figs. 5-A, 5-B* and *5-C*, were all produced with *similar frequencies* on both plates.

But now make the vertical frequency twice the horizontal and you'll find a "figure 8," a distorted "figure-8" or a parabola, depending on the phase relationship of the two frequencies. These are sketched in *Figs. 6-A, 6-B* and *6-C* respectively.



A B C

Fig. 5. Three traces produced with similar frequencies on both c.r. tube plates. Trace A is obtained from a single a.c. voltage.



• PHASE RELATIONSHIP EQUALS 90° or 270° • — A

• PHASE RELATIONSHIP EQUALS 135°, 225°, 45° or 315° • — B

• PHASE RELATIONSHIP EQUALS EITHER 0° or 180° • — C

Fig. 6. Traces obtained when the vertical frequency is twice the horizontal frequency, the shape of the traces depending upon phase relationships.

If the two frequencies differ by a ratio of 3-to-1 the patterns will look like those of *Figs. 7-A, 7-B* or *7-C*. The three loops due to the vertical frequency, and the single loop caused by the horizontal frequency are indicated in *Fig. 7-A*. Combinations of frequencies in multiples of 4-to-1 or more produce Lissajous figures of similar construction, differing only in that four loops will be produced when the vertical frequency is four times that of the horizontal frequency. Higher multiples will produce proportionately more loops. When the horizontal frequency is known, it is possible in this manner to determine the frequency of any multiple thereof which is applied to the vertical plates.

Receiver Alignment

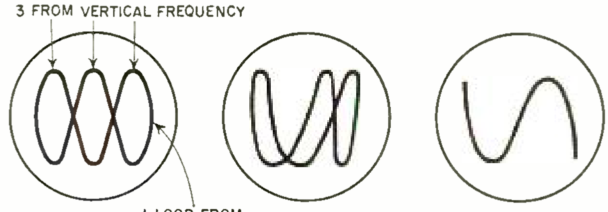
The method of connecting a signal generator and cathode-ray oscilloscope to a receiver to be aligned is shown in *Fig. 8*. Note that the oscilloscope vertical amplifier input leads connect from the diode load to ground; across which the rectified "wobbled" frequency is developed. As this frequency is usually of the order of 60 cycles or less, it is preferable to connect directly across the diode load rather than to the point marked "AF" because at the latter point a phase shift may be introduced by the coupling condenser which would alter the appearance of the image on the c.r. screen. Connection to the point shown will not short out the diode load, as might be assumed, because a blocking condenser is built into the input circuit of the vertical amplifier of the c.r.o.

Note that the synchronizing pulse is fed to the external synchronizing circuit. In most instruments a switch is provided for internal and external synchronization and should be adjusted so as to utilize the external pulse for aligning operations. If internal synchronization is employed, the image will drift and alignment will be difficult.

The first step in all receiver alignment operations is to align the last i-f stage, and the method of connecting the signal generator to do this is shown in *Fig. 8*. The signal generator is first tuned to the intermediate signal frequency and the signal is fed through a blocking condenser to the last i-f tube grid. The blocking condenser is necessary in order to avoid grounding out the a.v.c., which might cause the i-f amplifier to oscillate (this is more likely to happen when going through subsequent aligning operations than in adjusting the last stage, but is good practice anyhow). The test signal is thus amplified by the last i-f tube and adjustments of the last i-f transformer trimmers are made.

The secondary trimmer is first adjusted until a resonance curve appears on the screen, and the synchronizing voltage gain adjustment on the 'scope is adjusted until only sufficient synchronizing voltage is applied as is necessary to hold the image stationary on the screen. Any excess voltage tends to produce distortion which interferes with proper alignment.

When the adjustment of the secondary trimmer to produce a curve of maximum height is completed, the primary trimmer is then adjusted to produce a symmetrical curve. It may be necessary to go over



A B C

Fig. 7. If the two frequencies differ by a ratio of three to one, the patterns will look like those above.

the secondary adjustment and touch it up when the primary trimmer has been set at approximately the correct point. In making these adjustments, with 'scopes using the double-image system—which is by far the most widely used—make certain that the bases, not the peaks, of the resonance curves coincide. If the synchronizing voltage is not excessive, there will usually be no trouble in also making the sides of the curves coincide, but if adjustment is made only to make the peaks coincide, the stage will not be properly aligned.

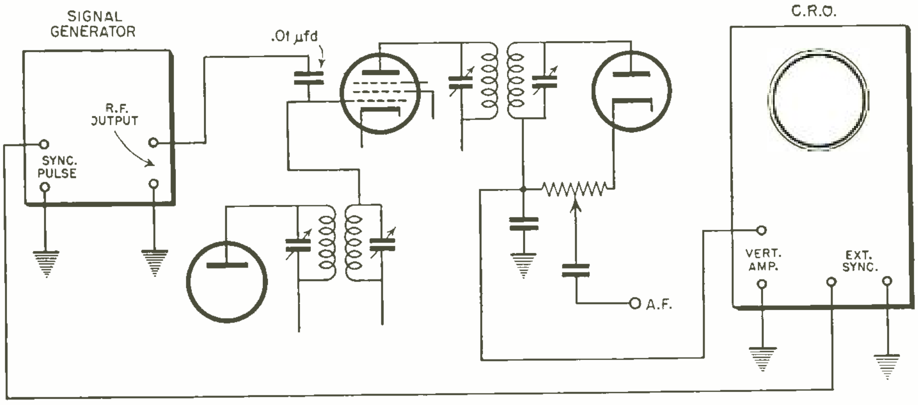


Fig. 8. The method of connecting a signal generator and cathode-ray oscilloscope to a receiver to be aligned. Note that the oscilloscope vertical amplifier input leads connect from the diode load to ground, across which the rectified "wobbled" frequency is developed.

Typical Screen Curves

Various stages in the aligning process are illustrated in *Fig. 9*. In *Fig. 9-A,* the alignment is correct but the traces fail to coincide due to incorrect synchronization. In *Fig. 9-B,* the alignment is incorrect; the bases of the two traces do not coincide, though the peaks do. In *Fig. 9-C,* the alignment is incorrect, though the bases coincide, because adjustments of the primary and secondary circuits have not been made so as to produce maximum gain. In *Fig. 9-D,* proper alignment is indicated, both traces coinciding throughout and the height of the peak indicates adequate gain.

After the last i-f stage is aligned, the next preceding stage is adjusted, connecting the signal generator to the preceding i-f grid but leaving the c.r.o. connections undisturbed. Adjustment of the preceding stage trimmers is made in the same manner as previously described, until a symmetrical curve is again obtained. Due to the increased amplification of the test signal, it is important to reduce the test signal level when feeding to any stage other than the last i-f grid, to avoid overload. Only sufficient signal strength should be used as is necessary to produce a clean signal trace on the c.r.o. screen. If the signal is too weak, it will be necessary to advance the gain control on the vertical amplifier of the 'scope to a point where hum and extraneous pickup make the trace fuzzy.

The last step in completing the adjustment of the i-f amplifier is to feed the i-f signal to the converter grid. Final adjustments are then made of the first i-f transformer trimmers and the i-f amplifier should require no further attention.

Oscillator Adjustment

Adjustment of the oscillator section of the converter may now be made by leaving the signal generator and c.r.o. connected as is, but readjusting the signal-generator frequency to the high-frequency aligning point specified for the band being aligned. For the broadcast band, this will ordinarily be of the order of 1600 kc. With this test signal frequency fed to the converter grid, the oscillator trimmer is adjusted to produce maximum signal output, as indicated by maximum height on the c.r.o. screen trace.

At this point we'd like to remark that the accuracy of frequency calibration for the frequency-modulated type of signal is not as great as that for the amplitude-modulated signal, because the beat-frequency principle is employed to provide the output signal in the former case, whereas only a single r-f oscillator is required for the latter. Thus, to produce a 1600-kc. signal, the average beat-frequency type of oscillator will supply the difference frequency resulting from the beating together of a frequency-modulated 700-kc (usually) signal and a 2300-kc unmodulated signal. Provision is made in all beat-frequency type signal generators to supply an amplitude-modulated signal for this purpose in which the beat-frequency principle is not utilized. Further, in aligning higher frequency bands, up to 20 mc, harmonics of the 700-kc oscillator used in the b-f oscillator cause difficulties. That is why only an amplitude-modulated signal is customarily used when aligning r-f and oscillator circuits on such bands.

These points are in no way derogatory to the beat-

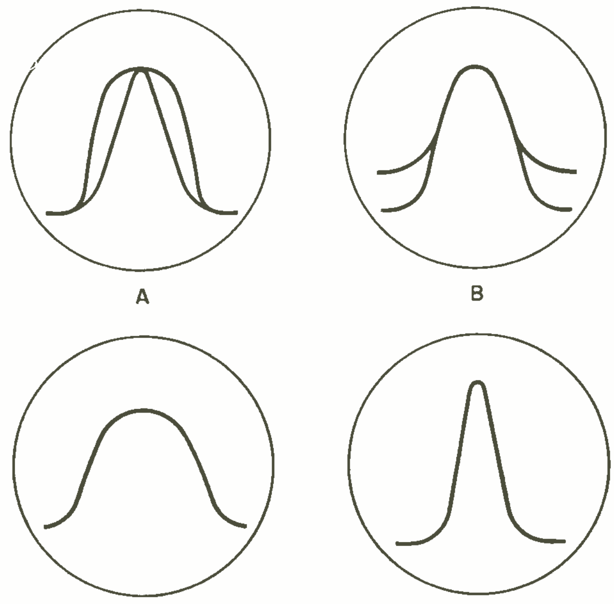


Fig. 9. Various traces obtained under specific conditions when aligning a receiver. Proper alignment is indicated in 9-D.

frequency type of frequency-modulated test oscillator, which is far superior in every way to simpler types when used in conjunction with the c.r.o. for aligning purposes; it is simply necessary to remember that each type of oscillator has its limitations, and each must be used for the purposes for which it is best fitted.

When using the amplitude-modulated signal, it will of course be necessary to use the internal sweep of the c.r.o., which is adjusted to the modulation frequency, usually about 400 cycles. Synchronization is ordinarily obtained with the internal synchronizing adjustment, and involves no particular care in adjustment, since we are primarily interested only in noting the height of the image and not its waveshape.

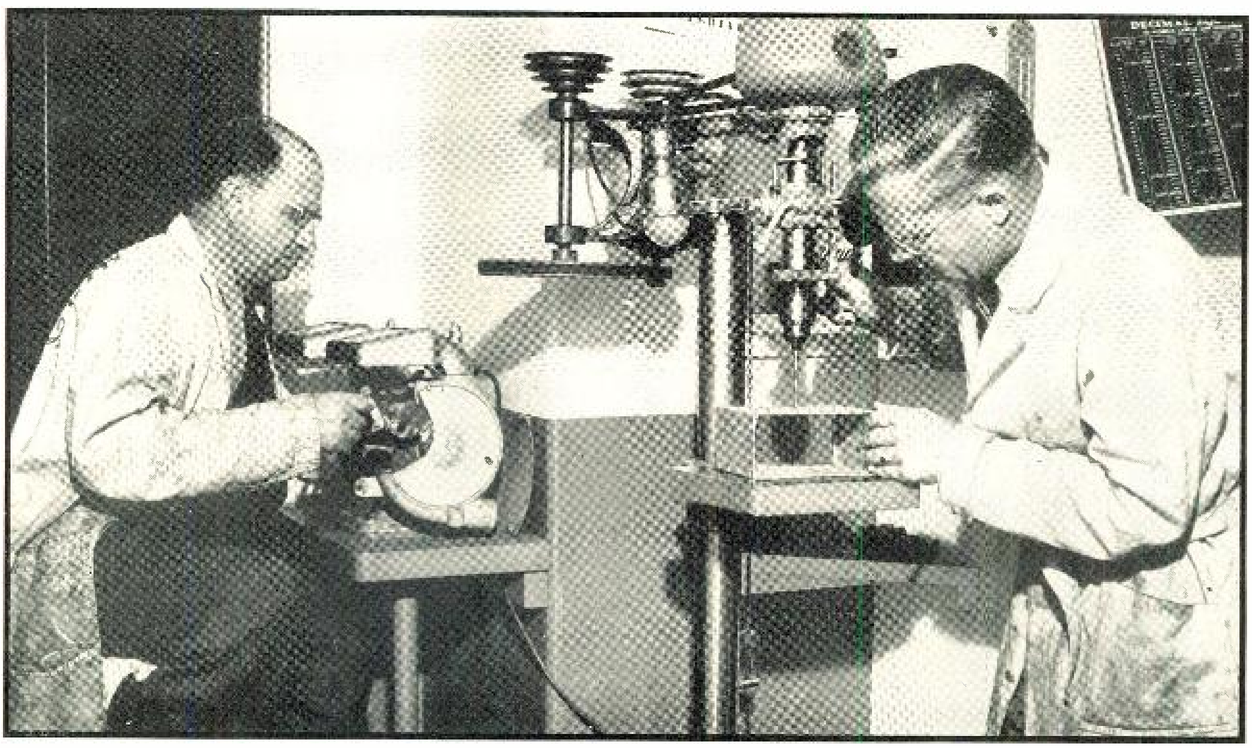
The oscillator adjustments just described are made, of course, with the receiver dial adjusted to the test frequency. This applies likewise to padding adjustments, which are made by tuning both the receiver and the signal generator to a specified frequency near the low-frequency end of the dial. For this adjustment, only a frequency-modulated signal should be used, because the interaction which normally results between circuits during this adjustment is thereby avoided. When a simple amplitude-modulated signal is employed, it is necessary to rock the gang condenser in order to avoid trouble from this source. This is automatically taken care of in the frequency "wobbling" resulting from frequency modulation.

After completion of the adjustments of the converter-oscillator circuits, the signal generator is connected to a preceding r-f grid—or to the antenna input, if no r-f stage exists, and the r-f coil trimmers are adjusted for maximum signal output at the specified aligning frequencies. The alignment is then complete.

Single-Image Method

Our discussion and traces have been based on the double-image system, which is employed in most of the c.r. oscilloscopes now in use. However, some use the single-image method, in which the return trace is suppressed by simply shorting out the sweep during the period of the return trace. The result is an image which varies in symmetry during the aligning process but upon which no reverse trace is superimposed. The final result obtained by either the single- or double-trace methods is identical, so there is no difficulty in applying either method. Some find the double-image method simpler, since the position of the return trace indicates at each instant, the effect of any adjustment. But the change in symmetry in the trace produced by the single-image method, as a result of similar adjustment, is equally informative to those who use the latter method, and in conjunction with a ruled screen, the frequency range covered is readily ascertained.

KFI'S SHOP NOW INDISPENSABLE



Repairing and using old equipment avoids priority troubles at the KFI transmitter. Material which would have been scrapped in the past, is now reused. Photo shows Blatterman (left) and Mason adapting old parts to new uses at the station.

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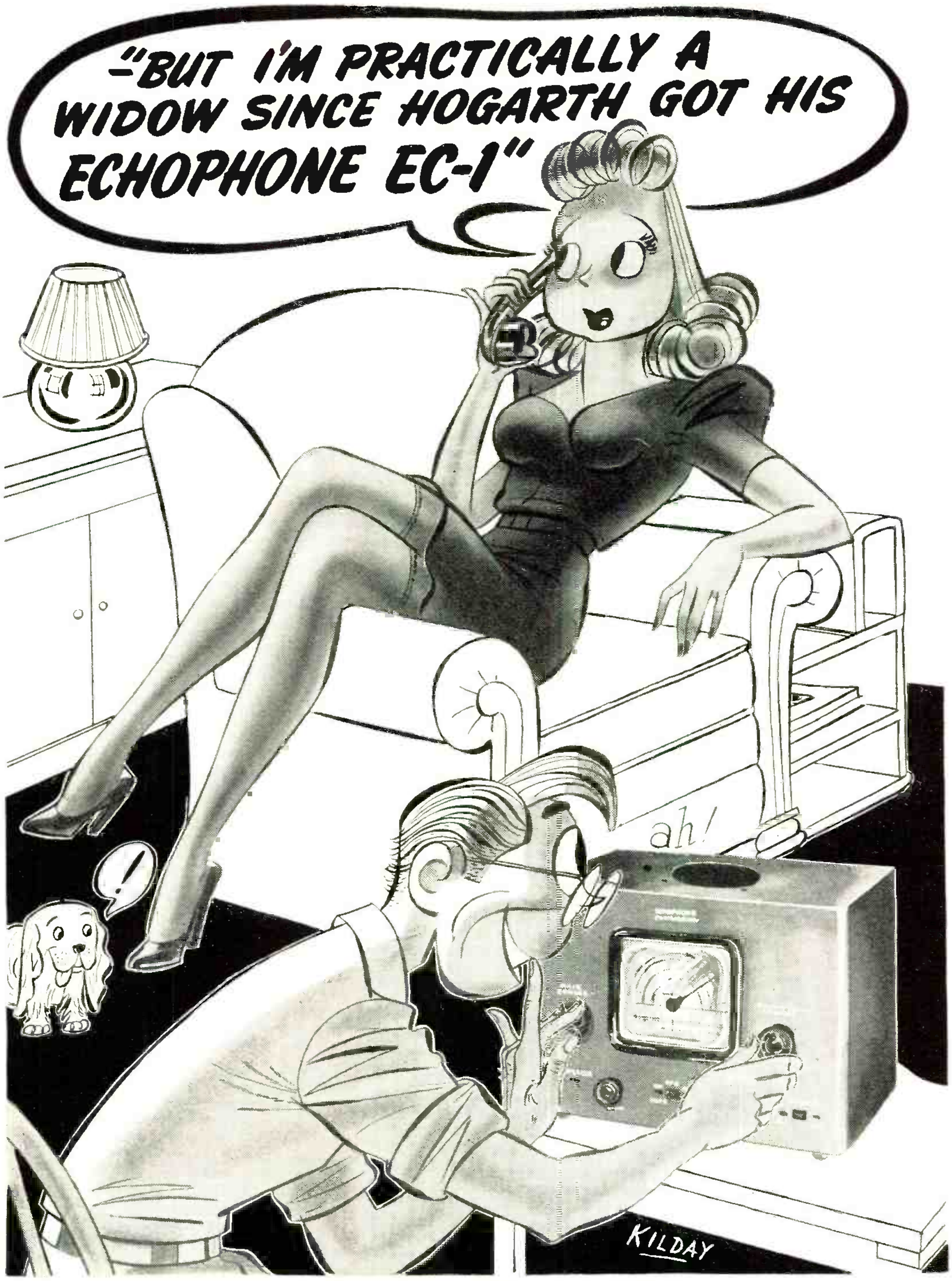

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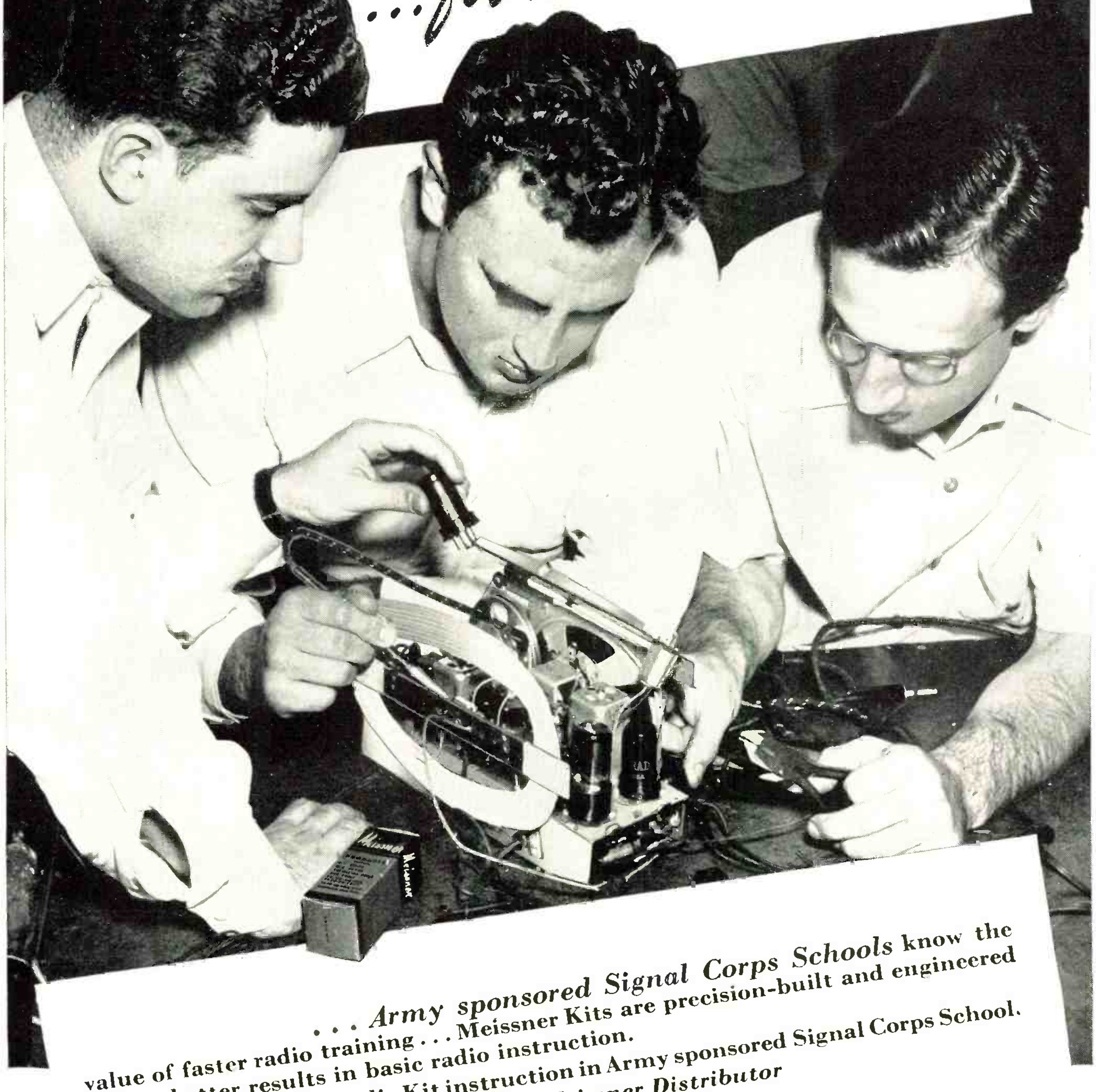

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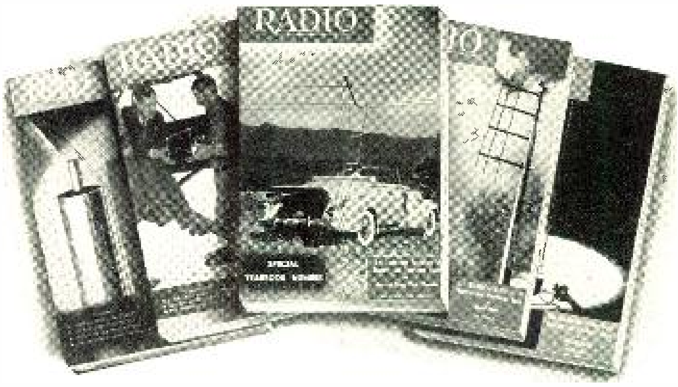

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APPLICATIONS OF GENERAL ELECTRIC GL-815 PUSH-PULL BEAM POWER AMPLIFIER

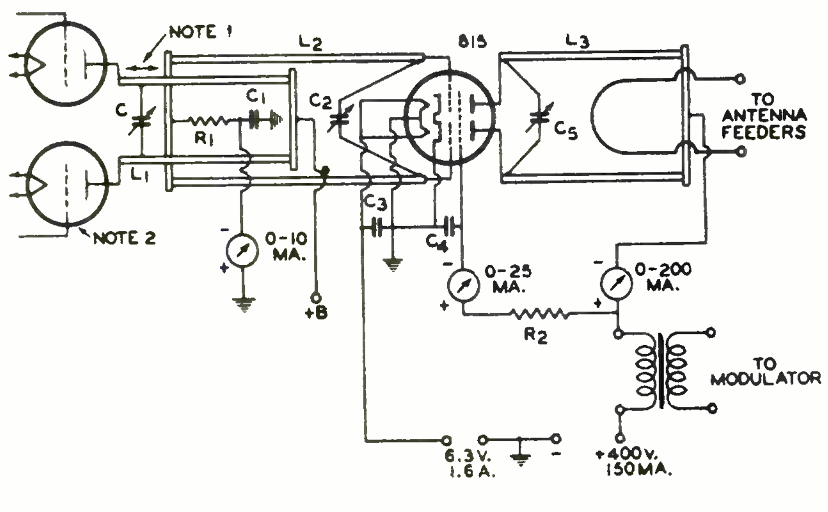
Revised data, including operation of the tube as a plate-modulated amplifier at 150 mc.

The *base* of the GL-815 fits the standard octal socket which may be installed to hold the tube in a vertical position with the base either up or down. It may also be mounted in a horizontal position provided the plane of each plate is vertical (on edge).

The *bulb* becomes very hot during continuous operation of the tube so that free circulation of air around the tube should be provided.

The *heaters* of the 815 are connected in series within the tube with a center tap brought out to a separate base pin. This arrangement permits either series operation from a 12.6-volt supply or parallel operation from a 6.3-volt supply. Either an a-c. or d-c. supply may be used. Under any condition of operation, the heater voltage should not vary more than ±10 per cent from the rated value. The heaters should be operated at normal voltage during stand-by periods. If the stand-by periods exceed two hours, the filament current may be shut off.

The *cathodes* of the 815 are connected together within the tube. The cathode circuit should be connected to the electrical midpoint of the heater circuit when the heaters are operated from an a-c. supply, or to the negative heater-supply lead when the heaters are operated from a d-c. source. In circuits where the cathode is not directly connected to the heater, the potential difference between the heater and cathode should not exceed 100 volts. If the use of a large resistor is necessary between heater and cathode in some circuits, it should be by-passed to avoid possibility of hum.



GL-815 as plate-modulated r-f amplifier at 150 mc.

C = See L_1

C_1 C_3 C_4 = 1 in. x 1½ in. copper sheet insulated from chassis by mica sheet 0.002 in. thick, or 0.0005-µfd. "postage stamp" mica condensers soldered to chassis with shortest practicable leads.

C_2 C_5 = Copper disks, 1/16 in. x 1½ in. Solder disks to 10-32 brass screws 1 in. long. Drill and tap grid and plate lines for 10-32 screws.

R_1 = 15,000 ohms, 0.5 watt.

R_2 = 15,000 ohms, 25 watts, adjustable.

L_1 = ½ in. diameter copper tubing. Length of tubing and capacitance of C depend upon driver tubes employed.

L_2 = ½ in. diameter copper tubing, 12½ in. long and spaced approximately ⅞ in. between centers.

L_3 = ½ in. diameter copper tubing, 13 in. long and spaced approximately ⅞ in. between centers.

NOTES

(1) The r-f driver stage should be able to deliver about one watt of useful r-f power, in order to insure ample grid excitation for the 815.
(2) Adjust coupling between L_1 and L_2 and tuning of C and C_2 for recommended d-c. grid current of the 815.
(3) L_1 and L_2 should be effectively shielded from L_3 by a metal chassis, or by a vertical metal baffle plate used to mount the 815.
(4) Adjust coupling of "hairpin" antenna coil to L_3 so that the amplifier is properly loaded.
(5) A small lumped inductance can be substituted for the amplifier grid lines, if desired. Such a grid coil is preferably tuned by varying its inductance, rather than by means of a variable condenser.

The *plates* of the 815 show no color when the tube is operated at its maximum plate-dissipation rating.

The *screens* of the 815 are connected together within the tube. Screen voltage may be obtained from a separate source, from a voltage divider, or from the plate supply through a series resistor. The choice of method depends on the service in which the tube is used (see Operation). When the screen voltage is obtained from a separate source or from a voltage divider, plate voltage should be applied before or with the screen voltage. Otherwise, with voltage on the screens only, the screen current may rise high enough to cause excessive screen dissipation. When screen-voltage regulation is not an important factor, the series resistance method for obtaining the screen voltage is desirable because of its simplicity and because it limits the d-c. power input to the screen. A d-c. milliammeter should be used in the screen circuit so that the screen current can be measured and the d-c. power input to the screen determined. *The screens should not be allowed to attain a temperature at which they will show color.*

The screen current is a very sensitive indication of the plate-circuit loading and rises excessively (often to the point of damaging the tube) when the amplifier is operated without load. Therefore, care should be taken when tuning an 815 under no-load conditions in order to prevent exceeding the screen-input rating of the tube.

A *protective device,* such as a high-voltage fuse, should be used to protect both the screens and the plates against overloads. When a bleeder resistor of poor regulation or a series resistor is used for obtaining the screen voltage, this device should be placed in the common positive high-voltage supply lead. It should remove the screen voltage when the d-c. screen current reaches a value of 50 per cent greater than normal.

Shielding of the r-f amplifier stages employing the 815 is required for stable operation. A convenient method of shielding is to insert the plate end of the tube through a hole in a metal plate so that the edge of the opening is in close proximity to internal shield of tube.

[*Continued on page* 58]

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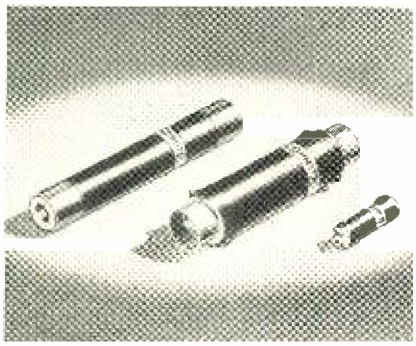

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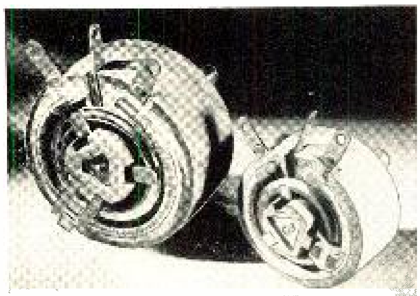

is firmly imbedded in a ceramic housing with an inorganic cement, resulting in a solid thermal mass. A graphited-copper contact shoe rides the collector ring and the winding, assuring two positive sliding contacts. Contact pressure is provided by a helical spring, concentrically mounted about shaft whose action is evenly distributed by use of a tripod-type contact carrier. The contact is insulated from the metal shaft by a center ceramic insulator, thus providing a "dead" shaft and mounting bushing. Available in any resistance value up to and including 10,000 ohms.

★

SAV-A-SHAFT VOLUME CONTROLS

The new National Union *Sav-a-Shaft* Volume Control introduces a new development in replacement control design by utilizing the shaft from the defective control. Not only does this *"Sav-a-Shaft"* for vital war material requirements, but for the service engineer it guarantees that the shaft will be of correct diameter and length and that the knob will fit the control perfectly. No cutting, filing or special knob is necessary regardless of whether the knob requires a flat, split knurl or other special shaft-end.

Another National Union feature provides *every* control with a switch. The control comes to you completely assembled so that the switch mechanism is inoperative.

National Union *Sav-a-Shaft* volume controls are available in various resistance values, tapers and taps to satisfac-

[*Continued on page* 56]

The U. S. Army Signal Corps

Its History and Services

Transmission of messages and signals by lights and other visual signals can be found throughout history. The use of visual codes between ships at sea has been practiced by mariners for centuries, yet, down to the middle of the 19th Century relatively little progress had been made in developing methods and instruments for the systematic exchange of information by means of signalling.

The construction of a practical working telegraph by Morse in 1832-1835 turned minds to the general subject of the interchange of ideas by signals. During the years preceding the Civil War, the first steps were taken toward the introduction of a method of signaling into general use in the U.S. Army.

The initiative was taken by a young army officer, Major Albert Myer, and the activities of the Signal Corps during the Civil War, and for 15 years thereafter, were mainly inspired and directed by him.

In 1854 his attention had been directed to the desirability of devising a simple method of communication. During his leisure hours at an isolated post in New Mexico he devoted himself to its development. Two years later the War Department recognized the possibilities of the system and appointed a board to examine the principles and plans of the mode of use in the field of visual communication.

From this emerged the most well-known of the visual systems, known as the "wig wag" system. In 1859, Secretary of War Floyd, commended Major Myer's system to Congress. As a result the first appropriation of the Signal Corps was made in the sum of $2,000. The same Act authorized the appointment on the staff of the Army of one Signal Officer with the rank, pay, and allowance of a Major of Cavalry.

On June 10, 1861, the first signal school was formally opened at Fortress Monroe in Virginia.

Following the Bull Run campaign, Myer submitted a project for the organization of a separate Signal Corps "to have charge of all the telegraph duties in the Army."

In his first annual report (November, 1861) Major Myer urged that visual signalling and telegraphy be taught to cadets at the U. S. Military Academy and that officers be detailed to each army and army corps to organize and instruct signal parties.

During the year 1862, 199 officers were detailed and instructed as signal officers. Improvement in the Union Signal Service in the West became evident. It was the accepted doctrine that signal officers should combine the duties of reconnaissance and signal communications. Experimental work was carried on with rockets, fires, telescopes, signal pistols, discharges, telegraph instruments and insulated wire.

The Act of March 3, 1863, provided for a separate Signal Corps during the War. In July, 1863, instructions in military signalling began at the Military Academy at West Point.

The second Chief Signal Officer was Brigadier General William B. Hazen. His administration was noted principally for the Arctic Expeditions, of which there were several. The most important was the well-known Greely Expedition.

In 1887 General Hazen was succeeded by Brigadier General Adolfus W. Greely, who became the third Chief Signal Officer. General Greely took immediate steps to revive interest in military signalling and to effect improvements in field equipment.

In 1888 a new type of heliograph made its appearance. Heliograph messages were exchanged up to a maximum of 125 miles. With the beginning of the Spanish-American War, the Signal Corps had a temporary expansion from its then existing strength to more than thirteen hundred. At the conclusion of the War, the Signal Corps found its duties greatly extended in Cuba, the Philippines and Puerto Rico, where telegraph and cable systems were to be constructed.

Through the vision and energy of successive chief signal officers, military aviation was to be introduced into the American Army. In 1908 the first heavier-than-air machine was purchased for the Signal Corps. By Act of Congress an Aviation Section, Signal Corps, was formed, July 18, 1914.

The Signal Corps in April, 1917, was composed of 13 officers permanently assigned, 42 of other branches temporarily detailed, and 1,570 enlisted men. This small force was organized into four field signal battalions, and six depot companies. These depot companies existed as organizations for administrative convenience only and had no fixed strength. In addition to the regular organization, the signal troops of our military establishment included units of the National Guard. In April, 1917, the National Guard Signal Corps consisted of approximately 160 officers and 3,500 enlisted men, organized into 10 field signal battalions and 16 separate companies.

Prior to the declaration of war, the possible development of the Mexican situation had prompted the accumulation of the quantity of signal equipment with a view of supplying the needs of three divisions.

This property included tractor radio sets, pack radio sets, heliographs, flag kits, wire carts, field glasses and the like.

In 1917 the scattered and scanty Signal Corps was now called upon to supply signal units for an army of a million men or more. Then, as now, the necessary expansion was made through advertising in newspapers, technical journals, Chambers of Commerce, schools and business men's associations. Telegraph, telephone and electrical supply companies proved most helpful aids through their patriotic policy of offering to the Signal Corps every assistance in their power.

During our nineteen months of war, the strength of the Signal Corps (exclusive of the Aviation Section) increased from 55 officers and 1,570 enlisted men to 2,712 officers and 53,277 enlisted men.

With the signing of the Armistice, the Signal Corps was required to demobilize its war establishment. Major General Squier was followed by Major General Charles McK. Saltzman; Major General George S. Gibbs, appointed January 9, 1928, and Major General Irving J. Carr, appointed July 1, 1931.

Major General James B. Allison followed and on October 1, 1937, the present Chief Signal Officer, Major General Joseph O. Mauborgne, was appointed. He has had the greatest of all Signal Corps problems to solve because the Signal Corps has expanded at a rate which it has never known in all of its great past. As a matter of comparison, the Signal Corps in peace on July 1, 1941, approximated 1,900 officers and 30,457 enlisted men. It will probably reach 5,000 officers and 100,000 enlisted men and more before the war is over.

The large estimated Signal Corps strength, seemingly very large when compared to World War figures, is due to the fact the Signal Corps has organized units whose types are very new to the Army. These follow:

Signal Company, Aircraft Warning
Signal Company, Operation, Aircraft Warning
Signal Company, Operation, Separate
Signal Company, Construction, Separate
Signal Company, Armored Division
Signal Battalion, Armored Corps
Signal Company, Aviation
Signal Company, Maintenance, Aviation
Signal Company, Air Wing

Signal Platoon, Air Base
Signal Company, Depot
Signal Company, Repair

Most of these new units have been developed because of new Signal Corps duties made necessary by the expansion of the Air Corps, the organization of the Armored Corps and the Aircraft Warning Service.

With the increase in numbers of men and types of units, many new types of specialists enter the picture to swell an already large number of specialists. The Signal Corps lists about 70% of its personnel as specialists. This percentage, with the possible exception of that of the Air Corps, is probably the highest of any arm or service.

The problem of training this great number of men in diversified specialties to operate and maintain the many new types of equipment is a problem which the Signal Corps has yet to solve completely. New schools, both military and commercial, are being employed.

The Signal Corps is a service as well as an arm and has the following missions (AR 105-5):

1. The development, procurement, storage, issue, and repair of signal, meteorological, and cryptographic equipment and supplies.

2. The development, procurement, storage, and issue of all electrical apparatus associated with direction finding for determining the location of radio stations, aircraft, and marine craft, and of all the electrical apparatus associated with range finding.

3. The procurement, storage, and issue of photographic supplies and equipment except that required for—

a. Photographic and cinematographic work made from aircraft.

b. Ground photography in connection with aircraft operation and maintenance.

c. Other special purposes for which the procurement, storage, and issue of photographic supplies and equipment have been specifically charged by the War Department to another arm or service.

4. The preparation and revision of all books, pamphlets, and instruction data required by the Army to make proper use of all equipment and apparatus developed, procured, and issued by the Signal Corps.

5. The preparation, publication, revision, storage, accounting for, and distribution of all codes and ciphers required by the Army, and in time of war the interception of enemy radio and wire traffic, the location of enemy radio stations, the solution of intercepted enemy code and cipher messages, and laboratory arrangement for the employment and detection of secret inks.

6. The installation, maintenance, and operation of all military signal communication systems and equipment, including military cable, telephone, and telegraph lines, radio apparatus and stations, except the routine maintenance and operation of fixed fire-control communication systems and fixed airways and airdrome control systems and radio aids to air navigation, and the installation, maintenance, and operation of signal communication systems used by combat troops in field operations over which it will exercise general supervision only.

7. The transmission of messages for the Army by telegraph or otherwise.

8. The coordination of the training of the personnel assigned to signal duties, under such instructions as may be prescribed in orders from the War Department.

9. The general supervision, coordination, and standardization of all radio operations and the enforcement of regulations concerning the same.

10. The assignment of call letters, radio frequencies, power, type of emissions, and schedules for all Army radio stations.

11. The procurement and supply of photographs and motion pictures directed by the General Staff, and in general all photographic and cinematographic work of the Army not specifically assigned to other arms or services.

12. The assignment of designation numbers to all Army submarine communication cables and the keeping of records thereof.

Walkie Talkie used by the U. S. Army Signal Corps at an outpost. Equipment is made by the Kellogg Switchboard & Supply Co.

13. The performance of all other duties usually pertaining to military signal communication other than as provided for above.

With modern warfare operating at terrific speed and requiring almost split-second coordination of all military units, the United States Army pays close attention to its Nerve Center—The Signal Corps.

Book Review

FUNDAMENTALS OF RADIO, edited by William L. Everitt; authors, Edward C. Jordan, Paul H. Nelson, William C. Osterbrock, Fred H. Pumphrey, and Lynne C. Smeby. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N.Y. Flexible cloth cover, 400 pages, well illustrated. Price $5.00.

The reviewer cannot recollect ever having run into a textbook dealing with basic radio principles that could begin to compare with the *Fundamentals of Radio*. It is, without question, the most concise, thorough and satisfying presentation of a difficult subject at best, so far to reach print.

Written for the prime purpose of training technicians for industry, broadcasting, and the armed forces, it starts, where it should, with the touchy subject of mathematics; but in a way so simple and straightforward that the lay reader is sure to be enticed. Individual problems are solved in steps so that the student may follow the reasoning: and accompanying each problem are a number of exercises for the reader to work out on his own.

The book is remarkably free of "blind spots"—those exasperating vacuums where the author's mind goes blank just at the critical points of explanation. Moreover, the main text has been so well stripped of verbiage that explanations are a model of clarity.

The chapters on d.c. and a.c. circuits and electronic principles form a groundwork of knowledge on which the subsequent chapters are based. In a continuous progression from the elementary to the more complex phases of radio, later chapters deal with rectified power supplies, sound and its electrical transmission, audio amplifiers, vacuum-tube instruments, electromagnetic waves, transmission of signals by radio, radio-frequency amplifiers and detectors, amplitude-modulation transmitters and receivers, frequency modulation, radio wave propagation, and radio antennas. An index is included.

Each chapter contains practical exercises using simple mathematics. The answers are given at the end of each chapter.

The *Fundamentals of Radio* provides a perfect foundation for a more advanced study of radio subjects. We recommend it to practicing technicians and students without reservations.—*M.L.M.*

★

ELECTRONIC TUBE CHART

A quick-selection and comprehensive chart of electronic tubes for industry, with technical data on applications and tubes, has been prepared by the General Electric Radio, Television and Electronics Dept., at Schenectady, N. Y., and is available on request.

★

NEW SOLAR CATALOG

Solar Manufacturing Corp., Bayonne, N.J., announce publication of a 48 page Catalog 12-section C, a most elaborate compilation covering only the Paper Capacitor output of this firm. Copies of this helpful treatise may be had only by addressing Solar on your company letterhead.

UNIVERSAL MIKE STANDARDIZED

Universal Microphone Co., Inglewood, Cal., has standardized its entire line of microphones for aircraft, ground stations and the like, in favor of its models CU-1 and CU-2. The AR-1 series has been discontinued.

★

MYCALEX INSULATOR BULLETIN

Mycalex Corporation of America, 7 East 42nd St., New York, has for distribution to those who make requests on company letterheads, a 12-page bulletin dealing with the technical qualities of

Mycalex insulation for radio and electronic use.

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New Products

[*Continued from Page* 50]

torily handle about 95% of usual replacements encountered in radio service work.

ECONOMICAL EXPEDITER

These low cost Intercom systems were designed for the expediting of vital war production.

Installation can be made to include all Masters to a total of five, a Master and a maximum of five Sub-stations, or a combination of Masters and Sub-stations to a total of five units. Operation on all systems is on 110 volts a.c. or d.c. Economy is again stressed in economical operation, approximately fifteen cents per month. Master station mechanisms are housed in sturdy walnut cabinets. Sub-stations are completely enclosed in durable metal cases.

In a system having one Master and a set of Sub-stations known as the Master Selective type, stations can be placed at any distance up to 2000 feet from each other and volume can be adjusted by means of the volume control.

Also available is the Combination Master System which permits the use of two or more Masters in combination with Sub-stations. Sub-stations may be called by either Master. The Super Selective System uses all Master stations and permits a number of two-way conversations to be carried on in complete privacy. Units of these systems may also be placed as far as 2000 feet from each other, and the volume may be adjusted.

All of these systems are available for use with 10, 20, 30, 40, 50, etc., stations.

A bulletin, "Talk-A-Phone Systems," with description and explanation of systems manufactured by the company, is available.

★

AUTOMATIC WIRE STRIPPER

General Cement Manufacturing Company, of Rockford, Illinois, announces a new Wire Stripping Tool that instantly

strips insulation from all types of wire easily and perfectly. Just press the handles and the job is done. It can also be used as a wire cutter. Saves many hours of time when making splices, repair jobs, etc. For information write General Cement Manufacturing Co., Rockford, Illinois.

NEW STANCOR CATALOG

A new 24-page catalog covering the complete line of Stancor Transformers and Chokes has been released for dis-

tribution. Address the Standard Transformer Corporation, 1500 N. Halsted St., Chicago, Ill.

★

SOLA CONSTANT-VOLTAGE TRANSFORMERS

A 22-page catalog with descriptions and technical data on the complete line of Sola Constant-Voltage Transformers

is available to engineers and technicians in the field. Address the Sola Electric Company, 2525 Clybourn Ave., Chicago, Ill.

★

WARTIME CONDENSER CATALOG

This is war. That is the keynote of the new 1942 Aerovox Catalog just off the press. Starting out with a cover that reflects the stern atmosphere of the huge plant working day and night on the radio fighting and home fronts, the catalog lists those essential condensers, resistors and test instruments in popular demand and therefore still produced.

stocked and available for prompt delivery. A further wartime note is the inclusion of several pages of motor-starting replacement capacitor listings, in acknowledgment of widespread and growing demand for refrigerator maintenance. A copy of this catalog may be had by addressing Aerovox Corporation, New Bedford, Mass., or through the local Aerovox jobber.

★

HOLES REVEAL LIGHTNING KICK

Punctured with 150 holes—one 0.9 inch in diameter—which makes it resemble a giant's pepper shaker, an 18-inch nickel-plated copper sphere which for seven years capped the 878-foot transmitting antenna tower of Station WSM in Nashville has revealed to Dr. K. B. McEachron important facts about the quantity of electricity in the lightning strokes which made the holes.

Dr. McEachron, who is research engineer of the General Electric Company's High-voltage Engineering Laboratory at Pittsfield, Mass., has told how he and J. H. Hagenguth, his associate, have devised a method for measuring from a hole made by lightning in thin metal surfaces the quantity of electricity involved in the continuing part of the stroke which caused it.

There are two major effects which characterize lightning strokes to objects on the earth, Dr. McEachron explained. One causes explosions, the other often results in fire.

"The explosive effects," he said, "are now known to be due to sudden increases in current which may reach a crest of several thousand or even a hundred thousand amperes in a few millionths of a second, decaying to half the crest value in a time of the order of 40 millionths of a second. It is the expansion effects in the air resulting from these rapid current changes which cause the thunder which we hear.

"The burning effects are the result of the flow of current of relatively low magnitude of the general order of 200 or 300 amperes for times which may be as long as 1.5 seconds, but on the average persist for about 0.3 second."

This continuing part of the lightning stroke, which was discovered in 1937, is responsible for the holes in the metal, and it accounts for most of the quantity of electricity in the stroke. Quantity of electricity is measured in terms of the coulomb. One coulomb is approximately the amount of electricity which passes through a forty-watt lamp in three seconds. The current peak of a lightning discharge is completed so quickly that very small amounts are involved, on the average only a fraction of a coulomb. But the charge represented by the continuing current may be of the order of 200 coulombs or more.

Artificial lightning generators, which operate as high as 10,000,000 volts, normally produce strokes of less than 10 coulombs, so their capacity would have to be increased more than 20 times to simulate nature completely. However, to study the effects of the continuing current, high voltage with long sparks is not necessary, so Mr. Hagenguth devised a special combination of generators to produce a high-amperage preliminary discharge, with a follow current of as many coulombs as required.

Using this apparatus, holes of various sizes were burned in sheets of copper similar to the material in the sphere, and also in other metals. So long as the same quantity of electricity in the continuing current was used the holes were the same regardless of the current, which ranged from 50 amperes to 600 amperes, values within the range of such discharges in natural lightning. Thus, it was possible to find a formula by which, knowing the area of the hole, the number of coulombs required to produce it could be calculated. According to this, a discharge of 240 coulombs produced the 0.9 inch diameter hole which was the largest in the WSM sphere.

It is uncertain how many times the sphere was actually struck by lightning. The station records indicate that there were at least 24 direct hits, and Dr. McEachron believes the number to be even higher. One stroke would usually produce several holes, though also, he stated, more than one stroke might contribute to the same hole.

These data were also applied in studying the effects produced by lightning which struck a house near Amherst, Mass., producing a hole nearly an inch in diameter in the galvanized iron shingle roof. The house was not wired, but the lightning went 162 feet along the ground, digging a channel as it travelled, to the house next door. There it punctured a hole in the cellar wall to make contact with a ground rod driven in the cellar. Approximately 250 cubic feet of earth were moved in the stroke's travel. From the size of the largest hole in the roof, a charge of 210 coulombs is indicated.

As a result of these studies, Dr. McEachron and Mr. Hagenguth conclude that "the use of thin metal surfaces makes a fairly satisfactory means of collecting data with respect to the number of coulombs contained in natural lightning strokes."

★

TELEVISION POSTS FOR SCHENECTADY AIR RAID WARDENS

Schenectady County (New York) civilian defense officials have established seven official television posts throughout the county for the instruction of air raid wardens via television. Programs are received by television receivers loaned to Schenectady defense officials by the General Electric Company.

Programs originated by NBC's television station WNBT, in New York, are picked up by a G-E television relay station (the first of its kind) located in the Helderberg Mountains near Schenectady. This station relays the programs to television station WRGB which rebroadcasts them for the Schenectady County wardens.

Prior to the establishment of the definite television posts, the air raid wardens were receiving part of their instructions through the courtesy of television-receiver owners who invited the wardens in for the WNBT-WRGB programs.

Five of the new television posts are strategically located fire stations, one in a town hall, and one at Union College in Schenectady. Over 2000 air raid wardens attend the lessons via television, after which they listen to lectures and have question-and-answer periods.

★

NEW RELAY AND TIMER GUIDE

In addition to giving full details on hundreds of relays and timers for a wide variety of applications, the new Dunco Relay-Timer Catalog, just issued by Struthers Dunn, Inc., Juniper and Cherry Sts., Philadelphia, Pa., has been designed to serve as a guide to relay and timer selection and usage.

Fully revised, greatly enlarged, profusely illustrated, and replete with detailed specifications and engineering information, the catalog is one that will prove helpful to designers, engineers, purchasing agents, production executives, and maintenance men alike.

In view of the extremely wide variety of Dunco Relays and Timers available for war or normal industrial requirements, particular pains have been taken to simplify their ordering. Standard units are listed in detail, following which complete information is given as to the many adaptations which may be obtained. This catalog introduces a new type designation system that greatly simplifies the specifying of required special features on units which are otherwise standard. Complete electrical information, as well as base dimensions, cover dimensions, coil data, magnetic structure diagrams and dimensions, contact diagrams, and descriptions. mounting styles, etc. are included. Several pages are devoted to a general discussion of the selection and application of Dunco Relays to meet practically any requirement. A copy will be sent upon request to Struthers Dunn, Inc. Ask for Catalog F.

General Electric 815

[*Continued from Page* 48]

R-f by-passing of the 815 at its socket is necessary in order to realize the full capabilities of the tube at the ultra-high frequencies. The impedance between the screen and the cathode must be kept low, usually by means of a suitable by-pass condenser. It may also be advisable in some applications to supplement the action of the by-pass condensers by r-f chokes placed close to the condensers in the voltage supply leads. It is important that the grid-, plate-, and screen-circuit returns are made to the common cathode connection in order to avoid r-f interaction through common circuit returns.

In order that the maximum ratings given are not exceeded, changes in electrode voltages due to battery- or line-voltage fluctuations, load variation, and manufacturing variation of the associated apparatus must be determined. An average value of voltage for each electrode should then be chosen so that under the usual voltage variations the maximum rated voltages will not be exceeded.

When a new circuit is tried or when adjustments are made, it is advisable to reduce the plate and screen voltages. This may be done conveniently by means of a protective resistance of about 4000 ohms (total) in series with the screen lead and a protective resistance of about 2000 ohms in series with the high-voltage supply lead.

The rated plate voltage of this tube is high enough to be dangerous to the user. Care should be taken during the adjustment of circuits, especially when the exposed circuit parts are at high d-c. potential.

Operation

In *Class B r-f service,* the 815 is supplied with unmodulated d-c. plate voltage and the gird is excited with r-f voltage modulated at audio frequency in one of the preceding stages. Under these conditions, the plate dissipation is greatest when the carrier is unmodulated. The screen voltage should be obtained from a separate source or from a voltage divider connected across the plate-voltage supply. Grid bias may be obtained from a rectifier of good regulation, or from a cathode resistor suitably by-passed for both audio and radio frequencies.

In *grid-modulated Class C r-f service,* the 815 is supplied with unmodulated r-f excitation voltage and a d-c. grid bias which is modulated at audio frequencies. Grid bias should preferably be obtained from a fixed supply. The plates are supplied with unmodulated d-c. voltage. The audio power required in this service is very small and need be sufficient only to meet the peak power requirement of the grids of the Class C amplifier on the positive crest of the input signal. The actual peak value is generally never more than 0.5 watt. The screen voltage should be obtained from a separate source or from a voltage divider connected across the plate supply.

In *plate-modulated Class C r-f amplifier service*, the GL-815 can be modulated 100 per cent. The screen voltage should preferably be obtained from a voltage-dropping resistor in series with the *modulated* plate supply, although it may also be obtained from a fixed supply. In any case, the screen voltage must be modulated simultaneously with the plate voltage so that the ratio of screen voltage to plate voltage remains constant. Modulation of a fixed supply can be accomplished either by connecting the screen lead to a separate winding on the modulation transformer or by connecting it through a blocking condenser to a tap on the modulation transformer or choke. With the latter method, an a-f choke of suitable impedance for low audio frequencies should be connected in series with the screen-supply lead. Control-grid bias should be obtained from a grid resistor or from a combination of grid resistor and fixed supply, or grid resistor and cathode resistor. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation. Grid-bias voltage for Class C service is not particularly critical so that correct adjustment may be obtained with values differing widely from those indicated for this service.

In *Class C r-f telegraph service*, the 815 may be supplied with screen voltage by any of the methods previously discussed. When a series screen resistor is used, the regulation of the plate supply should be good enough so that the plate voltage will not exceed 600 volts under key-up conditions. Grid bias may be obtained by any convenient method.

NATIONAL UNION PRODUCTION RALLY

On Thursday, August 6th, representatives of the Army and Navy, and famous heroes, along with the Reception Committee of National Union executives and Union representatives, made an inspection of the National Union Radio factories in Newark, New Jersey.

After the inspection of the plants by the Army and Navy representatives, heroes, etc., there was a rally at the National Union Radio Corp. McCarter Highway Plant.

BURTON BROWNE RECEIVES NAVY CITATION

For his work in originating and placing a National Advertising Campaign for the Radar division of the Navy, Burton Browne, head of the Chicago advertising agency of Burton Browne Inc., has been awarded a Navy Proclamation of Gratitude. The citation was presented to Mr. Browne by Commander Philip R. Weaver, U.S.N. More than twenty-five publications are cooperating in the Radar enlistment campaign.

Commander Philip R. Weaver U.S.N. presenting Navy Citation to Mr. Burton Browne

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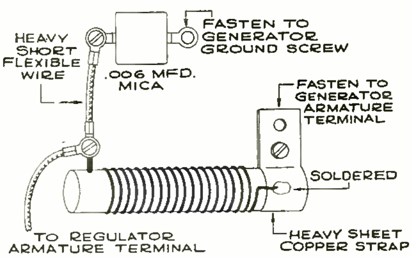
CAR GENERATOR NOISE

When ultra-high-frequency police receivers are installed in late model cars, one of the most frequent causes of noise is the car generator. The ordinary type of .5 μfd. generator filter condenser seldom is of any help. The reason is that the ordinary type of filter is not effective at these frequencies.



The filter in *Fig. 1* is very effective in eliminating this trouble and has been used in a number of cases by the writer. It consists of a choke coil wound on a 6" length of 1" dowel with 18 turns of No. 12 enameled wire. Also a .006 μfd. mica bypass condenser is used. This choke will handle the output of the heaviest generators. The winding should be spaced the diameter of the wire.

★

Voltage Regulator Noise

If the car has been used considerably the regulator may also cause a disturbance by the arcing of dirty points. Observing the operation of the regulator with the cover removed will quickly indicate which set of contacts is causing the trouble. Drawing a piece of medium sandpaper between the points will usually eliminate the difficulty. Make certain that a piece of sand does not get caught on one of the points as this will cause the regulator to cease operation.

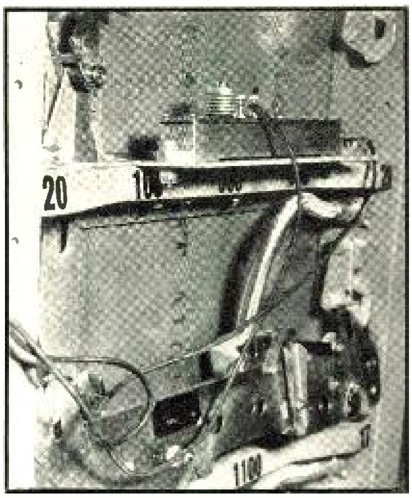
William C. Ryder.

★

ELECTRONIC STRAIN GAGE EQUIPMENT ON TEST FLIGHTS

By attaching strain gages to the proper parts of a wing, and by putting recording instruments in the plane, a few electronic tubes will write a complete record of the strains during a test flight From these records, the designer knows whether he can reduce weight and thus give more speed to bombers and fighters.

Stresses in the plane structure are detected by the strain gages, which are mounted on various parts of the plane. These stresses are converted into electrical impulses which are amplified suf-



ficiently to drive highly sensitive oscillograph galvanometers. By deflecting light beams of an optical system, the galvanometers record the strain gage impulses on a photographic film. Having calibrated this equipment before flight tests, the trace on the film can be converted to either pounds per square inch of load on the plane structure, or by thousandths of an inch deflection.

★

HYGRADE SYLVANIA CHANGES NAME

Hygrade Sylvania Corporation, third largest manufacturer of incandescent lamps, second largest manufacturer of radio tubes and one of the three largest producers in the fluorescent lighting field, has officially become Sylvania Electric Products Inc.

The change in name was voted by stockholders at a special meeting held on July 30, and became official with the fulfillment of the necessary legal steps incident to the move.

★

JOHNSON PROMOTED BY SYLVANIA

P. S. Ellison, Director of Advertising and Sales Promotion of Hygrade Sylvania Corporation has announced the appointment of H. C. L. Johnson as Advertising Manager of the company's radio tube division. Until recently, Mr. Ellison had been manager of both renewal tube sales and advertising, and Mr. Johnson had been assistant advertising manager of the division.

Mr. Johnson is well known in radio and advertising circles, having formerly been Advertising Manager of Thordarson Electric Manufacturing Company of Chicago. He has been with Hygrade Sylvania for almost five years. Mr. Johnson is a member of the New York Sales Executives Club, Advertising Club of New York and Treasurer of the Northwestern University Club of New York.

★

M. F. BALCOM ELECTED TO RMA

M. F. Balcom, Vice President and General Manager of the Radio Tube Division, Hygrade Sylvania Corporation, was newly elected Vice President of the Radio Manufacturers Association at the Annual Industry Meeting held recently in Chicago.

Mr. Balcom was also made Director of the Association and Chairman of the Radio Tube Division, succeeding Roy Burlew of the KenRad Radio Tube Company, Owensboro, Kentucky.

★

CRITICAL OCCUPATIONS LISTED FOR COMMUNICATIONS INDUSTRIES

Making no recommendations of its own, the Board of War Communications has announced that lists of critical occupations in the communications industries have been forwarded to the War Manpower Commission, the Selective Service System and the United States Employment Service for such use as these agencies may find.

Separate lists for each of the different types of communications show 23 classes of critical occupations for cable companies, 45 classes for telegraph firms, 51 classes for telephone organizations, 48 classes in the various subdivisions of commercial radio communications services, 15 classes in international short-wave broadcasting, and in standard broadcasting there are six classes of technical workers and three classes of skilled personnel in program departments.

The agencies were told "The Board does not feel that it is in a position to consolidate these lists for the entire communications industry due to the fact that the nomenclature of positions and the principles applied in the inclusion or exclusion of positions have been different in the various branches of the industry."

It was suggested that the industry and labor representatives on the Board's Joint Labor-Industry Subcommittee should consult directly with the Government agencies in supplying detailed information on the functions performed by persons in the listed positions. Members of the labor representatives are: Paul E. Griffith of the National Federation of Telephone Workers, for telephone workers; Joseph P. Selley of the American Communications Association, for telegraph workers, and Robert J. Watt of the American Federation of Labor, for radio workers. Industry representatives are: Keith S. McHugh of American Telephone and Telegraph Company, for telephone; Ellery W. Stone of Postal Telegraph, for telegraph, and Dr. C. B. Jolliffe of Radio Corporation of America, for radio. Sidney D. Spear of the Federal Communications Commission will assist the subcommittees and perform necessary liaison on this work for the Board.

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RADIO TUBE MACHINES LOSE RUBBER TO RCA RESEARCH

A semi-plastic material, made from alcohol and especially tailored for the job after months of research, has been pressed into service to release large quantities of rubber heretofore required to operate intricate machines used to build RCA radio tubes.

Intense fires are required for several steps in their manufacture. Time-honored custom has made rubber tubing standard for the flexible hoses needed to feed the fires with gas to moving burners from a fixed source. In addition, moulded rubber sections of almost pure gum have long been used as connectors between valves, traps, pumps and gauges in evacuating lines.

When the first indications of a rubber shortage appeared, RCA engineers took steps to see that the vital tube-building machines were kept running and that as much rubber as possible would be saved. Trials of flexible plastics and synthetic rubber-like materials were made to develop an alternate. All were discarded as unsuitable except "resistoflex," a semi-plastic made of polyvinyl alcohol.

HALF PRICE SUBSCRIPTIONS . . .

for Men in the U. S. Armed Services

Subscriptions to "RADIO" addressed to men in the U. S. Army, Navy, Marine Corps, or Coast Guard will be accepted at the below-cost rate of $1.50 per year. Subscriptions at this rate (whether ordered by the addressee or a donor) must be accompanied by a remittance in full; addressee's rank and military address must be given. This rate applies wherever domestic U. S. postal service extends, including naval units at sea and overseas army postoffices. No cancellations or refunds.

Simply write rank, name, and military address on a slip of paper and send, accompanied by remittance, to

The Editors of Radio, Stamford, Connecticut

This material was found to be highly resistant to the many solvents that depreciated the rubber and ruled out the other plastics. But it lacked the flexibility that was required. The problem was solved by RCA and Resistoflex Corporation engineers, who cooperated to work out formulas for suitable material.

Under actual operating conditions, the new rubber-less hoses have stood up under months of hard use even though saturated with hot oil and subjected to continuous flexing at the rate of 600 times an hour. An application placed on one machine a year ago has shown no signs of depreciation, although the rubber tubing formerly used had to be replaced about five times annually.

The new material has also been placed in use by RCA to replace rubber parts other than hoses. Washers, spacers, rollers and other machine parts have been made of moulded or laminated "resistoflex" sheet stock, machined to required dimensions, sometimes being frozen solid in liquid air to facilitate working.

In these mechanical applications, the material has consistently outlasted rubber, leading the way to a growing list of applications in the RCA factories. Among them are such mechanical parts as forming rollers, aligning devices, vibration dampeners, shock absorbers, power transmission drives, foot pedal coverings, sand blast lines and shields, metal belt pulley facings and many others. It is called for in ball mill cover gaskets, where it is subjected to solvents that destroyed the gaskets previously made of rubber. A small conveyor belt of the material has proved superior to a belt made of woven wire.

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INDUSTRIAL SALVAGE COMMITTEE

Formation of the American Industries Salvage Committee, representing groups of leading industrial concerns who are working with the Conservation Division of the War Production Board to help speed the collection of vital scrap materials, has been announced by Robert W. Wolcott, Chairman of the group and President of Lukens Steel Company.

Other members of the administrative committee directing the nation-wide $2,000,000 campaign are: Charles R. Hook, President of the American Rolling Mill Company, Vice Chairman; R. S. Wilson, representing Rubber Manufacturers Association; and O. E. Mount, representing Steel Founders' Society of America.

The work of the committee, backing up a broad advertising program, will be two-fold: one, to reach every manufacturing and business firm in the nation to impress upon them the absolute necessity of getting their scrap on the way to the production line; and, two, to get business men cooperating with the local salvage committees of WPB already set up in 12,000 communities.

The activities of the committee will be closely coordinated with the present intensified scrap collection drive of the WPB, according to Mr. Wolcott. In this connection, the committee is underwriting the cost of an extensive national advertising campaign approved by the War Production Board, with a number of major industries underwriting the costs.

The advertising being carried on in newspapers, magazines, farm and trade papers and on the air, focuses the spotlight of public attention upon the need for iron and steel scrap, non-ferrous metals, rags, burlap, rubber, tin cans (in some localities), and waste cooking fats.

Supplementing contacts with industry already established by the Industrial Salvage Division of WPB, the American Industries Salvage Committee will make a direct approach to individual industrial concerns, working through industry chairmen who are now being appointed. Leaders in fifty industries are being asked to serve as chairmen for their respective trades in a broad effort to see that every company appoints a salvage manager with authority not only to clean out production scrap, but also to junk obsolescent equipment and similar material.

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CRYSTAL REPLACEMENTS

Additional permitted uses for quartz crystals has been announced by the Director General for Operations, WPB.

Amendment No. 1 to Order M-146 lifts restrictions for these purposes:

Replacements of defective, cracked or broken radio oscillators and filters and optical parts in instruments directly used for war, public health, welfare or security.

Radio oscillators and filters for use in radio systems owned by foreign governments or for commercial airlines operating in foreign countries.

Under the terms of the order, purchasers of quartz crystals or parts containing them must file a certificate that the use of the crystals will conform to the provisions of the order. This action removes the requirement for a certificate if the purchaser is a U. S. agency or a foreign governmental agency.

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W85A NEW CALL FOR W2X0Y

Call letters of General Electric's frequency modulation station in Schenectady are now W85A instead of W2X0Y, according to an announcement by R. S. Peare, manager of General Electric broadcasting. W2X0Y was an experimental designation. The station will operate on 48.5 megacycles.

The station this month went on a daily schedule from 3:00 to 10:00 P.M. and increased the time of local programs by 86 per cent, and the time given to classical and concert music by 40 per cent.

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SILVER REPLACES SCARCE METALS

Just as Pizarro, conqueror of Peru, once shod his horses with silver in an emergency, General Electric engineers are now using the precious metal instead of tin, copper and other scarce materials in electrical apparatus.

There is at least a little silver now, according to Vice President Harry A. Winne, in almost every motor, generator, transformer or other piece of apparatus made by the company for the war.

"In many cases the use of silver adds to the cost, a consideration secondary to production at the moment," explains Mr. Winne, who is in charge of G-E apparatus design engineering. "In such instances, its use is probably temporary.

"On the other hand, the use of silver in current-carrying contacts and in brazing alloys frequently results in an improvement in quality sufficient to justify the greater cost, and so for these purposes its use will not only continue after the war but probably will increase."

The use of silver is saving huge quantities of tin at General Electric. In 1940, the company used approximately one million pounds of tin. This year, in spite of the fact that production has more than doubled, it is estimated that the amount of tin consumed will remain the same. Thus savings of more than 50 per cent in normal requirements of tin are being effected, in no small measure, by use of increased silver content in alloys.

One of the most extensive substitutions of silver is for tin in soft solder and for copper in brazing alloys, used for connecting conductors—bars or wires—in virtually every type of electrical equipment manufactured by the company.

Silver is replacing tin in soft solders, alloys which require comparatively low temperatures in joining metals. In the past, these alloys have had a relatively high tin content, ranging from almost pure tin to a very common composition of 40 per cent tin and 60 per cent lead. Today, however, solders in wide use range from 20 per cent tin, one per cent silver and 79 per cent lead, to 97.50 per cent lead and 2.50 per cent silver.

Substitutions of silver for copper are being made in brazing alloys, which require high temperatures for joining metals. One type of brazing alloy, widely used before the war, was composed mainly of copper, the remainder being silver and phosphorus. Now alloys with copper content as low as 16 per cent are in general use. A typical alloy consists of 50 per cent silver, 16 per cent zinc, 18 per cent cadmium and only 16 per cent copper.

Aside from saving tin by reducing the tin content of solders, brazing technique is now widely replacing soft soldering to conserve tin and copper. Brazing also, chiefly because of the silver present, is often quicker, more reliable and economical. Soft soldering requires a separate operation—pretinning of points of contact—not necessary in brazing. Some types of soft soldering also utilize a clip, or over-all metal band, in binding two bars together, which can be eliminated in brazing. In general a soft soldered bond is less strong than a brazed connection.

A fourth advantage of brazing has been developed from experiments in adapting joints to the process; such redesigning of joints has resulted in simplification and hence in further savings in the amount of copper used. Such economies as these in materials, costs and engineering, almost certainly will be carried over into post-war manufacturing practice.

Although silver is not under priority regulation, some suppliers are finding it necessary to ration the quantities they are able to deliver to their customers. The Treasury has much silver and the War Production Board is understood to be studying the possibility of obtaining supplies from this source.

It has been reported that the WPB already has effected a deal whereby silver has been loaned "for the duration" to an aluminum concern for busbars essential to production. The situation is complicated by legislation which requires the government to buy domestic silver at 71.11 cents an ounce, more than double the usual world price of approximately 35 cents. Also, the sale of Treasury stocks is forbidden.

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CALL FOR RADIO MEN

The Lexington Signal Depot, U.S. Army Signal Corps, is now engaged in a training program in which several thousand civilian employees, radio mechanics and radio engineers, will be trained in the maintenance of the radio equipment used by the Signal Corps. This Depot is now in urgent need of a large number of competent instructors. These positions are under Civil Service but a competitive examination is not

BONDS BUY BOMBS

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given to the applicants, the eligibility of the applicant being determined by his training and experience. The appointments are of the War Department Indefinite type which means that the employee does not obtain a permanent Civil Service status, nor has he any right to expect that this work will be continued after the war. Only persons in a deferred draft classification are considered for employment. Women are eligible for these positions as well as men.

The duties, qualifications and salaries for the various instructor grades are as follows:

JUNIOR INSTRUCTOR—P-1, $2,000.00 per year; duties include instruction, under the supervision of an instructor of rank of assistant or higher, of from 15 to 25 men on one particular type of radio equipment of a comparatively simple nature; the grading of quizzes on this unit; the placing of trouble in the equipment; and supervision of its repair and adjustment.

All applicants for the position of Junior Instructor must show that they have been graduated from a standard 4 year high school course, or have completed at least 14 units of high school study. In addition they must possess the qualifications listed under either (d), (e), (f), or (g).

(d) The successful completion of a 4 year course in a college or university of recognized standing leading to a degree in engineering, or physics, which has included a course in radio engineering or vacuum tubes and circuit theory.

(e) The successful completion of a 4 year course in a college or university of recognized standing leading to a degree in engineering, or physics, plus one of the following:
1. The successful completion of an E.S.M.D.T. course in any branch of radio work.
2. One or more year's experience as a radio operator.
3. One year's experience in the teaching of physics or engineering.
4. One year's study of electrical engineering or physics in a recognized graduate school.

(f) A total of four or more years' experience in radio work; this experience may include work as radio repairman, radio engineer, radio operator, etc., plus either three months' or more experience teaching radio, or one year or more as a supervisor of radio repairmen, radio engineers, radio operators, etc.

(g) The successful completion of the course of study in a RADAR SCHOOL recognized by the U. S. Army or U. S. Navy.

ASSISTANT INSTRUCTOR—P-2, $2,600.00 per year; duties include (under the supervision of an instructor of the rank of associate or higher):

(a) Instruction of 15 men or more on various advanced types of radio equipment.

(b) The writing and grading of quizzes on this equipment.

(c) The placing of trouble, and the supervision of the repair and adjustment of this equipment.

(d) The supervision of the work of one or more student or junior instructors.

In addition to the requirements for Junior Instructor, stated above, applicants for the position of assistant Instructor must show that they possess one of the qualifications listed below, subject to the restrictions shown:

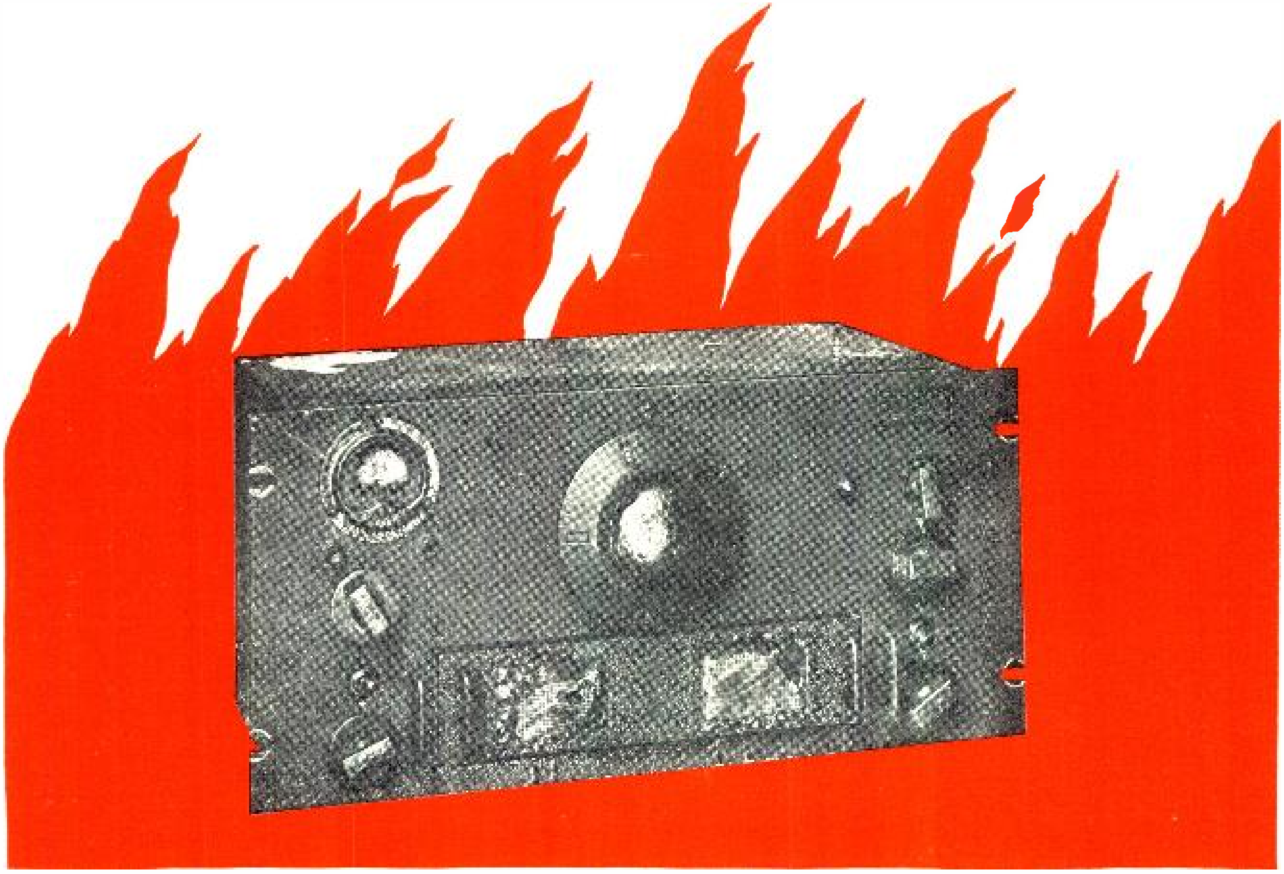
1. One or more year's graduate study in the field of radio, plus one or more year's teaching experience.
2. Six months' experience teaching radio.

Applicants for positions of all grades must have reached their 20th birthday but must not have passed their 56th birthday.

For the Assistant Instructor grade, the additional experience must have been of such a nature as to demonstrate that the applicant is qualified to supervise the work of instructors of lower grades.

There are also a number of positions of the Associate Instructor—Radio Electrical, P-3, $3,200.00 per year and the Instructor—Radio Electrical, P-4, $3,800.00 per year grades to be filled. Due to the rapid growth of the training program the opportunities for promotions are excellent.

All communications should be addressed to: Captain W. Gayle Starnes, O.I.C., Civilian Training, Lexington Signal Depot, Lexington, Kentucky.



HELL—AND HIGH WATER

The HRO Receiver shown above was one of four in a building severely damaged by fire. The heat was so intense that it blistered paint and distorted Bakelite parts on all four receivers. Without any repairs, two of the four receivers tested normal in all respects except for some noise when tuning. This defect was eliminated by wiping soot from the rotor contacts. The remaining two HRO's required only minor resistor replacements, after which they likewise showed superb performance.

Two HRO's being loaded on a ship were dropped into the salt water of the harbor when a loading sling broke. They were recovered, and returned to us. One, without any repair or adjustment, showed performance that approached normal, except on one coil range which had an open circuit. The second receiver gave satisfactory performance on one coil range, after that coil had been baked in an oven. In spite of the delays in shipment to us, salt water still dripped from the coils when the equipment was received at our plant. ¶ Incidentally, we do not recommend this type of treatment.

NATIONAL COMPANY — MALDEN, MASS., U.S.A.

It's a **Buyer's Market** *at*

HYTRON

IF YOU PLAN YOUR WAR PRODUCTION WELL IN ADVANCE

IF YOU ORDER NOW THE TUBES YOU WILL NEED THIS WINTER, NEXT YEAR

FROM M-Day on, the Government has made long-range plans which at first may have seemed to deal with grandiose and astronomical quantities. Men in a position to know, however, realized that only such careful thinking and acting ahead could win the greatest industrial offensive of all time. In *your* production campaign, too, let logistics precede strategy and tactics. Make sure that you will have the necessary tubes to meet your delivery schedules. If you will look to the future, Hytron will do its bit toward turning a seller's market into a buyer's market for you.

HYTRON
TRADEMARK REG.

Immediate Production Already Scheduled

Already the procurement divisions of far-sighted manufacturers and government agencies, after conferring with Hytron engineers, have contracted for present production capacity at Hytron. Their tube needs have been fitted into a production plan which will give them the tubes they want, when they want them. Whenever possible, small orders for standard Hytron types will be filled on short notice. Please keep in mind, however, the difficulties of procuring materials, of diverting production facilities for small runs, and of training new workers.

Facilities Available This Autumn

Place your orders for late Fall delivery NOW, to take full advantage of the production facilities to be available later. Give Hytron a chance to add to its schedule now the tubes you will need in large quantities at the end of '42, at the beginning of '43. Let Hytron help you to avoid those echoes of a seller's market: "Sorry, but—. With regret—. Unfortunately,—," Quadrupled War production space, fast being converted into a beehive of activity, is Hytron's assurance that your anticipatory orders will be shipped on schedule.

REMEMBER — *With your cooperation, it's a Buyer's Market at Hytron.*

HYTRON CORP., Salem and Newburyport, Mass.

. . . Manufacturers of Radio Tubes Since 1921 . . .