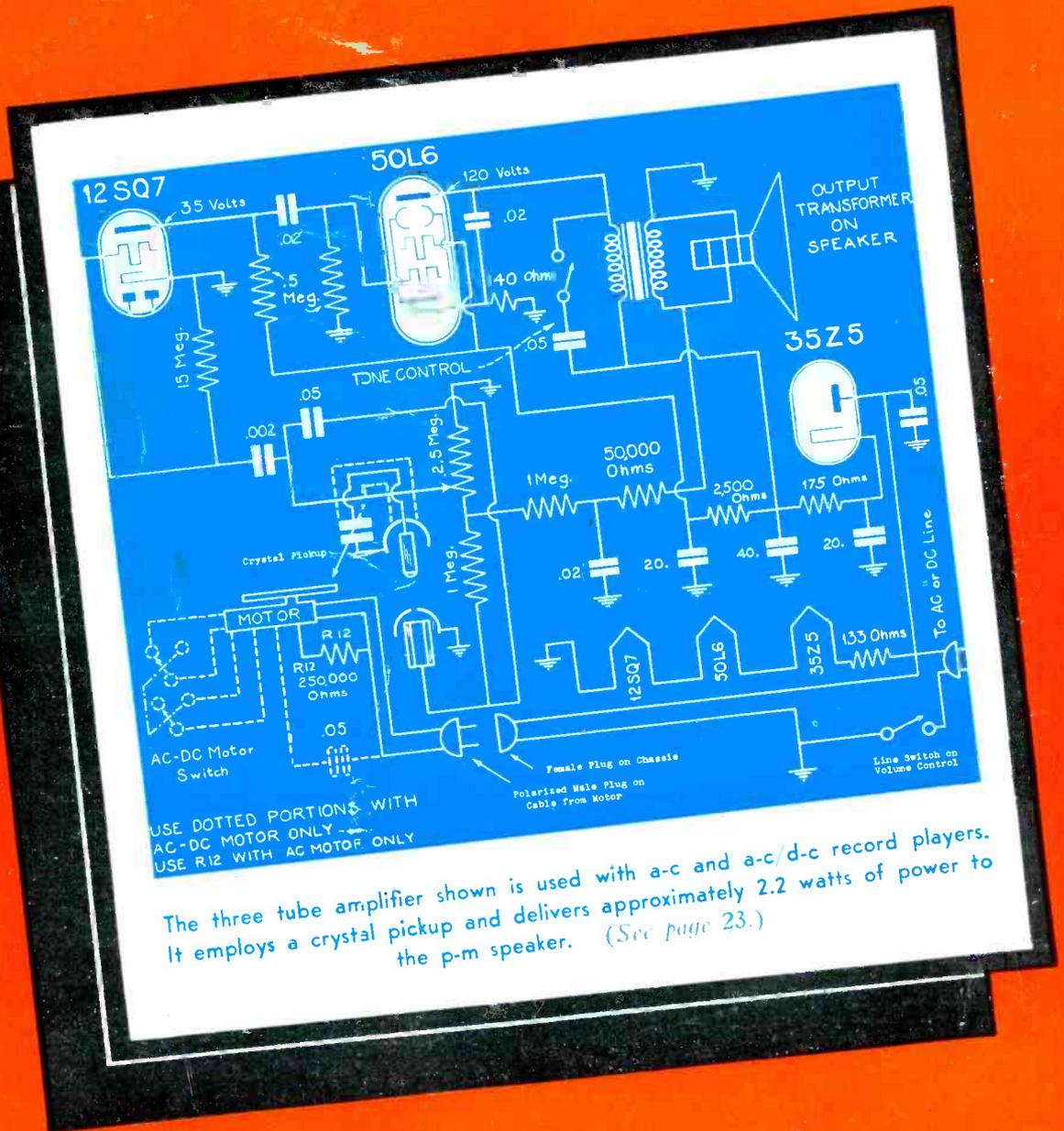


SERVICE



The three tube amplifier shown is used with a-c and a-c/d-c record players. It employs a crystal pickup and delivers approximately 2.2 watts of power to the p-m speaker. (See page 23.)

FEBRUARY
1942



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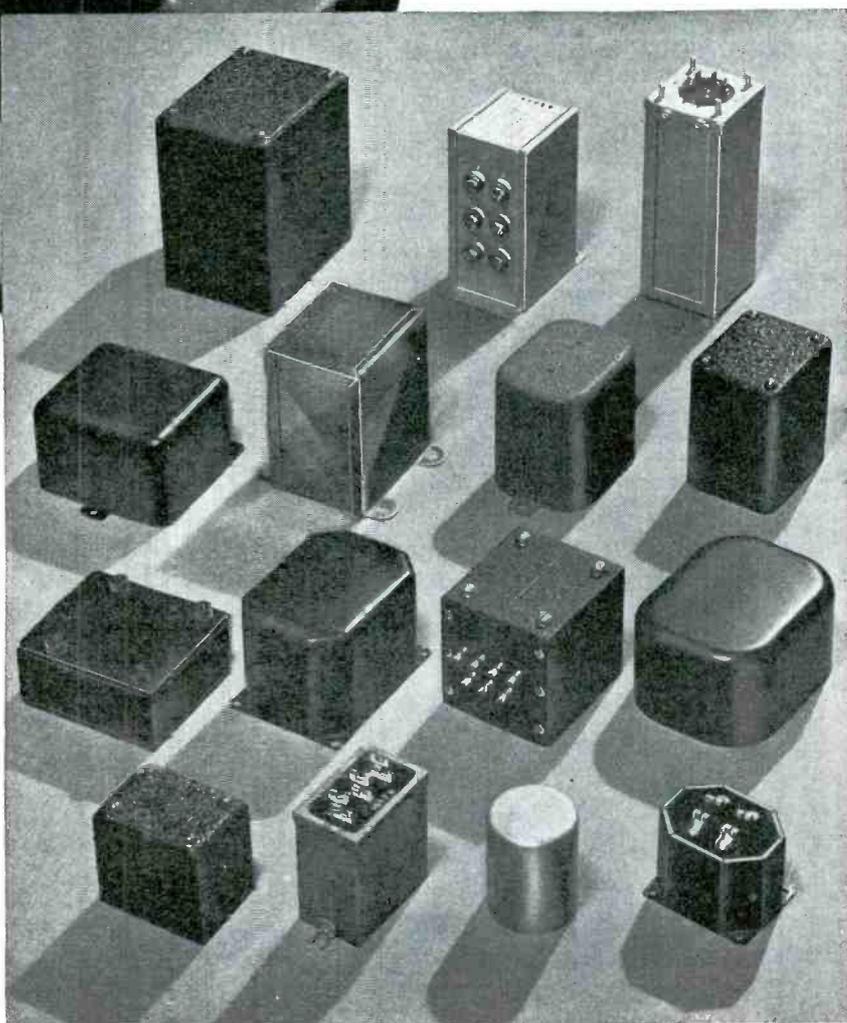
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In addition to the electrical characteristics, many customers' application problems are related to the physical appearance and dimensions of their transformer components. Fortunately, the UTC sheet metal division supplies practically all the housings, laminations, brackets, and other devices which control the mechanical characteristics of UTC units. Instead of restricting designs to specific cases, the sheet metal division can run off a special case to more closely fit the final transformer dimensions, or to effect the particular mounting provisions required by the application.

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A Monthly Digest of Radio and Allied Maintenance
Reg. U. S. Patent Office

IN THE past when we used the word "better" in making comparisons it generally indicated an improvement in quality. With today's war time conditions this may or may not be the case. The word "better" used in any connection now should place special emphasis on improvement from the standpoint of utility and dependability. This must be the case in everything we make or do.

While making replacements and repairs in the course of your everyday work you should bend your full efforts toward getting the utmost utility and dependability from the time and materials which you spend. This is your responsibility toward our victory effort.

Let us make ourselves clear. We do not mean that quality is to be a thing of the past. In all cases, basic quality of product will be a definite necessity to assure dependable reception and long life. We do feel, however, that if a substantial saving of time and material can be accomplished at a slight sacrifice of fidelity or by the elimination of frills and gadgets, then the saving is imperative.

BY THE time this column is published the War Production Board will have issued an order designed to suspend radio production on or about April 22, in accordance with the WPB program for conversion of the radio industry to a war production basis. Although appeals from the suspension order will be considered, these will be considered only in connection with expediting and facilitating war production. Inventories will enter into the consideration as a secondary factor.

While preliminary advices from the War Production Board indicate that there are no prospects whatever of any further allocations of aluminum, nickel and other vital metals for new set production, such allocations are contemplated for replacement parts.

In connection with the suspension order we quote from the New York Herald Tribune of February 14: "When manufacture of radio sets ceases, the radio Service Man will begin a period of prosperity. . . . These men face the prospect of more than 50,000,000 sets getting out of order at one time or another. . . ." 'Nuf said!

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RESISTORS and CONTROLS

INTERNATIONAL RESISTANCE COMPANY, 401 North Broad Street, Philadelphia, Pa.

SERVICE

A Monthly Digest of Radio
and Allied Maintenance

ROBERT G. HERZOG
EDITOR

INDUSTRIAL ELECTRONICS

By ALFRED A. GHIRARDI

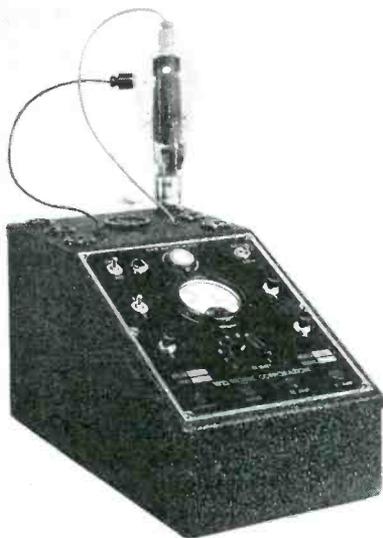
IN THE preceding articles of this series brief mention was made of the use of electronic equipment to control welding operations in which conditions make it necessary to limit the application of welding current to a tiny fraction of one second. Because such equipment illustrates principles and techniques employed extensively in various types of industrial electronic equipment, one of these devices is described here in some detail.

Split-Second Weld Timer

In the manufacture of radio tubes the high current required to make a satisfactory weld can not be applied for any appreciable length of time without burning up or otherwise damaging such small parts as grids, filaments, etc., or at least causing them to stick to the welding electrode. The welding timer to be discussed is one used by tube and lamp manufacturers and is shown removed from its case in Fig. 1. Its schematic circuit appears in Fig. 2.

The tube VT1 is a type C6J grid-controlled rectifier manufactured by Electronics, Inc., and is capable of delivering up to 77 amps (peak) in continuously recurring pulses, up to 12.8 amps d-c continuously for periods up to 3 seconds, and up to 6.4 amps d-c for unlimited periods. Maximum a-c short-circuit current rating is 770 amps for a period not exceeding 0.1 second. It is for use in circuits from 110 to 440 volts, with peak forward voltages to 750 and peak inverse voltages to 1250. Its filament draws 18 amperes at 2.5 volts. With peak forward voltage applied to the anode, a grid voltage of minus approximately 3.5 will prevent firing. As in the case of other thyatron type tubes described last month, the grid loses control completely when the tube fires and can again gain control only when the anode voltage is cut off or reduced substantially to zero.

In the circuit of Fig. 2, this tube functions as a heavy-duty relay through which the welding current flows directly from the 220-volt a-c line. This 220-



Weltronic Corporation has developed a special tube checker which not only provides conventional quality tests but gives fairly extensive analysis of various operating characteristics of thyratrons, gas and vacuum rectifiers and high-vacuum control tubes. Indications are provided on a meter and on a 1-in. cathode-ray tube.

Fig. 1. Automatic control unit through which applications of welding current are limited to single impulses of less than 1/120 second. The tube in the foreground is the type C6J discussed in the text.



volt supply is applied to the tube continuously but current cannot flow while switches A and B of the starting relay (actuated by a foot switch at the welder) are closed, for the reason that voltage from this same source, but reduced to 55 volts by the step-down transformers, is applied to the grid of the tube 180 degrees out of phase with the anode voltage. Thus the tube cannot conduct when the anode voltage is positive because the voltage applied to the grid is then negative; and when the anode voltage is negative or only slightly positive there can be no conduction even though the grid is highly positive at that point in the cycle.

This is made clear from the curves E_p , E_{g1} and E_{gc} of Fig. 3. Here the curve E_{gc} represents the critical grid voltage which just barely will prevent the tube from firing for the corresponding value of anode voltage. In other words, for the tube to fire at any point in this positive half-cycle, it is necessary for the grid to be more positive than the value indicated by E_{cg} at that point. With the anode and grid voltages exactly out of phase, it is apparent that firing cannot occur.

On the other hand, suppose that the phase relationship were altered, in effect moving E_{g1} along the horizontal axis to E_{g2} . The applied grid voltage then rises above the critical value during a few degrees near the beginning of the half-cycle, as indicated by A and B. To the left of point A the anode voltage is too low to fire.

When the switch at the welder is depressed, the starting relay (Fig. 2) opens switches A and B. In the case of A, this places R_1 in the circuit, and this resistor, in conjunction with condenser C_1 , shifts the phase relationship between the grid and anode sufficiently so that at the beginning of the next positive half-cycle of anode voltage the tube will fire. Should the switch by coincidence be depressed at an instant between the points AB of Fig. 3, the tube will fire immediately and current will flow during the remainder of that half-cycle. If de-

pressed during the time interval between B and C, or between C and the point on the next positive half cycle corresponding to A, the tube will not fire until this point is reached. Thus the tube can fire only during the first few degrees of the positive anode cycle. Once it fires, current flows until the end of that half cycle. It is therefore apparent that the current flow will always be of the same duration—just slightly less than one-half cycle—regardless of when (on the time-voltage characteristic) the welder switch is depressed.

Nor can the current again flow until the switch has again been depressed for another weld. The reason is that when the tube fires the condenser C_2 becomes charged by virtue of the fact that one side is connected (for that instant) to the positive side of the 220-volt supply (the drop across VT1 is negligible), while the other side returns to the negative side of the supply line through the rectifier, VT2. When the welder current ceases at the end of the half-cycle, VT2 prevents discharge of the condenser and its maintained charge therefore places a high negative bias on the grid of VT1, thereby preventing further firing even though the switch at the welder may be held down for an extended period of time.

Once this switch is released, closing the relay contacts A and B, the condenser discharges through contact B and the resistor R_3 . At the same time, the phase-shifting network R_1 , C_1 is made inoperative because contact A shorts out R_1 . The initial 180-degree out-of-phase relationship is thus reestablished and the tube cannot again fire

until the control switch is depressed by the operator for the next weld.

It is necessary that the anode and grid supply voltages of this set-up be drawn from the same a-c line to insure maintenance of the desired phase relationship. In this particular instance, two transformers (T_1 and T_2) are employed to step the 220-volt welder supply line down to 55 volts. A single 220-55 volt transformer would serve as well, the two actually being used as a matter of manufacturing convenience.

Interval Timer

The emphasis on gaseous tubes of the thyratron type thus far in these articles may tend to create the mistaken impression that, more or less, all industrial electronic installations make use of them. Such is far from the case, however. There are innumerable industrial equipments employing little, if anything, with which every Service Man is not already familiar.

An interesting example of such devices is an interval timer employed in the research laboratories of the Callite

can be subjected before breakdown. To serve the purpose, each "on" period must be sufficiently long to bring all components of the lamps up to normal operating temperature; the "off" period long enough to provide adequate cooling. A 7½-minute cycle has been adopted—6 minutes "on" and 1½ minutes "off". The function of the electronic timer is to apply and cut off power at these intervals, and do it automatically day after day and week after week. The circuit of this device is shown in Fig. 4.

The actual switching is performed by a relay operated by the plate circuit of an ordinary radio tube, a type 43. The timing is automatically controlled by charging and discharging a condenser through resistors in the grid circuit of this tube. This varies the bias sufficiently to operate the relay at the required intervals.

A 25Z5 voltage-doubler is employed as power supply for the 43 tube. On a line voltage of 120, the device provides an output of approximately 300 volts across the pair of doubler condensers, with 150 volts across each, as shown.

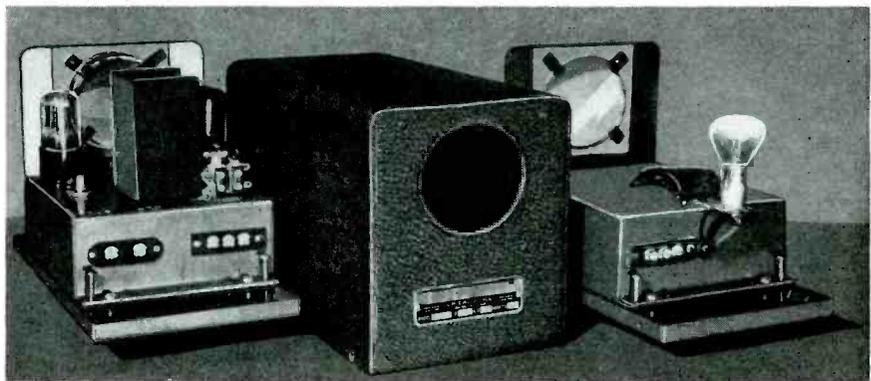
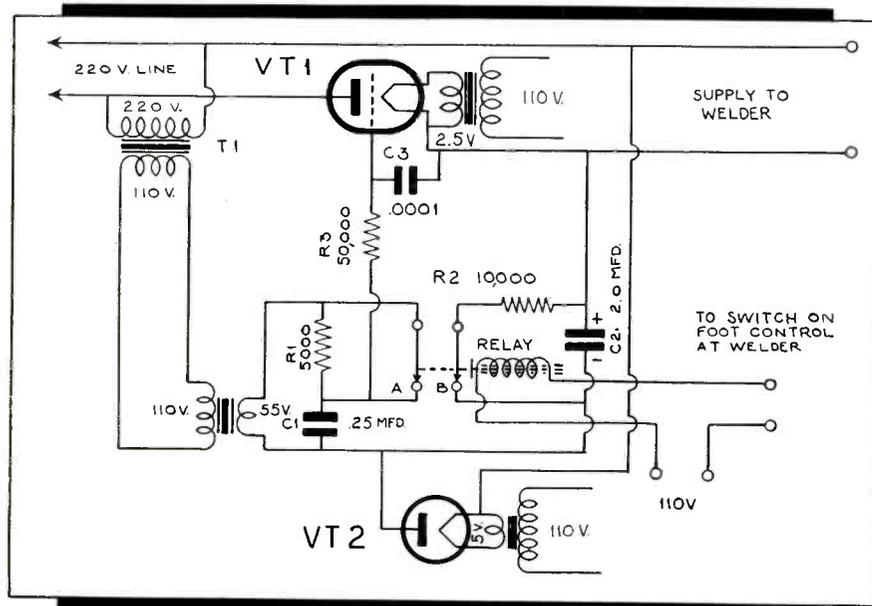


Fig. 2. Circuit of the automatic control unit shown in Fig. 1. The device is capable of delivering instantaneous current of several hundred amperes to the welder for the split second. It is manufactured by Callite Tungsten Corporation.

Tungsten Corporation for determining the number on on-off cycles to which experimental neon and fluorescent lamps

Worner Products Corporation Anti-Sabotage equipment. "Black" light source (right) provides invisible light beam for the photoelectric relay at left. Interruption of beam produces audible or visible alarm.



The 43 is so connected that its cathode is about 150 volts and plate plus 300 volts, in respect to the low side of the supply. Thus the grid can, for control purposes, be made considerably negative in respect to cathode.

The relay is normally in position 2, in which power to the load is off and the 43 grid is biased only by the value across the cathode resistor. As current flow is established, it exceeds the amount (10 ma) required to operate the relay with the result that it assumes position 1, applying power to the load and connecting the grid condenser C_1 across 150 volts through the 100 meg of R_1 . This causes C_1 to charge slowly, gradually increasing the bias applied to the grid of the 43 and accordingly reducing the plate current. In 6 minutes, C_1

charges to a value which reduces the plate current to 5.5 ma., at which value the relay drops to position 2, disconnecting the load.

In this position, C_1 discharges slowly through 20 meg (R_2) thus gradually reducing the negative bias on the grid with the result that at the end of $1\frac{1}{2}$ minutes plate current is again sufficiently high to throw the relay to position 1, initiating another cycle of operation.

The voltage regulator circuit through which C_1 draws its charging voltage represents an interesting application of standard 2-watt neon glow lamps. If the resistors included in the bases of such lamps are removed and a suitable external resistor is then connected in series with the lamps, the result is a

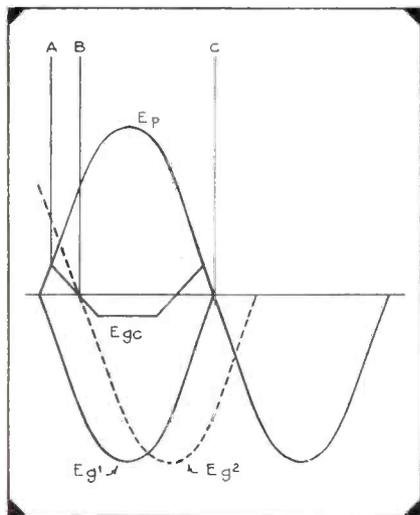
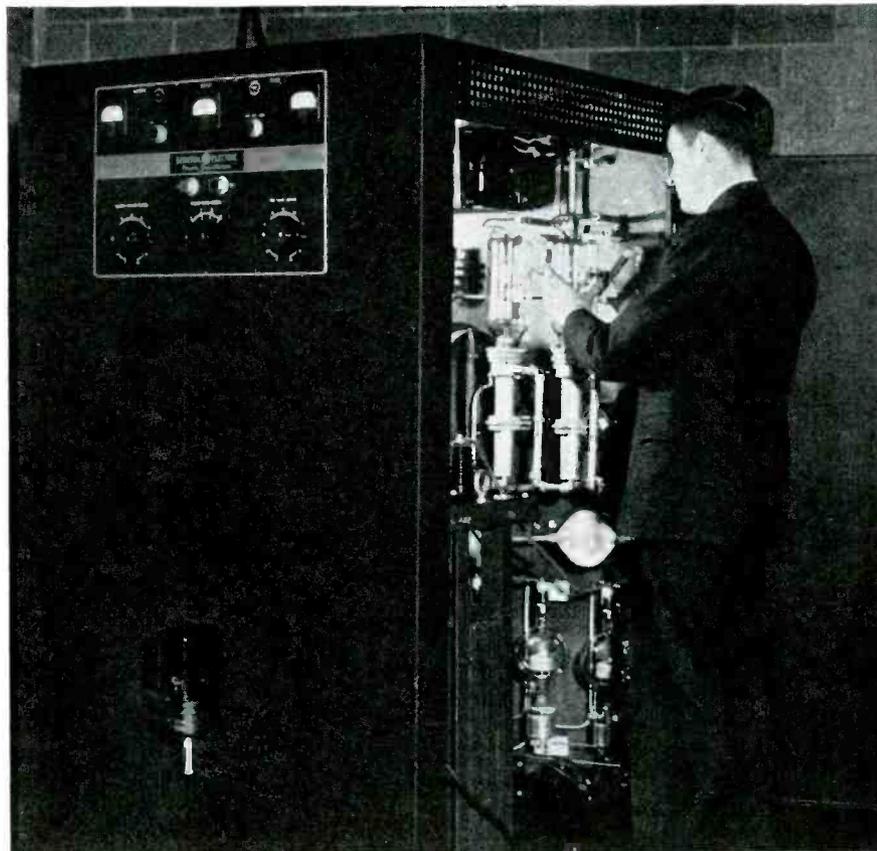


Fig. 3. The C6J tube can fire only during the first few degrees of the positive anode cycle. Once it fires current flows until the end of that cycle.

voltage divider in which the voltage across the lamps remains substantially constant despite wide variations in the current drawn by a load connected across them. They function in a manner similar to tubes of the VR series and have the following approximate ratings: starting voltage—75; operating current—4 to 20 ma.; operating voltage—65; external series resistor must be such as to limit current through the lamp to 20 ma. Glow lamps are also available without internal resistors. These are the most practical for this service and are supplied with small bayonet bases to distinguish them from the type with the internal resistors (which have standard screw bases).

The purpose for which this device is employed does not call for extreme precision of timing, therefore all components are ordinary radio parts, except that C_1 , C_2 and C_3 are paper capacitors rather than electrolytics. Precise regulation of all supply voltages, the use of high-grade capacitors (especially for C_1) and specially treated resistors help to



provide higher accuracy and dependability.

A mechanical contrivance could undoubtedly be designed to accomplish this same purpose, although this would be somewhat complicated and far more expensive than this electronic device, would be subject to wear, and would require more maintenance attention. Furthermore, should it be desired to change the timing cycle to meet the requirements of different types of lamps under test, it would only involve minor changes in the C_1 , R_1 , R_2 circuit of this electronic timer, whereas with a mechanical control unit, the required changes would be major ones and might even necessitate replacement of the entire unit.

Phototube Devices

Phototubes are employed in many industrial applications for an almost unbelievably wide variety of purposes. Electric signs or street lights are turned on automatically when waning daylight, as registered on a phototube, falls below a predetermined level; and are usually turned off again by the same phototube-actuated devices at daybreak. Colors are compared; an alarm is given when chimneys smoke excessively; labels or wrappings in mechanically packaged products are automatically lined up and registered; light values are measured; the transparency or turbidity of materials and fluids are measured; buildings and properties are protected from theft or sabotage by beams of light; objects

are counted or sorted by sizes and shapes—to cite just a few of the applications in which phototubes actuate measuring or control mechanisms as a result of variations in direct or reflected light. Normally the output of a phototube is not in itself sufficient to operate switches, relays or other mechanisms because the maximum anode current available even under extreme values of illumination seldom exceeds 20 microamperes. It is therefore the universal practice to employ some form of amplifier to build up the phototube impulses. Where a simple off-on operation is to be performed, such as in actuating a power relay, for instance, or in stopping or starting appreciable current flow to any other device, it is common practice to employ gas tubes of the thyratron type for this amplifying purpose. These tubes are, in effect, highly sensitive electronic relays by means of which the tiny phototube outputs applied to their grids enable them to control very much larger values of current in their anode circuits.

In Fig. 5 is shown a fundamental phototube circuit in which a thyratron

Using ordinary plywood manufacturing processes it takes approximately 8 hours to set the glue between the layers. By placing the plywood sheets (in stacks up to 14 in. thick) between great electrodes charged by this 300 kw, 1,500 kc G. E. transmitter, the glue sets in 5 or 10 minutes. Quick drying is the result of heat induced in the plywood itself by the r-f currents.

In Fig. 5 is shown a fundamental phototube circuit in which a thyratron

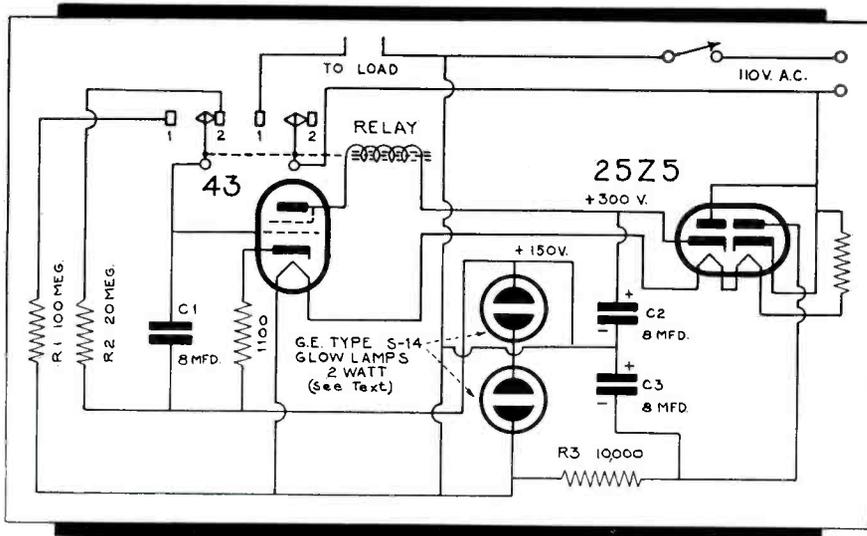


Fig. 4. The circuit shown is that of an interval timer employed to determine the number of off-on cycles to which certain neon and fluorescent tubes can be subjected before breakdown.

or relay tube is employed for the purpose of energizing a power relay when the light acting on the phototube exceeds a certain predetermined level. This device functions directly from the a-c line, and operates only on the half cycles during which the upper side of the line is positive. With no light applied to the phototube, the grid of the 2051 thyatron is maintained negative in respect to its cathode by the potential drop between points A and B of the voltage divider network. With light applied to the phototube, however, the photoelectric current flow through R_4 tends to apply a positive bias on the grid of the relay tube, thus partially offsetting the existing negative bias. As the light is increased a point is reached where the drop across R_4 due to photoelectric current flow is sufficient to cause the thyatron tube to fire. The light value at which this occurs is determined by the adjustment of the potentiometer R_3 .

Once the thyatron tube fires, it will continue to be conductive during the balance of that half cycle, and during succeeding alternate half cycles so long as the light remains above the triggering level. These half-cycle impulses will excite the relay in the anode circuit of the 2051, and thereby operate the relay contacts. The capacitor (C) across the relay winding may be necessary to prevent chattering of the contacts due to the pulsating excitation impulses.

Fig. 6 shows a similar circuit but one in which the phototube is so connected that the controlled relay will receive excitation only when the light falls below a predetermined value.

Here the grid of the 2051 is normally biased positive (during half cycles when the upper side of the line is positive) in

respect to its cathode by virtue of the voltage distribution along the divider R_1 , R_2 and R_3 . At least this is the case when no light falls on the phototube (and its resistance is therefore substantially infinite). Under these conditions the 2051 will fire during each half cycle when its anode is positive and the relay

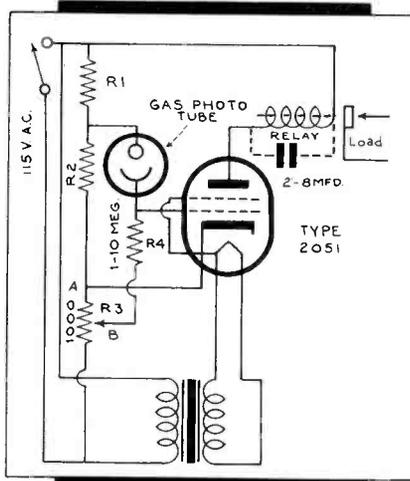


Fig. 5. The photoelectric tube circuit shown will operate a relay when the illumination exceeds a predetermined value. This value is adjusted by means of the resistor R_3 .

will therefore be energized. When light falls on the phototube, however, the photoelectric current flow causes a voltage drop across R_4 . The direction of this current flow is such that the grid of the 2051 becomes more negative in respect to the slider end of R_4 , and therefore less positive, or even negative, in respect to the cathode of the 2051.

Under the influence of appreciable light values, the voltage applied to the grid will prevent the 2051 from firing. As the light decreases a point is reached, determined by the adjustment of the slider of R_3 , where the tube will fire.

The circuits of Fig. 5 and 6 are fundamental ones which provide wide flexibility of application. This flexibility is

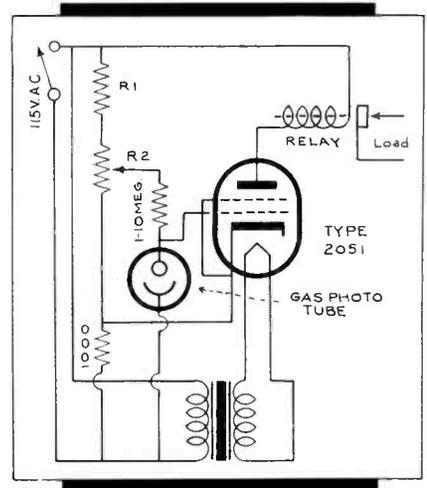
indicated by the fact that either one can be employed to either apply power to the load or cut off the power when the illumination on the phototube exceeds any predetermined value, or when it falls below this value. Thus the circuit of Fig. 5 will not only excite the relay when illumination exceeds the value for which R_3 is adjusted, but will drop out the relay when light falls below this value. The functioning of the circuit of Fig. 6 is just the reverse.

The mechanical relay may be one which opens the controlled circuit when current flows through its coil, or one which closes the load circuit when its coil is energized. Or it may be one which closes one or more circuits when energized and which opens these and closes other circuits when deenergized. Thus there is almost no limit to the functions that can be controlled by these two simple circuits. Nor is it by any means essential that a mechanical relay be used at all. The current flowing in the anode circuit of the thyatron can in many cases be applied directly to the circuit to be controlled. In the split-second welder discussed earlier, for instance, this is done. In that instance the thyatron tube was not actuated by a phototube but the principle remains the same.

In most applications of equipment utilizing a phototube-controlled thyatron the power is obtained directly from the a-c lines without resorting to any form of rectification (other than that provided by the fact that both the thyatron and the phototube are themselves fundamentally rectifiers) or filtering. Even a transformer may be necessary only where the use of a phototube of the vacuum type may require higher anode voltage than that supplied by the line, or where the voltage applied to the con-

(Continued on page 28)

Fig. 6. The photoelectric tube circuit will operate a relay when the illumination falls below a certain predetermined value. This device usually is used in conjunction with a light source.



SOLVING SHORTAGE PROBLEMS In I-F Circuits

By ROBERT G. HERZOG

EDITOR

FOR THE past few months we have been discussing the replacement of defective components in superheterodyne receivers with parts values other than those specified by the manufacturer's service notes, in the advent that duplicate values are not obtainable. We have progressed through the receiver circuit, taking up in turn the r-f input, the interstage circuit and the oscillator and mixer circuit. This month's article covers the replacement problems encountered in the i-f circuit. As part of the information presented we will take up the question of images and image interference. Also mentioned is the relation of the image frequency to the intermediate frequency and methods used commercially to overcome image interference.

Images

As mentioned previously, in superheterodyne receivers the incoming station signal is mixed with a local signal to produce a new signal called the i-f. The local oscillator, in receivers made in the U. S., is usually generating a frequency equal to the *sum* of the incoming station frequency and the intermediate frequency. Thus, when the signal from the desired station is 600 kc, and the receiver dial is tuned to that station, the local oscillator in a receiver whose i-f is 455 kc, will be generat-

ing a frequency of 1055 kc. The beat produced by the difference between the local oscillator signal and the incoming station signal (1055-600 kc) produces a new signal equal to the i-f (455 kc) which is passed and amplified by the i-f stage.

Let us consider for a moment a similar receiver whose i-f is 175 kc. In this receiver the oscillator would be generating a frequency of 775 kc when the receiver is tuned to a 600 kc station (600+175 kc=775 kc).

With this latter receiver tuned to 600 kc, and the oscillator generating a signal of 775 kc, what would happen if a station signal with a frequency of 950 kc were present on the grid of the mixer tube? Such a signal beating with the 775 kc local oscillator would also produce a frequency that would pass through the i-f amplifier stage (950-775 kc=175 kc). It is obvious that if such a signal were permitted to get through to the mixer grid, it, too, would be amplified in the i-f stage and would

be present with the reproduced signal in the receiver's loudspeaker.

A similar condition would exist in the previous receiver with the 455-kc i-f, for a 1510-kc signal. As mentioned above, the oscillator is generating a signal at 1055 kc when the receiver is tuned to 600 kc. The 1510-kc station signal beating with the 1055-kc oscillator signal produces a 455-kc signal (1510-1055=455 kc) which would be passed by the receiver's i-f stage.

Interference of this type, shown for the 600-kc dial position, can exist at any other point on the receiver dial. Because of the peculiar design of the superheterodyne circuit a second signal could be passed by the receiver's i-f for any position to which the dial is tuned. As can be seen from the examples given above, the frequency of this second signal always differs from the desired signal by an amount equal to exactly twice the intermediate frequency (2×455+600 kc = 1055 kc and 2×175+600 kc = 950 kc). (See Fig. 1.)

This second frequency is commonly referred to as the *image* of the first, and the interference which it causes is known as *image interference*. Examination of Fig. 1 will show that there is a greater possibility for image interference over a given dial spread when the

Fig. 1. More images are possible over the dial range with a low i-f than with a higher i-f.

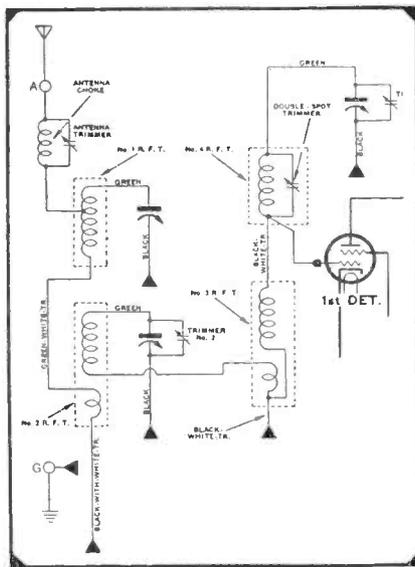
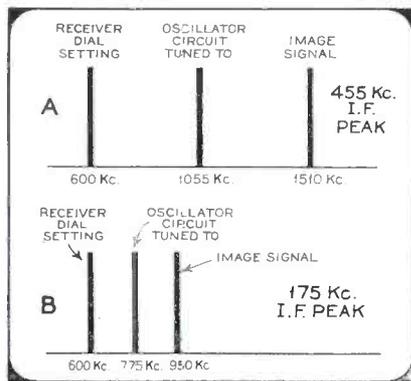
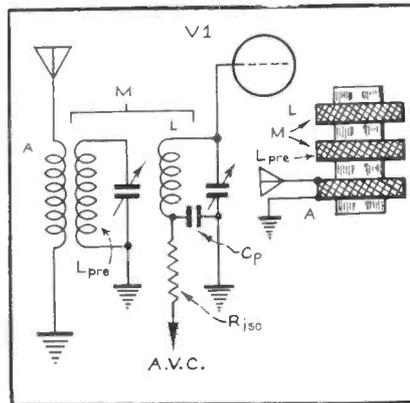


Fig. 3. Atwater Kent Model 72 used a complicated input circuit for preselection.

Fig. 2. Early superheterodyne receivers employed an extra circuit to preselect the desired signal.



i-f is low (175 kc) than when the i-f is high (455 kc).

For this reason the intermediate frequency chosen, especially in receivers without an r-f stage, must be sufficiently high to spread the images as far as possible from the desired signals. With an i-f of 455 kc or more the image of any given broadcast station frequency will fall above the band.

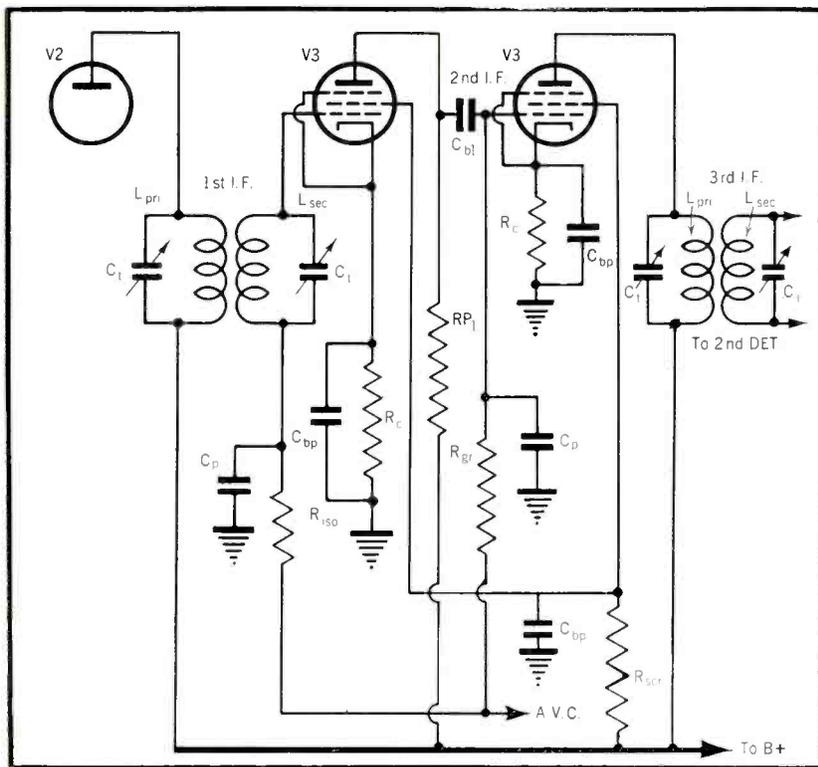
If the image and the desired frequency are not spread across the full length of the band, some efficient means must be employed to keep the image frequency from getting through to the grid of the mixer stage.

The large majority of receivers manufactured within the past few years employ an intermediate frequency of 455 kc. In fact, with the exception of a few auto-radio receivers that employ 175 kc or 262 kc i-f, the 455-kc i-f has become practically universal.

Other things being equal, the lower the frequency chosen for the i-f the higher the gain in these stages. This increase in gain, too, is independent of the frequency range of the receiver, since the r-f tuning does not change the i-f. Because of these advantages early superheterodyne receivers were designed with intermediate frequencies of 175 kc, and sometimes as low as 130 kc or even 110 kc. Since there is ample possibility for image interference with such ifs, elaborate means were employed to suppress the image signal before it could reach the mixer grid (See Fig. 3).

Preselection

One of the simplest methods used to



improve the selectivity of the early superheterodyne is shown in Fig. 2. The type of coil used is shown to the right of the circuit. A lower coil (A) is connected to the antenna and ground circuits. The second (L_{pre}) and third (L) coils are the same and each is connected to a separate section of the tuning gang (C_t). The three coils, as can be seen from the illustration, are wound on the same form and are inductively coupled to each other. The first or lower coil is the normal antenna coil and the third is the normal tuning coil connected in the grid circuit of the first detector tube. The middle coil, tuned to the same resonant frequency as the grid coil merely adds selection to the desired signal.

The method was known as preselection and was used extensively during its time. It helped accomplish its purpose of minimizing image interference and improved the general selectivity of the first stage.

Several manufacturers went in for a more elaborate system of signal preselection that employed more than one extra gang section, and a number of additional coils. As a typical example of the extreme in this direction the input circuit of an early Atwater Kent (Model 72) is shown in Fig. 3. The receiver used a four-gang tuning condenser, although no tuned r-f stage was incorporated. Three of the gangs, together with four r-f transformers, housed in separate cans, are employed

Fig. 5. Resistance coupled i-f stages became popular with the advent of the battery portable.

to select the signal for the first detector grid.

The I-F Amplifier

In Fig. 4 there are shown the elements of a single stage i-f amplifier. The i-f transformers usually consist of two coils spaced well apart with individual tuning of each coil. The spacing of the primary and secondary is such that the selectivity of these transformers is better than can be obtained with the transformers coupling the r-f stages of the receiver.

Earlier i-f transformers employed copper vanes or discs between the primary and secondary to increase the effective spacing of the coils without increasing the actual size of the transformer.

Most of the gain and selectivity of a superheterodyne receiver is made up in the i-f amplifier. In fact, most of the smaller, and even some of the larger, superheterodyne sets have dispensed entirely with the tuned-radio-frequency

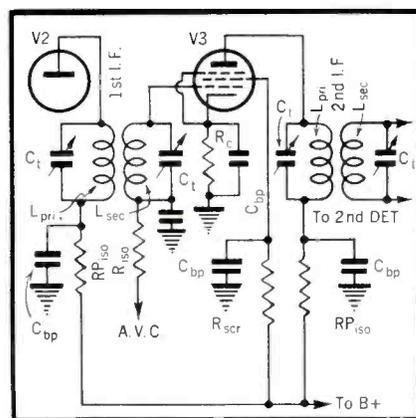


Fig. 4. The typical i-f amplifier stage uses transformer coupling between the tubes.

stage ahead of the first detector and depend upon the gain and selectivity of the i-f amplifier for the receiver's performance.

In other respects the intermediate-frequency amplifier operates exactly like the tuned-radio-frequency amplifier stage explained in the first article of this series¹. The condensers marked C_t are simply adjusted so that the coils marked L_{pri} and L_{sec} tune to or resonate at the intermediate frequency. The condensers C_i are then left in these positions, unless it is evident that retuning or realignment is necessary.

Individual Variations

Figs. 4 to 9 illustrate i-f circuits in present-day radio receivers. The types of tubes employed in these circuits are similar to those employed in the r-f input stages explained in the first article

1. "Solving Shortage Problems in Input R-F Stages," by Robert G. Herzog, SERVICE, November 1941, p. 5.

of this series¹. The same considerations mentioned then apply here as well.

Fig. 4 is a typical single stage i-f amplifier using transformer coupling for both input and output. With the exception of the plate return isolating resistor RP_{iso} and its accompanying condenser C_{bp} , the remaining resistors and condensers are familiar from the previous articles. RP_{iso} is used in such circuits to prevent coupling between the several circuits connected to the same B supply. Where it is employed its omission would generally cause oscilla-

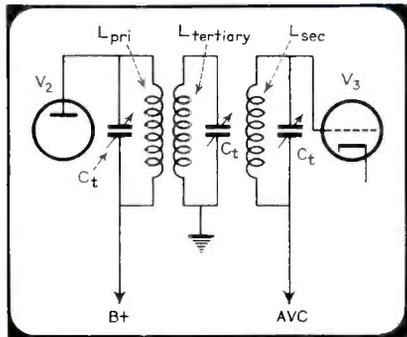


Fig. 6. Triple tuned i-f transformers are used in high-fidelity receivers to obtain broad band-pass characteristics.

tion. Its value varies, in different receivers, from 5,000 to 15,000 ohms. Its value is not at all critical. The condenser which accompanies this resistor is used as a r-f by-pass and need not be larger than 0.01 mfd.

Fig. 5 shows a two-stage i-f amplifier that uses resistance coupling between the stages. The resistance-coupled i-f circuit became popular with the advent of the battery portable as added sensitivity was required to provide adequate performance in rural districts. Such stages give an i-f gain of from ten to fifteen times depending upon the tube used, the circuit's constants and the applied voltages. This gain is realized over the entire range of the receiver. The gain of a similar resistance-coupled circuit used in the r-f, on the other hand, would vary from one end of the band to the other. In spite of the variation in gain, however, the resistance-coupled r-f stage offers an improvement in the signal to noise ratio over that of the resistance-coupled i-f. The values of resistors and condensers used in r-f or i-f stages are the same and were discussed in the second article of this series².

The circuit of a triple-tuned i-f transformer is shown in Fig. 6. Such transformers are employed in high-fidelity receivers where flat-topped tuning characteristics are required.

In midget receivers, where additional gain is sometimes required for proper

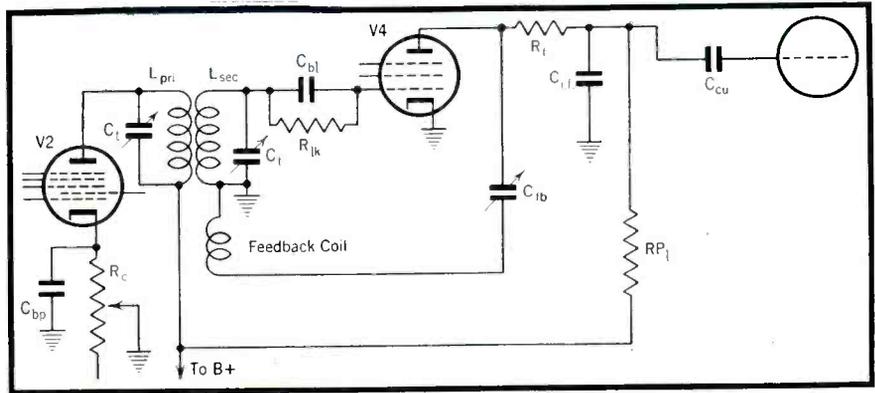


Fig. 8. Regenerative circuits such as the one shown above are popular in midget receivers that couple the converter directly to the second detector.

performance, some form of regeneration is often used. Several popular i-f circuits, that incorporate regeneration, are shown in Figs. 7, 8 and 9.

In Fig. 7 a portion of the i-f signal is fed back to the cathode of the converter tube. The amount of regeneration is controlled in the design of the receiver through the selection of the capacity of the cathode by-pass condenser. This latter condenser is a common impedance in both the i-f transformer primary and the converter-tube cathode circuits. Because of its dual role its value is quite critical. It is generally about 0.01 mfd.

The circuit shown in Fig. 8 was particularly popular in midget receivers in which a single i-f transformer coupled the plate of the converter tube to the second detector circuits. In this circuit an extra feedback winding is wound on the i-f transformer coil. This winding is connected in series with an adjustable condenser to the plate circuit of the second detector tube. A small amount of i-f voltage is built up on this plate by using a resistor (R_f) in series with the plate, ahead of the usual coupling condenser for the first audio grid. Any i-f plate by-pass used across the detector would necessarily be connected after this resistor. The amount of regeneration can be adjusted in the field by means of the series condenser C_{fb} .

The value of the resistor R_f found in different models is from 10,000 to 15,000 ohms. It is not critical. The detector plate load (RP_1) will vary from $\frac{1}{4}$ to 1 meg depending upon the type of tube used and the particular make of the receiver. Grid leaks (R_{1k}) from 3 to 5 megs are found in different models. The feedback condenser (C_{fb}) generally has a capacity range from 50 to 100 mmfd. The cathode resistance R_c in this circuit is the volume control for the receiver (no avc) and has a maximum value of the order of 50,000 ohms.

In Fig. 9 a feedback winding is employed on the i-f transformer and it is connected in series with the screen voltage supply. Any screen by-pass condenser would, of course, be connec-

ted before the voltage is applied to this winding. In this circuit, as in Fig. 7, the amount of regeneration is fixed in the design of the receiver. In this case it depends upon the number of turns of the feedback winding and its proximity to the other windings of the transformer.

At this point it might be well to mention that regeneration incorporated in the i-f amplifier of a superheterodyne receiver remains constant over the tuning range of the set. This is in contrast to r-f regenerative circuits where the amount of regeneration may vary with the tuning.

Repairs

Once again we make mention of the fact that any suggestions concerning the use of alternate values in making replacements will at best produce only a makeshift. Substitutions should be used only in the advent that difficulty is experienced in obtaining the exact value required for a particular repair.

More than one of the changes mentioned will certainly produce noticeable effects in the receivers performance. In every case the exact value prescribed by the set manufacturer's original design should be used if it is at all available. On the other hand, because material shortages have already reached the critical stage, extensive repairs of some components should be attempted before replacements are considered.

As in the case of broadcast r-f coils, one or two turns on the i-f coils are not critical. If breaks occur and they can be located and repaired without losing more than one or two turns, receiver performance will not be affected noticeably. In making repairs on litz coils it should be remembered that each and every one of the many strands must be carefully cleaned, and they must all be soldered to the terminal, else noise and loss of gain will result.

In removing and replacing i-f shield cans care should be taken to fasten them

2. "Solving Shortage Problems in Interstage R-F Circuits," by Robert G. Herzog, SERVICE, December 1941, p. 9.

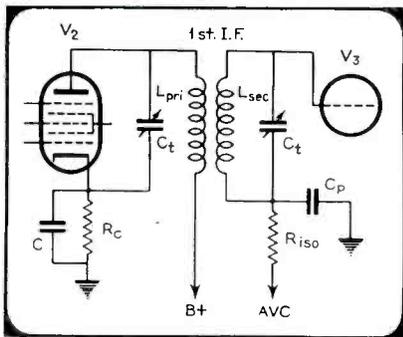


Fig. 7. The simple expedient of returning the primary trimming condenser to the cathode provides regeneration in this superheterodyne.

solidly and to assure a good electrical connection to the receiver chassis. This is an especially particular requirement in loop receivers. In such receivers eddy currents developed in the shields are more easily fed to the loop to cause regeneration.

The spacing between the windings of the i-f transformer is important to both the selectivity and the gain of the i-f stage. It is, therefore, important in making repairs or replacements of windings that they be returned to the same position which they previously occupied.

Shorts in i-f tuning capacitors occur because of defects in the mica separators. Such shorts can be located and the individual defective mica separators replaced.

Where resistor or condenser components connected to the i-f stage, and located within the i-f can, become defective, the defective component alone should be replaced and not the entire i-f. It is preferable to follow the designer's original procedure and remount the replacement inside the i-f can. A particular offender in this respect is the by-pass condenser used in conjunction with the plate return isolation resistance. Some older receivers located this condenser in the i-f transformer can and filled the assembly with pitch. In such instances the pitch can be melted out of the can and the condenser replaced. It is not always necessary to return the pitch.

Replacements

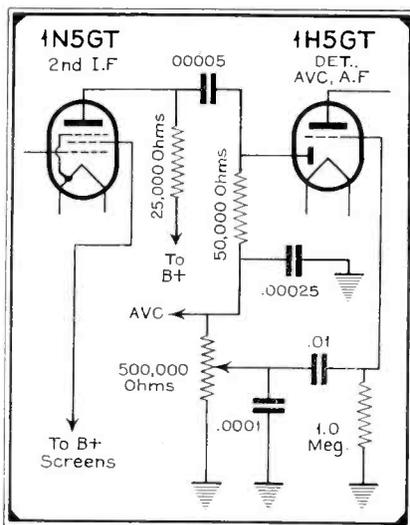
Iron-cored i-f transformers employ a fixed condenser, usually of the silver-mica type, across the primary and secondary windings. In making replacements of these condensers it is advisable to replace with duplicate values having close tolerance.

As mentioned in previous articles of this series a change in value up to 25% in screen dropping resistors and in plate and grid isolation resistors is permis-

sible. A decrease in value up to 20% is permissible in the accompanying by-pass condensers. Any larger by-pass condenser may be used in these screen and plate and grid return circuits.

Similarly, an alteration of 20% either plus or minus is permissible in the plate and grid load resistors and in the grid leak, and the resistances (R_r and RP_1) in the detector plate circuit of Fig. 8. Likewise, a 20% change in value of any of the blocking or coupling condensers will produce no noticeable effects in receiver performance.

Cathode resistors in the i-f stages, are somewhat more critical than those



This Air Chief portable provides an example of a typical resistance coupled i-f stage. Other sets use such a circuit between first and second i-f.

in other parts of the receiver and closer adherence to the prescribed values should be practiced when making replacements. As mentioned above, the cathode condenser shown in Fig. 7 is part of the regenerative circuit and

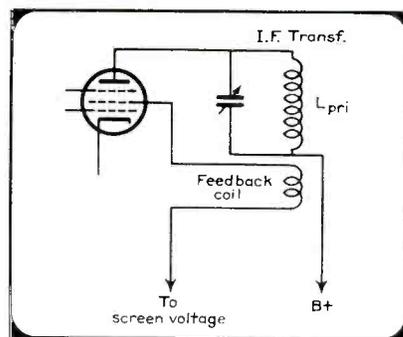


Fig. 9. Regeneration is provided in this receiver by feeding back an induced voltage from an extra winding on the transformer to the screen.

should replacement be necessary, a duplicate value should be employed.

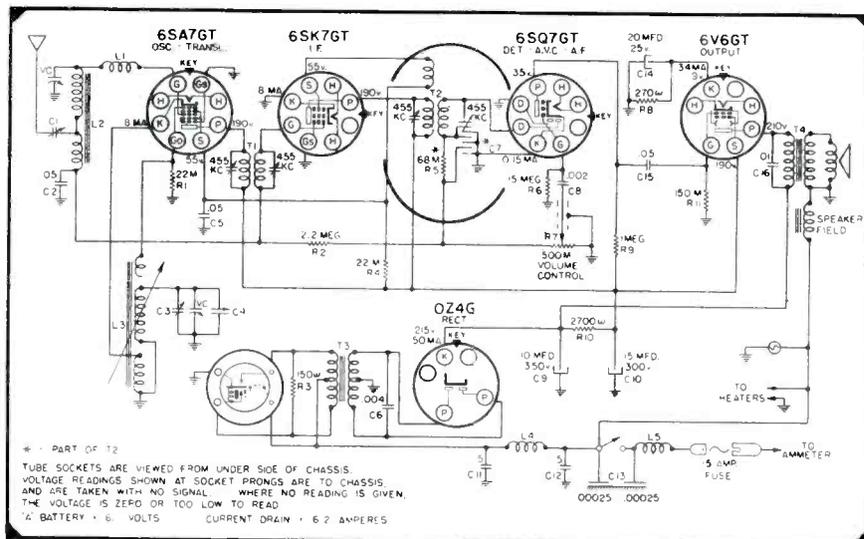
Should it become necessary to replace trimming condensers in the i-f circuits it is important that the required capacity can be obtained within the variable range of the replacement. The replacement can be made up of a fixed and an adjustable condenser connected in parallel.

Summary

Image frequencies in superheterodyne receivers are spaced from the desired signal by twice the intermediate frequency. They are caused because this frequency will beat with the local oscillator frequency to produce a new signal equal to the i-f. More or less elaborate means of preselection were used in early superheterodyne receivers to reduce the possibility of image interference. These early receivers employed i-fs of 175 kc or lower with the accompanying in-

(Continued on page 27)

Silvertone Model 7091 employs regeneration in the i-f amplifier for increased gain with a tickler in the screen circuit of the i-f.



SER-CUITS!

By HENRY HOWARD

WE AGAIN feature applications of degeneration, this month as exemplified in General Electric and Air King receivers. The *Air King Models 4245 and 4265* use a 6SJ7GT first audio pentode feeding a 6V6GT output stage. The feedback voltage is taken from the voice coil and fed to the cathode of the first audio tube through a 0.005-mfd condenser. Inserting the condenser in the feedback circuit favors the degeneration of the higher frequencies; the low frequencies are unable to get through because of the higher reactance of this small capacity to these frequencies. It is reasonable to assume that an increased bass response is obtained. The 6SJ7GT has a 10-megohm grid leak and a 250-ohm bias resistor. Note the 5,000-ohm grid resistor in the output tube circuit; also the 300-ohm unby-passed cathode resistor which allows further degeneration. As an interesting side light, compare the 0.005-mfd condenser to the 250-ohm 6SJ7GT bias resistor; the reactance of the former is 100 times the value of the resistance, at about 1250 cycles. (See Fig. 1.)

Degeneration

General Electric Models L915W and L916 feature a higher degree of inversed feedback, as can be seen in Fig. 2. The audio lineup is as follows: 6SQ7 second-detector-first-audio; 6J5GT second au-

dio; 6J5GT cathode (signal divider) inverter; and a pair of push-pull 6V6GTs for power output. Feedback runs from the output transformer secondary through 10,000 ohms to the second audio cathode. The cathode bias resistor is comparatively large (10,000 ohms) allowing plenty of degeneration. A shunt network, consisting of an 0.02-mfd condenser and an 1,800-ohm resistor in series, is connected to the feedback line. (See Fig. 2.)

This is another method of applying an equalizer. Note the low value of plate by-pass condensers (only 0.002 mfd per tube) in the push-pull stage. Note also the tone controls; treble, 0.005-mfd condenser and series resistor at the first audio plate, and bass control operating in conjunction with the volume control on the bass compensation tap.

Filter Chokes

Filter chokes are coming back in small sets. Here's one in Sear's *Silver-tone Model 7025*, a compact 5 tuber. The choke is not used in the power tube plate circuit, however. A method of hum bucking is used to neutralize the ripple voltage. As shown in Fig. 3, a 12,000 ohm, 1-watt resistor is connected from the rectifier output to the 35L6GT cathode. The cathode resistor is 150 ohms, unby-passed. Hum voltage from the 35Z5GT half-wave rectifier (60 cycles) is purposely delivered

to the cathode to combat or neutralize the hum voltage delivered to the plate. Because of the inductance in series with the plate, the voltages are not exactly in phase opposition but the cancellation is very effective.

In the loop circuit of this receiver, a 10,000-ohm resistor appears across the antenna coupling coil, or primary. In spite of this, the primary is normally shorted out. When an external antenna is to be connected, the short is removed. The unshorted primary would probably cause dead spots to appear at one or more points in the broadcast range.

Dual Rectifiers

Emerson's *Models GH437, GH447, GH2-447*, 7-tube combinations for a-c only, use two 35Z5s in parallel to supply a 3,000-ohm shunt connected field in addition to the usual receiver load. This is made necessary because of the lack of p-m speakers. (See Fig. 4.) A separate filament circuit is used for the two rectifiers and the pilot light is run from tap to tap on the heaters. Note the tube types selected: a 12SF7 diode-pentode serves as i-f amplifier and detector while a 12SJ7 with grid leak bias serves as first audio. The power-tube cathode resistor is unby-passed permitting a measure of degeneration.

(Continued on next page)

Fig. 1. Air King Models 4245 and 4265 feature a novel method of degeneration.

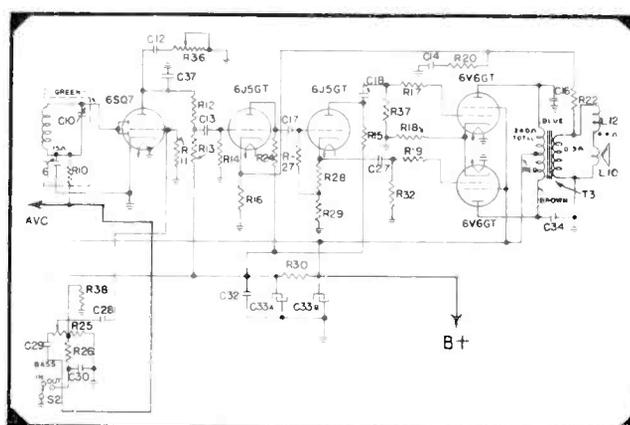
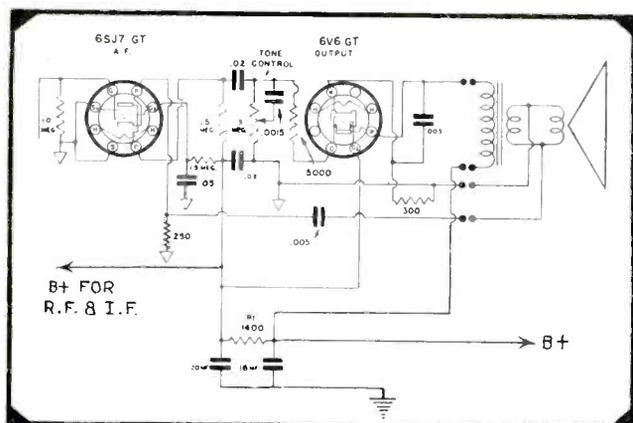


Fig. 2. General Electric L915W features a higher degree of degeneration.

SER-CUITS

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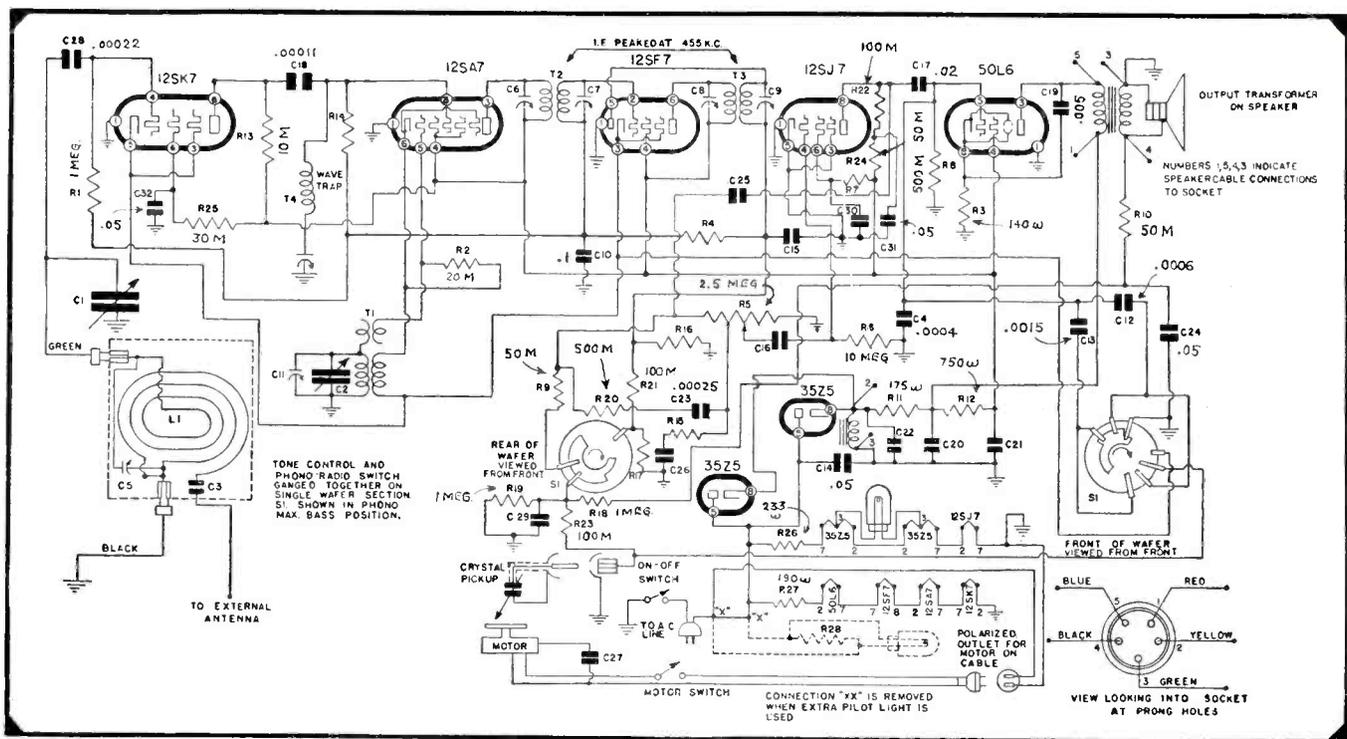
Higher-Priced Model

Silvertone Model 7039 is in a higher price class. This 9-tube receiver has 3 bands with one spread band covering the range from 9.3 to 9.9 mc. It has eight push buttons, five for stations, one for phono-radio switching, one for hi-boost and the eighth for lo-boost. Two dual concentric controls make a balanced panel design. The left control consists of on-off switch and tone control on the outside, while the volume control is on the inside. The right hand combination has the band switch outside and the tuning control inside. A 6J5GT separate oscillator is used, shown in Fig. 5. Note the 180-ohm resistor in series with the 0.01-mfd blocking condenser in the plate circuit. Coupling to the first detector grid is made through a wire to wire coupling with a capacity of about 3 mmfd. An i-f wave trap is used on the broadcast band only. An antenna plate replaces the loop on short-wave reception. The speaker is a 9-inch oval.

Noise Limiter

Fig 6 shows *Philco's Model S1926*, a 7-tube auto-radio receiver with 265-kc i-f and a noise limiter. The latter feature is particularly useful, in auto sets, because of the nature of ignition inter-

Fig. 4. Emerson Models GH427, GH447 and GH2-447 use two 35Z5s in parallel (below).

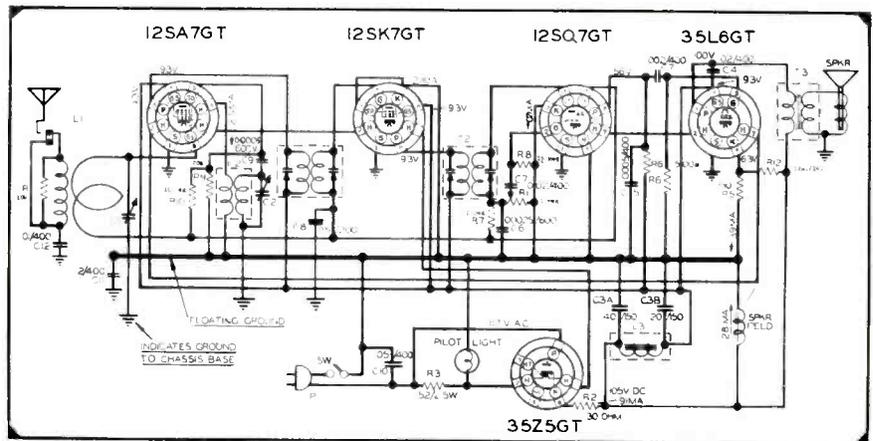


ference. Noise limiters cut the peaks off any signals or noise (interference) which exceeds the voltage derived from the wanted signal. Ignition interference is of a very peaked nature hence is very readily chopped down, facilitating reception of weak stations.

This particular Philco noise limiter has what may be termed delayed detection. The detector tube is biased so that no signal can get through until it attains a greater amplitude than the bias voltage. Weak signals as well as background noise are thus eliminated.

When noise limiters were introduced a half dozen years ago, many thought this was to be a major boon to the industry, but for reasons of complication and distortion it fell flat. Only the manufacturers of communications type receivers really took hold of the noise

Fig. 3. *Silvertone Model 7025* is a compact 5-tube set that uses a filter choke in the B supply (below).



“chopper-off” and made it a valuable accessory to an already fine line of receivers.

Communications Receivers

While on the subject of communication sets, let's consider the new *Hallcrafters SX28 Super Skyrider*, a hefty deluxe 4-gang chassis weighing 75 pounds. The principal features include: 2 stages of pre-selection; calibrated bandspread; tuning range 550 kc to 42 mc continuous; wide-range variable selectivity from razor sharp to band pass; adjustable noise limiter; double avc system; the usual tone control plus separate bass boost; wide angle S meter for measuring carrier strength; band-pass audio filter; improved signal/noise and signal/image ratios; and 8 watts of push-pull audio into a separate speaker. Quite a set-up in any radio man's language. Other manufacturers have similar features in those types of sets. Many cheaper models are avail-

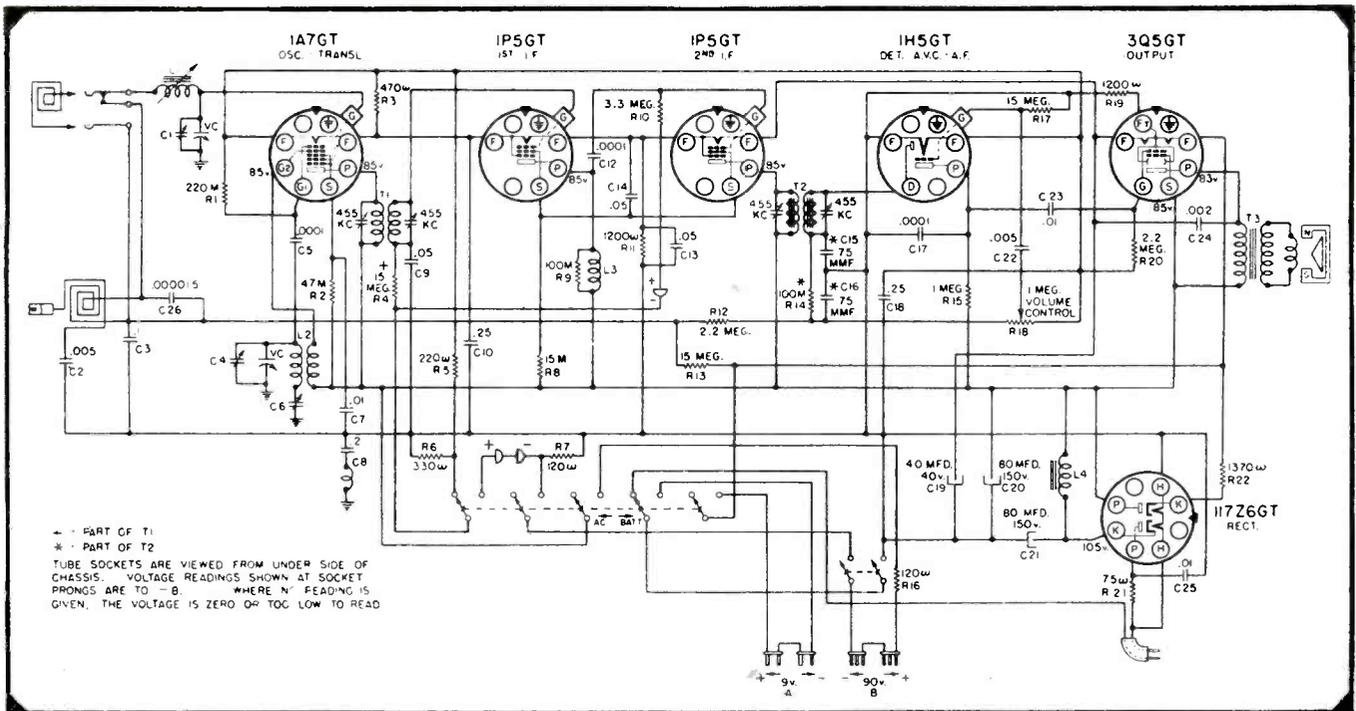


Fig. 7. Silvertone 7085 and 7090 battery and line portables have two i-f stages and sensitivity compensation.

which features three short-wave band-spread ranges besides broadcast. It has a battery thrift switch, or economizer, and an optional adaptor for a 2-volt storage cell.

Unusual Tube Lineup

An unusual tube lineup is found in the General Electric Model L740 for a-c only. A 6SF7 serves as combination i-f amplifier and diode detector-avc. Also, another dual tube (6SC7 dual triode) serves as an audio amplifier and inverter. This tube has a common cathode which is left unbiased.

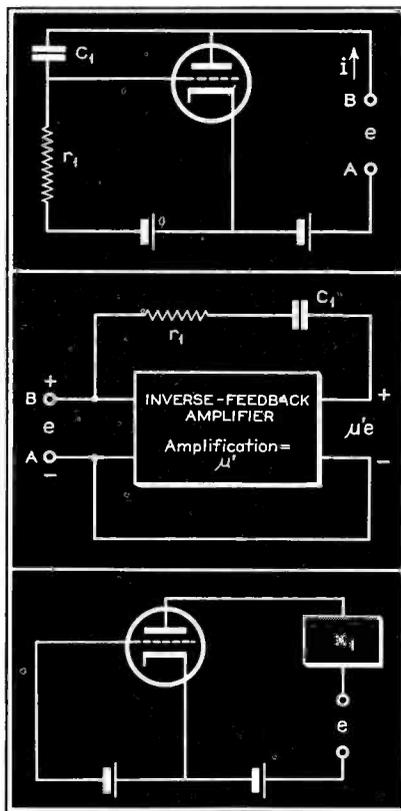
VACUUM TUBE As Variable Impedance

BECAUSE of their application in automatic tuning and f-m, circuits in which tubes are used to produce a variable reactance, have achieved great popularity. However, the use of tubes to produce effective reactance, the magnitude of which may be controlled by voltage, is only one aspect in the study of the application of tubes in changing the phase angle of an impedance. For in this plane are the application of tubes for the production of negative resistance and of effective capacitive reactance without the use of capacitance, or of inductive reactance without the use of inductance, said Herbert J. Reich, Professor of Electrical Engineering, the University of Illinois, at the recent New York IRE convention.

A parallel type of circuit in which a vacuum tube may be used to change the magnitude or phase of an impedance is shown in Figure 1. It is also possible to vary the phase angle by the grid bias of this tube. This circuit has its principle application in automatic tuning and in f-m. Although a triode is shown in Figure 1, the plate and grid may be

replaced by any two electrodes of a multielectrode tube, if the control electrode is maintained sufficiently negative to prevent the flow of electrons to it. As a matter of fact, said Professor Reich, the plate and grid may be replaced by the screen and suppressor respectively of a pentode, with the plate and first grid voltages being maintained constantly. In Figure 2 we have another type of circuit that may be used in changing the phase angle or magnitude of an impedance. This is done by the use of inverse feed-back and with low impedance in the final stage of the amplifier. In this way the voltage amplification μ' is made independent of r_1 and C_1 throughout the frequency range in which the circuit is to be used.

Figs. 1, 2 and 3. Circuits in which vacuum tubes may be used to vary the magnitude or phase of an impedance.



Variation of Phase Angle

In a third type of circuit, the phase angle of an impedance may be varied, as shown in Figure 3. Since the plate resistance of the tube may be adjusted by means of the voltage of one or more grids, the effective reactance and resistance between A and B may be controlled by a voltage, continued Professor Reich. This circuit does not have a variety of applications since it does not give an inductive reactance when x_1 is capacitive. This is because it does not afford a negative effective resistance since the effective capacitance is always less than the capacitance of x_1 . In addition, the effective shunting resistance cannot be infinite.

By the use of an inverse-feedback amplifier, said Professor Reich, it is possible to obtain very large effective capacitance or very low negative resistance, the magnitudes of which may be varied by means of the amplifier gain.

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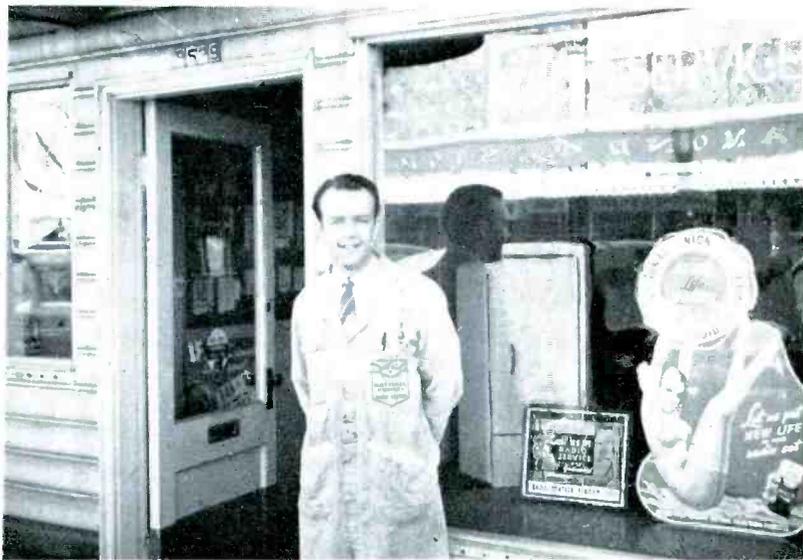
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SOUND IDEAS

By JAY ALLEN

IN THESE days when the war industries are looking for every possible production aid there are ever widening applications for sound installation and maintenance. Not that prospects for conventional systems need be neglected, but imagination and the trouble to study the problems of the plant contemplating such an installation will often disclose additions and adaptations which will make the sound system more effective in meeting the precise needs of the particular plant where it is being installed. More often than not such vision will add equipment and accessories and not infrequently will be the means of closing the sale.

Production Aid

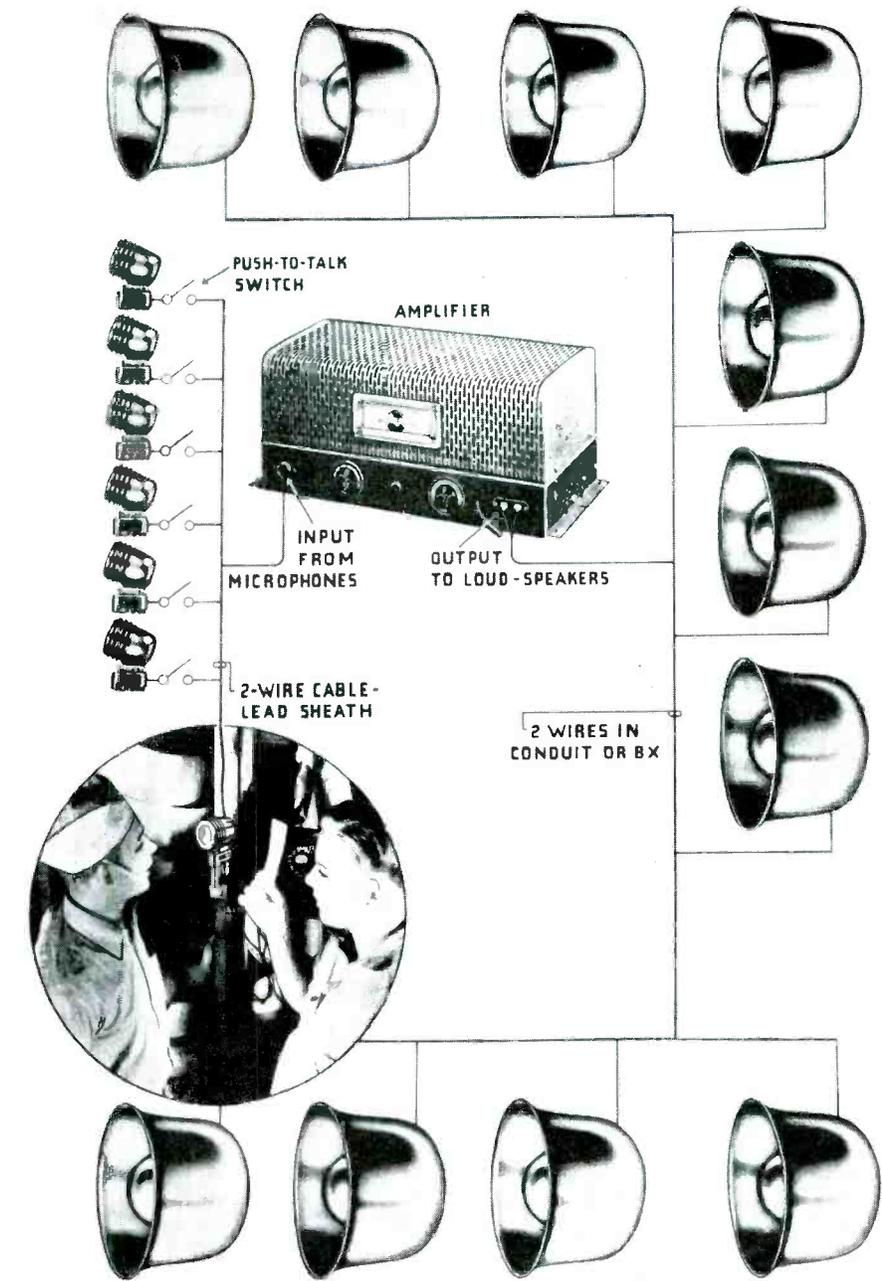
A good example, demonstrating how standard components can be combined to make up an installation tailored to the specific requirements of an individual industrial plant, is an installation made in the plastics department building of the E. I. DuPont de Nemours & Co., Arlington, New Jersey.

Examination of the pictorial layout of Fig. 1 will show the simplicity of the set-up; also the unusualness in that instead of the single microphone which constitutes the input to the conventional call system, this one includes several—and they are of a type employed in high-grade sound installations where good frequency response is important, or where fidelity and extreme sturdiness must be combined.

The installation consists of a 50-watt Lafayette Type 485T booster amplifier, 11 marine type speakers paralleled across its 250-ohm output, and 8 Amperite Type PG close-talking dynamic microphones. The latter are paralleled across the input line, but are in the circuit only when their individual push-to-talk buttons are pressed.

The amplifier is of the simple booster type with single input and output circuits. In order to provide sufficient gain for operation directly from microphones rated at 56 db. a preamplifier stage was built in by the manufacturer on special order.

Very special considerations were involved in the selection of microphones and speakers. In this plant the processes are largely chemical ones and involve the presence of fumes, dust, a great deal of moisture and high temperatures. In some departments the chemical powders



precipitated on floor and walls make it necessary to wash them down daily with a hose with the result that the conditions under which the sound system operate are far from ideal. Not that either the microphones or speakers are subjected to the direct hose stream, but under these conditions of work it is apparent why the humidity in some of these rooms is close to the saturation point, particularly as in some departments great troughs of water or chemical solutions under constant agitation extend across an entire room.

It is an interesting commentary on the microphone used that it has with-

Fig. 1. Industrial systems such as illustrated are helping America go all-out on war production. Inset shows one of eight microphone positions; from any one calls can be broadcast to all other departments.

stood this for over a year since the installation was made without a trace of trouble. These same conditions have likewise dictated the choice of marine type speakers.

This sound installation replaced an existing call-bell system, most of the wiring for which had been installed in rigid conduit with a few short runs of bx. This same conduit was utilized for the speaker wiring by mounting the



Fig. 3. Sound systems have several distinct advantages over other equipment when used to give air raid alarm signals. The trumpets shown above were used in a test in Newark, N. J.

speakers in the locations formerly occupied by the gongs. This simplified the installation wiring job considerably. The microphone wiring consists of lead-sheathed 2-wire cable run directly along the surface of the brick walls and attached thereto by suitable saddle clamps. Care was exercised in insulating the sheath where it passed through walls, crossed over metal pipes, etc., to avoid grounding at points other than intended. Experience in industrial sound systems indicated that where cable shields are grounded at two or more remote points the potentials built up along the shield may be sufficient to introduce serious disturbance in the input circuits.

The system serves a three-fold purpose. It is basically a highly flexible call system which makes it possible to page any individual in the building from any one of the individual department rooms, or from the office. But it is also an intercommunicator network because a call initiated at any microphone can be answered from any other, and conversation carried on via the loudspeaker system. True, this conversation will be heard throughout the building, as all speakers are in the circuit at all times, but this is an advantage rather than a drawback because conversation carried on over the sound system concerns production and the production system in this plant is such that all departments are intimately tied together, therefore information that interests one or two interests all. Verbal contacts not involving production can be carried on by ordinary telephone, each department having its own instrument right next to the microphone.

Another feature of the sound system is that it simplifies the operation of the telephone system. This phone system is one in which all extensions are paral-

leled across one incoming line and a call coming in from outside can be taken at any extension. Likewise conversation can be carried on between any two extensions without the need for a switchboard or operator. It would appear on the surface that while this arrangement is simple, it might readily lead to confusion. But it is the presence of the sound system that makes such simplicity practical.

Only one of the phones has a bell and this is one at a position where a worker is always present. If a call comes in from outside the building, this man answers. He then turns to the microphone next to the telephone and requests the wanted individual to take the call at the nearest telephone. In making inter-department phone calls the one initiating the call first pages the desired individual over the sound system, asking him to go to the phone. He then listens at the phone for the reply and the conversation proceeds.

Not only does this arrangement cut down telephone costs by eliminating the need for an operator, bells and a ringing system; it likewise saves much time. With a conventional telephone system a ringing phone in a department would require that whoever happened to be nearest answer it, then call the individual desired, possibly even having to look for him outside of the department.

With the present system the intermediary is eliminated and the person called is reached instantly.

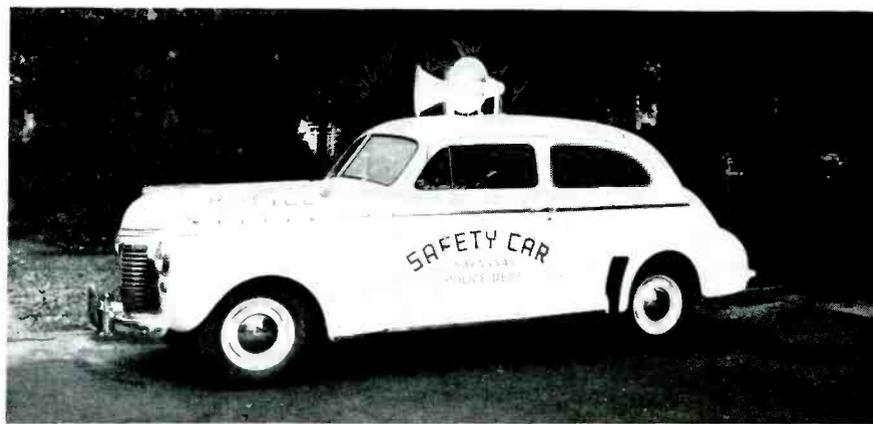
But perhaps the most important function of the sound system in this plant is in the direct part it plays in production. To make this understandable it is necessary that the production system be briefly described.

The product of this plant is the transparent plastic film used in making safety glass such as that now universally employed in automobiles. After an early stage of manufacture, this plastic is formed into a great continuous ribbon several feet wide which then progresses through the various processing stages (departments) on rollers, like a giant belt. Obviously the timing of the processing in each department must be perfectly controlled if production is to be coordinated. Because the plastic ribbon is endless its movement cannot be slowed down in one department, speeded up in another, etc. Should it be necessary to slow it down in one department, it will likewise be slowed down in others, necessitating appropriate adjustments of processing in these other departments.

Visualizing this production scheme, it is easy to understand the effectiveness of the sound system as a production aid. Should any processing change become necessary in one department, information concerning it is instantly and simultaneously passed along to all other department heads so that they in turn can make the necessary adjustments. Without the sound system such information would have to be conveyed by messenger or by telephone calls to the other individual departments. Either of these methods would involve delay and the expenditure of the time of the messenger or the one who makes the phone calls.

One mark of real sound salesmanship is illustrated in this instance. That is

Fig. 2. Sound systems are doing double duty these days in police cars. They serve generally as safety crusade cars and also to give directions during black-outs or to give air raid warning signals.



the ability to analyze requirements and to insure that the recommended equipment includes everything that may be logically utilized—but not one thing more. In this installation, for instance, it might have been possible to increase the contract price by including a conventional amplifier rather than one of the less expensive booster types, on the assumption that the customer probably had never heard of the booster and therefore wouldn't know that for his purposes, which required only a single input circuit, it would (with a pre-amplifier stage built-in) serve just as well as the conventional multi-type. When the Sound Man informed him of this possibility, indicating that he was looking out for the customer's interest as well as his own, it is quite understandable that an atmosphere of complete confidence was at once established.

Ordinance Plant Installation

Another unique industrial plant sound installation has been completed at the Des Moines Ordnance Plant, Des Moines, Iowa, by the Technical Service Corporation, Sound Specialists of Des Moines. This system includes a master control station, paging facilities as well as four groups of reentrant speakers powered by separate amplifiers which are installed on the same poles as are the horns. The equipment is RCA throughout.

The master control station is located in the administration building where microphone and radio and phonograph facilities have been provided. Remote microphones are installed at the switchboard and at various other points throughout the plant in connection with the paging system.

The amplifiers located on the poles are supplied with signals from the control station by means of telephone cables.

Warehouse Installation

Another outstanding installation of sound equipment was made by the RCA Victor Distributing Corporation, Kansas City, Missouri, at the Davidson Furniture Company warehouse in that city.

A paging and communication system, it consists of a RCA master unit and a number of powerful RCA speaker assemblies in which talk-listen switches have been installed. Each assembly serves as a remote unit and can communicate (both talk and listen) with the master station.

Several of the units are used in elevators and are connected into the sound system by means of flexible rubber encased cables. After the installations in the elevators, it was noted that elevator efficiency was increased and ship-

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Police Car Systems

Police car sound systems are deserving of more than passing interest these days because of the possibility of their use in giving air raid alarms, in directing the public during blackouts, and in the event of an actual air raid.

A system specifically designed with this possibility in mind was sold recently to the Municipal Police Department in Savannah, Georgia, by the South Eastern Radio Parts Company of the same city. The car, with the system

installed, serves as a safety crusade car to direct traffic and pedestrians in addition to the war-time service mentioned above.

The 32-watt mobile amplifier (Bogen Model EX632) used in the system, is mounted in the trunk compartment of the police car. A remote-level control unit mounts at the dashboard for easy control of the several amplifier input positions. A phone top provides facilities for an air raid signal source through the medium of a single frequency phonograph record. An Ameri-

(Continued on page 22)

HIGH SIGN OF
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SERVICE
 by
FRANK FAX



WHEN this column bowed in last month, I promised, as a Sylvania engineer, to aid you all I can with your problems and your selling—and to supply you with whatever promotion helps your business needs.

Well, here's a good example of the kind of promotional help I had in mind—the "Complete Radio Service" sign pictured below.



Size: 11" high • 19" long • 3 1/4" thick • weight 4 pounds

This handsome electric sign should prove mighty useful to you radio experts in cultivating the sort of all-round trade that brings in the big profits.

For it puts passersby on notice that you're a fellow who knows his way around any type of radio—home, portable or auto. It says, whatever your problem, you'll find the answer here.

These signs are being offered to all Sylvania dealers at a below-cost price—\$1.50. To get one just drop a note to me, Frank Fax, Dept. S 2, Hygrade Sylvania Corporation, Emporium, Pa., and enclose your check or money order. Or if you prefer, you can order direct from your Sylvania jobber.

And keep shooting your puzzlers to me. My staff and I will be glad to answer any and all queries, no matter how intricate or technical. So far the questions have been extremely interesting and later on we hope to discuss a few of them right here.

SYLVANIA

RADIO TUBE DIVISION

HYGRADE SYLVANIA CORPORATION

22 • SERVICE, FEBRUARY, 1942

SOUND IDEAS

(Continued from page 21)

can Type D8T close-talking dynamic microphone and two University Labs Type LH trumpets with Type SAH p-m driver units, complete the equipment.

Several features of the amplifier are worthy of mention. It is of standard, 6-volt d-c, 110-volt a-c design and employs two vibrators for B supply when operating from a 6-volt source. A special stand-by switch is provided to permit the B supply to be shut off during short idle periods, thereby saving battery power and tube life, both important in these war times.

Although the amplifier is rated at 32 watts, it is capable of delivering 40 watts peak. Full advantage may be taken of this extra power for the reproduction of the air raid signal, since distortion is unimportant in such cases. The triple-range tone corrector may also be helpful in such instances, to concentrate the amplifier range on the narrow frequency of the air raid signal.

Smaller System

A similar, but smaller, police car system is used by the Municipal Police Department of San Francisco, California. The type of equipment used in this installation converts the auto into a sound car, yet is no more cumbersome than the ordinary auto-radio receiver. The Bogen Type E66 amplifier has overall dimensions of 5 3/4 by 7 3/8 by 6 3/4 inches. The miniature, Type IB8 University Lab waterproofed reflex type speaker is mounted under the hood.

A novel feature of this equipment is that, although its rated normal output is only 8 watts, its effective output is said to be equivalent to that of a standard 12 to 18-watt system. The speaker design contributes materially to this in that it cuts off the frequency response below 250 cycles. The relatively large proportion of the power normally dissipated in the reproduction of these low frequencies is thus concentrated in the normal voice and higher frequency ranges with their much greater carrying power.

Air Raid Alarms

Amplifying systems are being installed in many communities, and are under consideration in others, as devices for giving warning in the advent of air raids. Present advices point to sound equipment as the best means for this purpose. While steam and air-driven sirens give a somewhat louder sound with greater carrying force, the sound system has in its favor a lower first cost and a simpler installation and control problem.

In order to determine which type of

system would be best for their purpose, the Department of Public Safety of the City of Newark, New Jersey, tested a number of these systems on December 21, 1941. Several are shown mounted above the roof of the Swift and Company Building at Port Newark in the accompanying photograph. Public Director John B. Keenan and other engineers of the department listened to the warning signal from the devices by riding about the city in police cars.

One of the systems used employed the four University Labs Type 2YR, 50-watt trumpets shown to the left in the illustration. A 75-watt Thordarson amplifier and a special phonograph record supplied the signal for the speakers.

Systems of this type should generally be self-contained and self-powered because of the possibility of failure of the power lines. Where amplifiers and turntables are employed they should either be of the universal 6-volt d-c, 110-volt a-c type or should provide for operation from a gasoline-driven generator.

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(See Front Cover)

THIS 3-tube record player, (Emerson Model FY) comes in two types—FY434 for a-c only and model FY2-434 for a-c/d-c. The only difference in the two models is in the motor; no change is made in the circuit. The universal motor is equipped with a switch which permits optimum performance on d-c or a-c when the switch is at the respective position. It will be remembered that most universal motors have a lot more power on d-c than on a-c because the inductance of the windings acts to limit input current on a-c.

A crystal pickup delivers voltage to a 2.5 megohm volume control through a 1-megohm resistor and 10-mmfd condenser, the combination acting as an equalizer. The first a-f consists of a grid leak biased 12SQ7 which feeds a 50L6 beam output tube. The cathode resistor is not bypassed, allowing some degeneration. The most interesting feature in the circuit is the bass regeneration scheme which delivers increased low-frequency level to the speaker. Voltage is picked off the voice coil and fed through a T-section low-pass filter to the high side of the volume control. The filter consists of a 50,000-ohm resistor, a 0.02-mfd shunt condenser and a 1 megohm resistor. This filter shunts the high frequencies to ground, allowing only the lows to pass through and be regenerated. The speaker is a 6½-inch p-m.

INTERFERENCE ANALYSIS

MANY interesting studies on the generation of combination signals in the presence of strong fields of broadcast stations have been made lately, particularly since the advent of higher power stations. Analyses have been made in various parts of the country with specific emphasis on those sections where the sum frequency have fallen in some band of popular usage. Such was the instance of study of signal generation of stations WILL and WDWS in the area of Champaign and Urbana, Illinois, by A. James Ebel, Chief Engineer of station WILL of the University of Illinois. In his talk at the IRE, recently, on the Source of Spurious Radiations in the Field of Two Strong Signals, he pointed out that the sum of the signals generated by 5,000 watt WILL (580 kc) and 250 watt WDWS (1370 kc*) happen to fall in the 1.8 mc amateur band.

All measurements were made with a

* WDWS now operates on 1400 kc, as a result of the frequency shift ordered under the North American Regional Broadcasting Agreement. Thus the difference frequency now appears at 820 kc.

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portable loop battery receiver with a-v-c removed and an output meter installed instead. In the tests, it was found that metal structures in or about the area under study exhibited a trace of the combination signal. For instance, a 140 foot galvanized windmill tower grounded to a buried grid of wires was one of the points at which traces of the signal could be found.

Generally speaking, said Mr. Ebel, it was found that most spurious radiations, in the field of two strong signals, are generated in the receiving antenna system. This is particularly true in an a-c receiver that is not grounded, for the electrical distribution ground systems

are excellent rectifiers. An antenna system balanced against a ground, either using a loop or matched transmission, seems to be a solution, said Mr. Ebel. In conclusion, Mr. Ebel said that the possibility of a receiving antenna generating combination signals of a nonlinear element acting as a secondary source of these signals, depends on the extent of the nonlinearity of the impedance, the effective heights of the conductors, and the impedance of the conductor at the combination frequency as well as the field product. Thus, the field product cannot always be used as a criterion for the occurrence of objectional interference from such a source.



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Copies of the catalogs and bulletins discussed below may be obtained directly from the respective manufacturers mentioned. Write for them today!

• • • • Alden Products Co., 117 N. Main St., Brockton, Mass., have issued their latest "Stock and Can Make List", in which they enumerate the various plugs and sockets which they have in stock for immediate shipment (subject to prior sale), as well as other items which they can schedule for near future shipment.

• • • • Potter & Brumfield Manufacturing Co., Inc., Princeton, Ind., have issued a bulletin illustrating and describing their relays and process timers.

PERSONNEL



• • • • Ben Miller, sales manager of Meissner Manufacturing Co., Mt. Carmel, Ill., recently went on a tour of Meissner jobbers. Among the cities to be visited are: St. Louis, Kansas City, Los Angeles, San Francisco, Portland, Ore., Seattle, Spokane, Minneapolis, St. Paul, Milwaukee and Chicago.

• • • • The Turner Co., Cedar Rapids, Iowa, have announced the appointment of S. W. Berk of the S. W. Berk Sales Co., 530 William Penn Way, Pittsburgh, Pa., as their representative in Western Pennsylvania and West Virginia.

E. J. Watkins, 580 Market St., San Francisco, Cal., has been appointed Turner representative for Northern California.

EXPANSION

• • • • The Columbia Broadcasting System has revised its shortwave schedule to coincide with commencement of full scale operations over its three new powerful transmitters: WCRC, WCBX and WCDA. From early morning to late afternoon the transmitters are beamed on Europe and thenceforth until 11 PM they are directed toward South America.

• • • • Potter and Brumfield Manufacturing Co., Inc., Princeton, Ind., announce the opening of a sales and engineering field office at 63-12 Haring St., Rego Park, L. I. This office is under the direction of Sam Harper.

• • • • Plans for the erection of a radio tube manufacturing plant in Lancaster, Pa., by the RCA Manufacturing Co., Inc., were disclosed recently with the announcement that a large tract of land had been purchased by the company in that vicinity. Ground for the new building will be broken about March 1.

• • • • Technical Appliance Corp., have moved to larger quarters at 516 West 34 St., New York City. The new quarters provide about three times the space of their former location.



Additional information and prices of the items described below may be obtained, without obligation, from the respective manufacturers.

• • • • Hygrade-Sylvania Corp., 500 Fifth Ave., New York City, announce an electric sign featuring "Complete Radio Service". The colors of the lettering and



illustrations are orange, green and black. The sign hangs or stands; chains are provided for hanging and a metal easel for standing. It is available to Service Men at \$1.50.

• • • • The Ken-Rad Tube & Lamp Corp., Owensboro, Ky., announce the development of a new tube carton incorporating constructive packaging suggestions received



from dealers, jobbers and representatives. The new carton is made in two instead of the conventional three pieces and is said to be more durable than the old and eliminates the use of metal stitches.

NEW PRODUCTS

Additional information and prices of the equipment described below may be obtained, without obligation, from the respective manufacturers.

Record Album

The Peerless Album Co., 38 W. 21 St., New York City, announce their "Symphonic" padded Fabrikoid covered record albums. The new albums are available in either ivory, saddle tan or maroon and feature rounded corners. Either 10- or 12-inch types can be had in any of the colors specified.

BOOK REVIEWS



AUTOMATIC RECORD CHANGERS AND RECORDERS, by John F. Rider, published by John F. Rider, Publisher, Inc., 404 Fourth Ave., New York City, 744 pages, 8½ by 11 in., illustrated, price \$6.00.

The first few chapters of the book do an exceptionally good job of covering the subjects of motors and motor drives; maintenance of motors and commonplace troubles; speed regulators and reduction drives; recorders and phonographs; needles; pickups; and automatic record changer mechanisms and troubles.

Some 674 pages of this generous volume are devoted to a manual of commercial record changer and recorder mechanisms. Included in these pages is the manufacturer's service data for practically all the automatic record changers and recorders on the market at this time. These data are more comprehensive than those pertaining to radio receivers, as notes on the functioning of the devices, their adjustments and care, have been supplied in most cases by the manufacturer.

Not only is the text section indexed, but an extensive cross-reference index indicates with a minimum of effort just which record changer or recorder is used with any particular radio-phonograph combination and where the data covering the changer or recorder can be found in the book. Also the record changers and recorders are listed under their own maker's name, as well as being indexed as mentioned above. The data have been arranged in the same way that has proved so successful in Rider's Manuals.

If you ever had the least hesitancy about how to go about repairing and adjusting these complicated mechanisms, this volume will put you at ease. If you service this type of equipment at all (and you can't be in the service game today without running into such machines) then you need this volume. Once you have it you'll consider it a life saver. R. H.

REPLACEMENT TRANSFORMER ENCYCLOPEDIA, prepared and published by Thordarson Electric Manufacturing Co., 500 W. Huron St., Chicago, 32 pages, 8½ by 11 in., self covers, free to readers of SERVICE.

Transformer replacements for over 4,000 receivers are given in Thordarson's new edition of their "Replacement Encyclopedia." Receiver types have been arranged to enable selection of power transformer, filter choke, audio or output transformer. The booklet also gives the electrical and physical characteristics of the recommended replacement types given in the listings.

The book is recommended to everyone who makes a living from the repair of radio receivers. L. T.

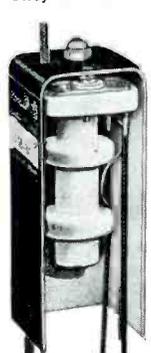
GOVERNMENT SEEKS RADIO OPERATORS

War Department, Federal Communications Commission, Civil Aeronautics Administration, Coast and Geodetic Survey,

Replace with MEISSNER COILS

**"PLASTIC"
I. F. Transformers**

Each year for the past several years there has been a marked increase in the demand for Meissner "Plastic" I.F. Transformers both for replacement and new set construction. They will give superior performance and occupy a space only 1¼" square by 2½" high. Not affected by temperature, humidity or vibration and are exceptionally stable. They have a wide, usable frequency range. Available in Air Core "Plastic"—list price each \$1.25, or the new Ferrocart Iron-Core "Plastic"—list price each \$1.75.





STANDARD I. F. Transformers

The accepted standard for general replacement purposes. Among their many outstanding features are: Compact standard size shield is 1¾" square by 3½" high. All popular frequencies. Convenient mounting. Ceramic-base trimmers. Impregnated windings. Gain characteristics have been designed to correspond closely with values found in the majority of commercial receivers.

See your Meissner distributor today.

The Meissner I.F. Replacement Manual will more than save its cost to the busy serviceman every day. Lists replacement I.F. Transformers for practically all receivers made by every manufacturer since the introduction of Super-hets, also valuable service data never before published. Get your copy today—only 25c. DEPT. SE-2





MT. CARMEL, ILLINOIS

"PRECISION-BUILT PRODUCTS"

and other Government agencies are needing radio operators. Persons are needed to stand regular watch for the transmission and reception of radio messages and other communications. In some cases operators will be responsible for the maintenance and operation of a radio station and its equipment. In others they may have to transmit messages by teletype as well as in code.

To fill the jobs, which pay \$1,620 and \$1,800 a year, an examination was recently announced by the Civil Service Commission. Because of the large number of vacancies which exist applications will be accepted at the Commission's Washington office until further notice.

While no paid experience is required, ap-

plicants for these positions must show that they are able to transmit and receive messages by radio-telegraph at a rate of 20 words a minute, transmitting either by hand or bug. For some positions persons are needed who can operate a regular typewriter at 40 words per minute, or a teletypewriter at 35 words per minute. The age limits are 18 to 55. Persons are to be rated on their experience or training and fitness to perform the work.

Operators who are interested in this work and who would be available for Government employment are urged to secure the proper application forms from the Commission's representative at first- or second-class post offices, or directly from the Commission in Washington.



A WAR MESSAGE to ALL EMPLOYERS

★ From the United States Treasury Department ★

WINNING THIS WAR is going to take the mightiest effort America has ever made—in men, in materials, and in money! Every dollar, every dime that is not urgently needed for the civilian necessities of food, clothing, and shelter, must, if we are to secure final Victory, be put into the war effort.

An important part of the billions required to produce the planes, tanks, ships, and guns our Army and Navy need must come from the sale of Defense Bonds. Only by regular, week by week, pay-day by pay-day investment of the American people can this be done.

This is the American way to win. This is the way to preserve our democratic way of life.

Facing these facts, your Government needs, urgently, your cooperation with your employees in *immediately* enrolling them in a

PAY-ROLL SAVINGS PLAN

The Pay-Roll Savings Plan is simple and efficient. It provides, simply, for regular purchases by your employees of United States Defense Bonds through systematic—yet voluntary—pay-roll allotments. All you do is hold the total funds collected from these pay-roll allotments in a separate account and deliver a Defense Bond to the employee each time his allotments accumulate to an amount sufficient to purchase a Bond.

The Pay-Roll Savings Plan has the approval of the American Federation of Labor, the Congress for Industrial Organization, and the Railroad Brotherhoods. It is now in effect in several thousand companies varying in number of employees from 3 to over 10,000.

In sending the coupon below, you are under no obligation, other than your own interest in the future of your country, to install the Plan after you have given it your

consideration. You will receive—1, a booklet describing how the Plan works; 2, samples of free literature furnished to companies installing the Plan; 3, a sample employee Pay-Roll Savings authorization card; and 4, the name of your State Defense Bond administrator who can supply experienced aid in setting up the Plan.

To get full facts, send the coupon below—today! Or write, Treasury Department, Section B, 709 Twelfth St., NW., Washington, D. C.

HOW THE PAY-ROLL SAVINGS PLAN HELPS YOUR COUNTRY

- 1 It provides immediate cash now to produce the finest, deadliest fighting equipment an Army and Navy ever needed to win.
- 2 It gives every American wage earner the opportunity for financial participation in National Defense.
- 3 By storing up wages, it will reduce the current demand for consumer goods while they are scarce, thus retarding inflation.
- 4 It reduces the percentage of Defense financing that must be placed with banks, thus putting our emergency financing on a sounder basis.
- 5 It builds a reserve buying power for the post-war purchase of civilian goods to keep our factories running after the war.
- 6 It helps your employees provide for their future.

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709-12th St., NW.
Washington, D. C.

We want to do our part. Please
rush full information regarding
the Pay-Roll Savings Plan.

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POSITION

COMPANY NAME

ADDRESS

NUMBER OF EMPLOYEES



MAKE EVERY PAY-DAY... BOND DAY!
U. S. Defense BONDS ★ STAMPS

This space is a contribution to NATIONAL DEFENSE by SERVICE

SOLVING SHORTAGE PROBLEMS

(Continued from page 12)

crease in the possibility of image interference. Present day receivers spread the images across the full band through the selection of an i-f in the vicinity of 455 kc.

Most of the gain and selection of a superheterodyne receiver is made up in the i-f amplifier. The elements that compose the i-f amplifier are similar to those that make up the r-f circuits which were explained in the previous articles of this series^{1,2}. With few exceptions permissible alterations while making replacements follow the information given for r-f counterparts.

SAFE OPERATION OF A-C/D-C EQUIPMENT

AN INTERESTING note on the safe operation of transformerless a-c and a-c/d-c radio sets and equipment comes from a recent issue of the magazine QST. Because of its obvious importance we felt that it was worth repeating here.

The suggestion is made that the negative return of the power supply from the equipment be connected directly to a good ground. Only one prong of the line plug is used in this case, to connect the "live" leg to the power source. Should this plug be inserted the wrong way, no damage will result. To assure proper operation it need then only be reversed.

This procedure is particularly applicable in cases where such devices are to be used in conjunction with others of the same type or with transformer operated equipment. It can also be used to advantage in the case of straight d-c equipment.

PARTS TOLERANCES

SERVICE MEN and jobbers are overlooking standard tolerances covering resistance and capacity values and are thereby slowing up shipments of such items. Orders are being received at various factories for special values of resistors and condensers, in many instances not more than 10% or so off the standard stock values. Inasmuch as the standard items are labeled with their values the factories hesitate to ship standard items even though they would come within the tolerance

NEW UTAH AC FIELD EXCITED SPEAKERS

SUBSTITUTE FOR PERMANENT MAGNET SPEAKER NOW AVAILABLE

● A serious problem for the radio and sound equipment industry has again been solved by Utah engineering. Several months ago critical shortages occurred in the raw materials needed for the fabrication of permanent magnet speakers. The condition made it necessary to develop a line of speakers to replace those in which materials vital to national defense were used.

Utah solved the problem! A complete line of AC Field Excited Speakers is now available—humless in operation and equivalent in performance to the famous Utah Permo-Dynamic line. A speaker has been designed for every public address and sound requirement. They require only the addition of the AC Field Supply shown at right to substitute for any Permo-Dynamic application. The new Utah speakers have standard Utah weather-resistant construction.

If Your Jobber Can't Supply You Write Us Direct



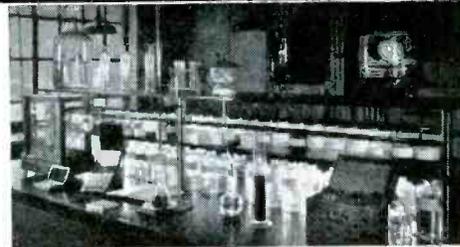
USE STANDARD UTAH OUTPUT TRANSFORMERS

Utah Transformers assure reliability and satisfactory performance under all operating conditions. They avoid failure due to



SPEAKERS

VIBRATORS • TRANSFORMERS • UTAH-CARTER PARTS



In the laboratories of the Utah Radio Products Company, engineers are constantly engaged in new developments and in intensive research—working day and night to meet the demands of the National Defense Program and its necessary restrictions of some materials. All the experience, knowledge and skill of the Utah production staff are required to comply with the ever-increasing demand for Utah Speakers, Transformers, Vibrators, and Utah-Carter Parts.

NEW UTAH AC FIELD EXCITATION SUPPLY PROVIDES HUMLESS OPERATION

This AC Field Supply is properly designed for humless operation of any of the speakers listed below. At 117 volts, 60 cycle input, the maximum output is 12 watts at 105 mills. The supply may be mounted directly in the speaker baffle. A separate supply should be used for each speaker. The price does not include rectifier tube, but includes ballast and plug. No cord is furnished. 1-50 Y6 GT rectifier tube is required. New Utah AC Field Excitation Supply, U.S.A. list price \$4.75. Special Bracket P-9030 for Mounting Field Supply on 12" Speaker. U.S.A. list price 25c.



NEW UTAH AC FIELD EXCITED SPEAKERS

| STOCK NO. | CONE DIAM. | VC IMP. | VC DIAM. | NORMAL WATT. | PEAK WATT. | U.S.A. LIST PRICE |
|-----------|------------|---------|----------|--------------|------------|-------------------|
| 8AC30 | 8" | 6-8 Ohm | 1 1/4" | 12 | 18 | \$9.50 |
| 10AC12 | 10" | 6-8 Ohm | 1" | 9 | 14 | 6.60 |
| 12AC12 | 12" | 6-8 Ohm | 1" | 10 | 15 | 7.75 |
| 12AC20 | 12" | 6-8 Ohm | 1" | 13 | 20 | 10.00 |
| 12AC40 | 12" | 6-8 Ohm | 1 1/4" | 16 | 24 | 12.50 |
| 12AC75 | 12" | 6-8 Ohm | 1 1/2" | 21 | 32 | 19.25 |

moisture because of the complete impregnation of interlayer insulating paper by Utah's vacuum pressure methods.

Be sure to insist on Utah products. Look for the Utah trademark. Utah Radio Products Company, 816 Orleans Street, Chicago, Illinois. Canadian Office: 560 King Street, W., Toronto. In Argentina: UCOA Radio Products Company, SRL Buenos Aires. Cable Address: Utaradio, Chicago.

limits of the requested values.

It is highly important, especially in these days of shortages and delays, that Service Men and jobbers note the standard 10% plus or minus tolerance in most receiver components. In other words, even at the labeled values, resistors and condensers vary in value sufficiently, yet absolutely satisfactory results will be obtained. To expedite their orders, therefore, Service Men and jobbers will do well to stick to stock values which are reasonably close to the exact value required by their

particular application. This will help everyone concerned.

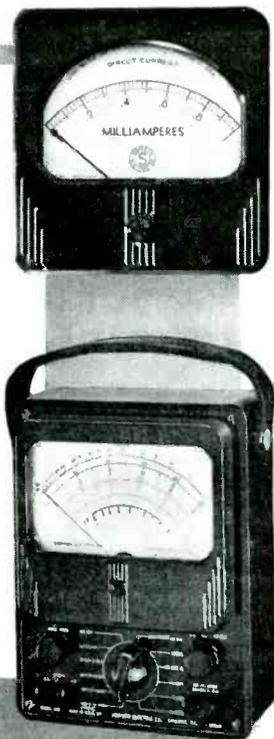
Vic Mucher
CLAROSTAT MANUFACTURING CO., INC.

Our uncles, brothers, cousins and sons are fighting on all fronts. It is a desperate battle and it can only be won with great quantities of airplanes, tanks, ships, guns, and the like. Do your share on the home front and buy U. S. Defense Stamps and Bonds.

If your need for instruments is essential enough to give you the right to buy, it is essential enough to rate the best.

To those who have searched out the facts, best means *Simpson!*

SIMPSON ELECTRIC CO.
5216-18 Kinzie Street, Chicago, Ill.



Simpson
INSTRUMENTS THAT STAY ACCURATE

**ALWAYS
IN LINE**



DEPENDABLE
Radio Tubes
KEN-RAD

**WHEN YOU CHANGE
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Be sure to notify the Subscription Department of **SERVICE** at 19 E. Forty-seventh St., New York City, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

INDUSTRIAL ELECTRONICS

(Continued from page 8)

trolled load by the thyatron must be higher than the line value, etc. Thus the design of these automatic control units is both simple and economical. The foregoing, coupled with the high control factor, low grid current (which permits the associated phototube to be operated with a high load resistance, and therefore at high sensitivity), and high output of thyatrons, make them ideal for many applications.

Because the thyatron recycles itself automatically on alternate half cycles of the supply current, its operation from an a-c source offers obvious advantages. It can also be employed on d-c supply providing it is required to perform but a single operation. It will not recycle on d-c. In other words, once the tube fires it will remain conductive unless some external means is provided to reduce its anode voltage to substantially zero. This can be accomplished by means of a hand switch or relay to momentarily break the anode circuit, or by special automatic arrangements. Because these are likely to be complicated and relatively expensive, thyatrons are less commonly used in d-c circuits involving repeat operations.

Where the output of a phototube device is required to reflect continuous variations in photocell illumination, as in the reproduction of sound from film, in light measurement work, etc., the thyatron cannot be used because it is essentially an off-on relay which knows no intermediate steps between its full conduction and no conduction condition. In set-ups which involve varying degrees of output, therefore, standard radio tubes and standard tube amplifier circuits find wide application. Radio Service Men are already familiar with such circuits and discussion here of circuit details is not deemed necessary.

Before closing the present article it might be well to point out one field of importance which the average Service Man is quite qualified to tackle immediately. That is the installation and servicing of burglar-alarm types of phototube protective devices.

At no time in the history of industry has automatic protection of property been as essential as it is now. During the last war industrial plants went in heavily for brilliant floodlighting of their properties as a means of night-time protection, extensive fencing for day and night protection, and large forces of guards and watchmen. Such

a combination of protective measures was effective although extremely expensive.

In the present emergency the conditions with which the plant owner is faced are quite different. They now not only have to guard against sabotage but against possible attack by enemy bombing planes. Exterior floodlights are therefore of vastly decreased usefulness for the reason that they must be extinguished in blackouts—at the very time when protection may be most needed. In inky blackness, guards are effectively blinded and no fence is unscalable. By far the most effective protection aid obtainable is that provided by a carefully designed network of phototube equipment intercepting light beams which are so directed as to weave an impregnable skein around the industrial plant and within the plant as well. Such a system can utilize invisible light (so called "black light") powered by batteries or by a small local generator. Thus neither blackouts nor failure of power lines can interfere with its effectiveness.

Commercial protective equipment of this type is available in which a light source and the phototube unit may be

placed up to several hundred feet apart. An intruder passing between these will intercept the light beam thus sounding a general alarm or providing a silent signal, depending on the requirements for which the system was designed. Such a system can be arranged to indicate in which of the protected areas the intruder is present and can give this indication in the main office or at as many guard houses or other points as may be desired.

Equipment for shorter light throws may be such that the light source and phototube receptor are in a single case. This is a more economical arrangement as it reduces both installation and equipment cost. With such equipment the beam of light is directed on a distant mirror which reflects it back to the phototube. By suitably shielding the phototube and mirror and by use of a fairly powerful light source, such a protective system can function in daylight as well as in darkness. This is, of course, also true of systems in which the light source and phototube equipment are separate units. Either therefore affords 24-hour protection.

Complete directions for installing commercial phototube protective systems are available from manufacturers of phototube equipment and they are glad to cooperate in the planning of a system best suited to the regulations of an individual plant or property. Such cooperation is an important aid to a radio Service Man who is just entering the field and this, plus his general electrical and radio ingenuity, qualify him to undertake installations without extensive preliminary training.

Maintenance of these protective systems is also a worthwhile element of the business. Lamps employed as light sources are often rated for a specific life and in order to avoid a breakdown in the system should be replaced regularly at intervals usually less than this rating. Where the lamps and the tubes involved render 24-hour service a complete checkup at least once a month is desirable. For this reason this sort of work lends itself to a flat monthly maintenance charge.

The following list of books and papers offers helpful study and reference material for the Service Man who is really desirous of gaining a thorough working knowledge of the practical and theoretical considerations involved in industrial phototube applications. This list is published through the courtesy of the RCA Manufacturing Company. As the titles imply, some of this literature also covers industrial electronic applications other than those of phototubes, and is therefore especially helpful in obtaining a

A BIG NEW BUSINESS

THE SERVICING OF "AUTOMATIC RECORD CHANGERS & RECORDERS"

NEW RIDER BOOK

Just Out!

Here is a new source of profits for the serviceman who knows this new business.

Unlike radios, with which you are familiar, Automatic Record Changers and Recorders are made up of electrical and mechanical components that are new to you. The operations of cams, pawls, gears, and the study of motion are just a few of the elements that are different from those you are used to dealing with. This Rider Book shows you how to study the functioning (the cycles of operation) of any record changer. It goes into small motors and their care. It explains the different types of turntable drives, various kinds of speed changing mechanisms and, by means of actual photographs, breaks down—step by step—the operation of a simple drop-type record changer.

The book also explains how Recorders function and their different characteristics.

"Automatic Record Changers and Recorders" carries manufacturers' service data on practically every Automatic Record Changer and Recorder on the market today. It is indexed and cross-indexed so you can tell who made the record changer on any set and refer to the pages on which the data can be found.

Record Changers and Recorders open a new market—virgin territory for extra profits. Some service shop is going to benefit—be sure it is yours—and be sure you can handle the work profitably—be sure you have it at your finger tips

"AUTOMATIC RECORD
CHANGERS AND RECORDERS"
744 PAGES (8½ x 11") \$6.00

Order This New Rider Book Today

OUT APRIL 15th

RIDER MANUAL
VOL. XIII

1650 Pages — Price \$11.00

This new Rider Manual covers sets issued in 1941. The O.P.M. announces that 13,000,000 sets were sold last year. What a market! What a source of profit if you have the necessary data for efficient operation!

We are fortunate in being able to complete arrangements for publishing Vol. XIII. That is why we say

ORDER NOW

Avoid Disappointment

that might result from your putting off buying until "tomorrow."

JOHN F. RIDER Publisher, Inc.
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New York City. Cable: ARLAB

well rounded knowledge of the broad field of industrial electronics. The material listed is available from libraries, or from the publishers and technical book stores.

References

Photoelectric Cells, by Campbell and Ritchie; Isaac Pitman & Sons, Ltd.
Industrial Electronics, by Gulliksen and Vedder; John Wiley and Sons, Inc.
Electronic Tubes in Industry, by Kieth Henney; McGraw Hill Book Co., Inc.

Photoelectric Phenomena, by Hughes and DuBridge; McGraw Hill Book Co., Inc.

Application of Conventional Vacuum Tubes in Unconventional Circuits, by F. H. Shepard, Jr.; Proc. I.R.E., Dec., 1936.

Some Unconventional Vacuum Tube Circuits, by F. H. Shepard, Jr.; RCA Review, Oct. 1937.

Photocells and Their Applications, by Zworykin and Wilson; John Wiley and Sons, Inc.

SERVICE, FEBRUARY, 1942 • 29

ASSOCIATIONS



RTA, Long Beach, Cal.

Certain changes have been made in the Long Beach Radio Technicians' Association which should be voiced to other service groups. The outbreak of the war has changed the Service Man's viewpoint and with the oncoming shortage of tires it will change our entire business relation with the public.

President F. E. Smith has been called to the colors for service in the U. S. N. Vice-president Duane Davis and past president Harry E. Ward, Jr., will carry on the meetings. The association unanimously and voluntarily joined the Voluntary Defense Bureau for repair work on radio, communications, etc.

Plans were also laid for central service of all radio repairing; whereas, one or two trucks could be maintained to take care of all the radio pick-up and delivery. Prompt service on calls for immediate service work would have to be taken in slower stride to conserve tires and delivery trucks.

Some talk was given in utilizing women and boys of high school age as much as possible. The service of the receivers would be handled similar to chain production of manufacturers: each man would have only one section of radio to work upon; audio, i-f section, avc, and antenna section, power transformers, and sound, which will give you some idea of the division or breakdown of the service work. Testing tubes and all around checking will be handled entirely by young men or women.

This may be of interest to other groups throughout the country. We are open to suggestions if others have tried similar working plans. *Harry E. Ward, Jr.*

Radio Club of America

Paul Ware, veteran radio amateur and professional, of Allen B. DuMont Laboratories, has been elected president of the Radio Club of America for the ensuing year.

Lehigh Valley, Pa.

Lehigh Valley Radio Servicemen's Association, Allentown, Pa., held their Fourth Annual Banquet and Parts Show at the Hotel Allen, on Jan. 26, 1942. Over 73 Service Men, with representatives from Philadelphia and Reading, attended and

enjoyed the festivities.

As the principal speaker of the evening, Robert G. Herzog, editor of SERVICE Magazine, told the assembled group of the necessities of war-time service work. He explained that we would be required to exercise more than ordinary common sense in the replacement of parts and that often we would have to make extensive repairs on components rather than to replace them. Distribution of many radio components, for other than defense purposes, has already been discontinued and that of others will soon follow. In any event, it is our duty to keep at least one set operating in every home.

After the talk the dinner guests were treated to an evening's entertainment and we must say that the committee has done itself proud on the budget which they were allowed. Representatives of the Allentown and Bethlehem Press were present and took pictures for publication in their morning editions.

Ray E. P. Abbott, Secretary.

RADIO SERVICEMEN OF AMERICA

CONGRATULATIONS are in order for Don Stover. He has been appointed to the Service and Installation Division of the RCA Manufacturing Co., Inc.,

in Camden, N. J. It is with regret, however, that we learn that his acceptance of the new position has brought with it his resignation as executive secretary of the RSA. Don's work for the past seven months in the latter capacity cannot be surpassed.

The executive committee has elected Alfred A. Kilian, former secretary of the Chicago Chapter to succeed Don. This change has also necessitated a shift in the National Headquarters at 414 Dickens Ave., Chicago. Another change has been required of late, although not connected with the change in executive secretary: this is the increase of national dues to \$2.00 per year.

Binghamton, N. Y.

Election of officers for 1942 resulted in the reelection of all of the 1941 officers to their respective positions.

Earl L. Pittsley, Secretary.

Monongahela, W. Va.

It's indeed a pleasure to announce that the Service Men of Fairmont, W. Va., have completed affiliation with the RSA and will be known as the Monongahela Chapter. Officers are: President, Russell G. Dotson; vice-president, John G. Gil-

Intimate group photographed at Fourth Annual Banquet of Lehigh Valley Radio Servicemen's Association. Left to right: Raymond J. L. Miller, president; Ray E. P. Abbott, secretary; Stanley E. Eisenhard, chairman entertainment committee; Edward H. Pond, toastmaster, and Robert G. Herzog, Editor of SERVICE, who was guest speaker.



Photo courtesy Allentown Morning Call

YESTERDAY
TODAY
TOMORROW

← SUPREME



Every instrument scientifically engineered and soundly built for dependable, accurate, profitable radio servicing. See your jobber or write for new catalog.

SUPREME INSTRUMENTS CORP. GREENWOOD, MISSISSIPPI

SAVE \$1.00!!!

- The Group Subscription Plan for *Service* enables a group of service men, dealers or jobbers to subscribe at one-half the usual yearly rate.
- The regular individual rate is \$2.00 a year. In groups of 4 or more, the subscription rate is \$1.00 a year. (In foreign countries, \$2.00.)
- Each subscriber should print his name and address clearly and state his occupation—whether a dealer, jobber, independent service man, service organization, etc.

Remember this Group Plan when Your
Subscription Expires

THE \$1.00 GROUP PLAN Is Still Available

OUR GROUP SUBSCRIPTION PLAN enables you and three or more of your co-workers to subscribe to SERVICE at one-half the regular yearly rate—only \$1.00 each for twelve issues. The Group Plan low rate only applies when 4 or more subscriptions are ordered at one time. (Foreign \$2.00.)

Speak to three or more of your friends . . . let them sign up with you and then you can remit for the whole group. (Renewals or extended subscriptions are acceptable as part of a group.)

— TEAR OUT AND MAIL —

SERVICE—19 E. 47th St., N. Y. C.

Please enter annual subscription (12 issues) for each of the undersigned for which payment is enclosed at the rate of \$1.00 each; foreign \$2.00. (This rate applies only on 4 or more subscriptions when occupations are given.)

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State whether Employer is a Service Organization, Dealer, Jobber or Manufacturer

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Name
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Occupation
Employed by
State whether Employer is a Service Organization, Dealer, Jobber or Manufacturer

Name
Address
City-State
Occupation
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State whether Employer is a Service Organization, Dealer, Jobber or Manufacturer

bert; secretary-treasurer, Carl L. Roach. The membership of our chapter expressed themselves as well pleased with the service notes furnished by RSA on the occasion of our first 1942 meeting held in Fairmont. "Red" Rhodes gave a good talk on r-f circuits, seasoned by remarks and questions from his fellow members. Mr. Johnson, of Fairmont, came through as usual with some excellent information in the course of the discussion. In the absence of Russell Dotson, of Grafton, vice-president John Gilbert of Morgantown presided.
E. H. Flowers, Publicity.

Oklahoma City, Okla.

We had to shift our regular meeting first one way and then the other in order to get the men together, because everyone has been loaded with work lately. Uncle Sam has all of our extra help. Our next meeting is scheduled for the election of officers. L. G. Deering, our District RSA director, has just returned from the hospital after a short siege of pneumonia. We are looking forward to a lot of hard work, and also helping in any way we can in any of our local defense work.
R. B. Cherry, President.

Pittsburgh, Pa.

The Pittsburgh chapter held its Jan. 8 meeting in the directors' room of the Commonwealth Trust Co. Samuel Avins, Pittsburgh RSA attorney, gave full details covering the confiscation or alteration of alien short-wave receivers. We had tags printed with an affidavit showing the owner's name and address and the name, address and phone number of the service shop that made the alteration. The bottom of the tag carries the notice "Do not tamper with this receiver. Should it require service notify the Service Man who signed this sworn statement."

The matter of wholesale selling of radio sets and parts by wholesale houses, at wholesale prices, to retail customers has been taken up with Senator Guffy. He, in turn, took it up with Leon Henderson of the OPA and Mr. Henderson promised an investigation. Further, the matter was taken up at the NRPDA meeting at Canton, Ohio, on Jan. 18.

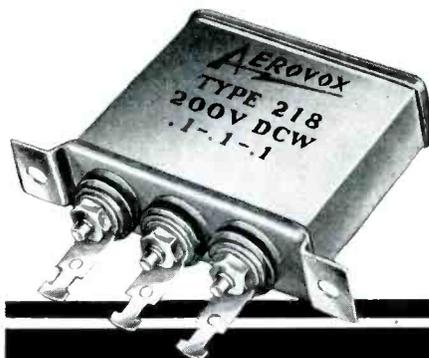
We wrote to the FCC concerning the possibility of National Licensing of radio Service Men, but have not received an answer as yet.
R. G. Devaney.

Wichita, Kans.

We have had a rather quiet chapter here and you hardly knew that Wichita existed, but from now on loud noises will emanate from us and our chapter is buzzing with plans. For the next few months, we are conducting a first-class technical school in radio servicing. We use "Principles of Radio" for a text and Drakes "Cyclopedia" for reference. Our present attendance is about twenty-five.
Mack Lovern, Acting Secretary.

Radio Servicemen's Association of Luzerne County

Members of the Radio Servicemen's Association of Luzerne County, Wilkes-Barre, Pa., and friends of Spencer Eddy were present at a farewell party given in his honor on Feb. 7. Mr. Eddy left for Ft. Monmouth, N. J., on Feb. 8, to accept a position with the Signal Corps. C. Foster Hick, acting as official spokesman, bid Spencer farewell and mentioned that we were losing a member that it would be impossible to replace.
C. F. Bogdan, Secretary.



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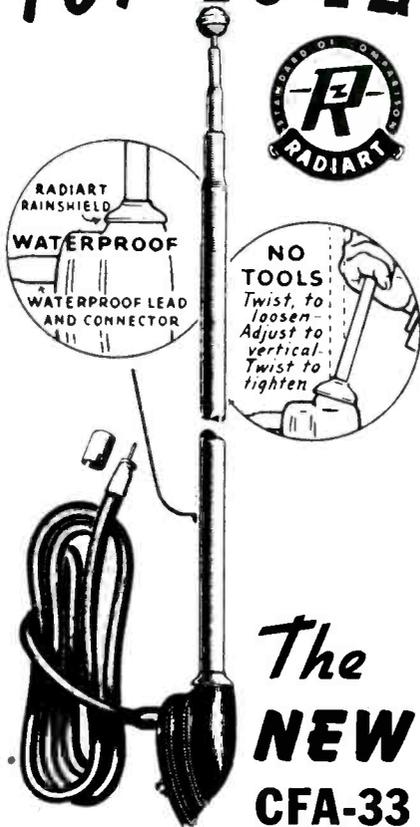
Type 18:
Similar to Type 16 but for inverted mounting with terminals at bottom. 200, 400 and 600 v. D.C.W. .05 to .25 mfd.; .05-.05 and .1-.1 in double-section; .05-.05-.05 and .1-.1 mfd. in triple-section. Not listed in general catalog but obtainable in Transmitting Capacitor Line.

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LEAD**

**AND THE ROD IS
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CLEVELAND, OHIO**

Farrell
Says:—

By C. H. FARRELL

FROM lads who know come tales of electron applications which build up servicer sales; the prosperity of nations. But Service Men still hibernate and give not one damn 'bout the fate that overtakes the sleepers. And Charlie Farrell squawks aloud, reminding all the snoozing crowd that soon they may be weepers. Each job your competition's getting proves the fact that you are letting beaucoup bucks go sliding down the drain. For the bookies never pay off on a nag that wants to lay off, and a sale that's lost will not return again. So get going pretty quick, Sir. Let your think box start to tick, Sir. You can't get by unless you use your head. Play some profit song harmonics; sell 'industri-electronics;' that's the only way to climb out of the red. I don't intend to scold you, but remember that I told you of the dire fate that's waiting for the mopes. So eliminate waste motion; to your sales plans show devotion; for Service Men can never live on hopes. Never mind my lousy rhyming; just forget about my timing; it's the thought that counts—so let it sink right in. If you want to catch more moolah; better go right back to schoolah; and learn the methods that are bound to win.

Into
Pastures
Green

I WOULD rather sit over a hot corned beef sandwich and a glass of beer with an up-and-coming servicer than hold Myrna Loy's hand. Come Spring and I might change my mind, but that's the way I feel about it now, for my avocation of "trend spotting" can always get a good play when I talk with a real Service Man. Several such conversations lately have convinced me that servicers are waking up to the terrific opportunities presented by the non-radio applications of radio parts. One chap in particular raised my eyebrows away up to here. He liked to fiddle around with photocell controls in his spare time, and being an ingenious, intense chap, began to see the possibilities of this type of product in factories of all sorts. He actually taught himself how to apply radio to industrial production. One day he went to a large factory in his home town and made a proposition to the factory manager. He

installed a control device as a speculation and within three weeks it had proved its worth. He was asked for more ideas and he had as many ideas about that factory as a mongrel has fleas. The factory hired him and gave him what practically amounted to *carte blanche*. His salary now is \$100 a week and he is the happiest lad in the world.

I have been privileged to see many electronic developments which are going to help Uncle Sam win this war. I can't talk about them, but this much I can say; hundreds of electronic devices which are being proved in the developmental laboratories of Mars can be applied to (and will be applied to) peace time uses on a scale which is well nigh incomprehensible.

The radio Service Man who anticipates the "industri-electronic era" and prepares himself to gather in the harvest which the green pastures will furnish can be tagged "Smart Hombre."

THE purchasing agent of a large radio receiver plant recently received a requisition from the 'lab' for a *million white ants* together with instructions for breeding them. The frantic P.A. thought

Insect
Aside

that either priorities had finally driven the engineering department daft or that he had better change his brand of gin. But it all turned out all right. The Manufacturer had been receiving complaints from the Tropics. White ants crawled into radios and feasted on the insulation—with *youknowwhat* results. The 'labs' wanted the ants for feeding experiments. They are endeavoring to develop a formula for insulation which will be to white ants what spinach is to most kids.

Pity the poor manufacturers! They are plagued by the locusts of Priorities! And now . . . to add insult to injury—*they have ants in their plants!*

IT IS easy to complaint about current conditions. We contemplate our mounting National Debt and get the screaming meemies figuring out how much each of us is going to have to pay.

World
Is
Right

To some people, it is easier to squawk than put on a show of cheerfulness and resolve to make the best of it. From time immemorial, thinkers

and philosophers have written on the subject of good nature as an antidote for most human ills. There have always been situations which, at the time, seemed just as bad as Act II of the World War, Priorities and Taxes. Thackeray wrote; "The world deals good naturedly with good natured people, and I never knew a sulky misanthropist who quarreled with it but it was *he* and not *it* that was in the wrong."

THE impact of our all out war effort is being felt more and more each day in our lives and in our businesses. Our overburdened transportation systems, for instance, will have an important bearing on the number of condenser and tube types to be produced in 1942. And the size of various radio components. The shortage of rubber tires will also be a contributing factor to the cutting down of sizes and types. For the battle cry in this country today is "Conserve—Don't Waste." Servicers will naturally benefit from any mass movement on the part of the public to conserve. The psychology of conservation must inevitably be translated into terms of servicer profits, for when the public is waste conscious, they are less likely to purchase new radio receivers, more likely to make the present set do for another year—with a little fixing up.

Anything that the Service Men of America can do to further the campaign against waste should be done. They should 'talk it up.' They should set the example for others.

Each bit of copper wire that is re-used is a help to our armed forces. Each saving in the expenditure of solder is a help. Each short cut that saves time is a help.

Leslie Rucker, the Washington Jobber, is doing a fine job of encouraging Service Men to conserve time, materials and effort. He says that a dual purpose is thus served. Saves money and provides the wherewithal to purchase Defense Stamps and Bonds.

SOLDIERS USE DISCS

Soldiers have often found difficulty in writing home after a day's hard training. With this fact uppermost a new business is opening up in the neighborhood of Uncle Sam's training camps—supplying a portable instantaneous disc recorder and a supply of paper core blanks. With this, the recruit can speak those words for home into the microphone. *From Commercial America* 8-41.

Help Beat Hitler . . .

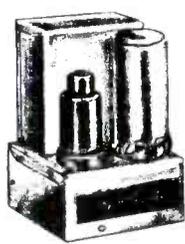
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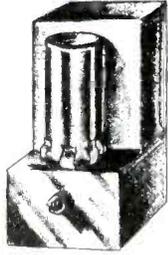


Check especially on
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4200-D or 4200-DF

—a compact unit delivering 300 volts at 100 m.a. Also tapped for other voltages. (4200-DF has built-in audio filter).

RADIART VIPOWER

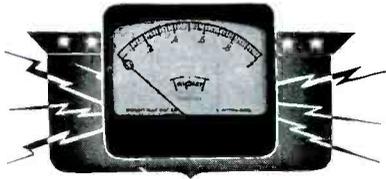
4203-D. Same characteristics as Model 4200-D, except that the use of Radiart 4255 reversible synchronous vibrator eliminates the need for a rectifier tube.



YOUR RADIART JOBBER
 will supply you with Bulletin 840 or
 keep in touch with the Radiart Engineering
 Department for latest developments

THE RADIART CORP

CLEVELAND, OHIO



For Triplet Customers Only

Long before the state of emergency was proclaimed, the Triplet Company was getting ready to do its part in building our national security. We knew that we must meet important new responsibilities. At the same time, we felt keenly our continuing obligations to our customers—old friends with whom we have had happy business relations through many years.

We doubled—then tripled—our output to fill the needs of our old accounts. We added to our production facilities . . . hired many more men . . . are working extra shifts at time-and-a-half.

All this has not been enough. We have been called on to produce more and more for national defense. We are proud of the job we are doing to help meet the emergency, but it is difficult not to be able to serve our old friends equally as well. In the face of these conditions, the Triplet Company has adopted these policies "for the duration."

FIRST: We will continue to serve you by our service to our mutual responsibility—the national emergency.

SECOND: We will continue to do everything we can to fill orders from our regular customers, even though some deliveries may be temporarily delayed. No business from new accounts has been nor will be accepted until after our old friends have been served, except where priorities make it impossible to do so.

THIRD: Our engineering and research departments will continue to work on the development of superior equipment and improved methods to serve you still better when we can resume normal operations.

The present emergency is incidental and as we work towards the future, we will do our best to continue to merit your confidence and loyalty.

President
The Triplet Electrical
Instrument Company

MANUFACTURERS OF PRECISION
ELECTRICAL INSTRUMENTS

34 • SERVICE, FEBRUARY, 1942

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QUANTITIES OF THIS VITAL WAR MATERIAL . . .**



TYPE DY

Wet electrolytic condensers—and screw-base aluminum cans—dry—are SCARCE! War restrictions make it impossible for any condenser manufacturer to obtain the necessary screw-base aluminum cans in sufficient quantity for all replacement purposes.

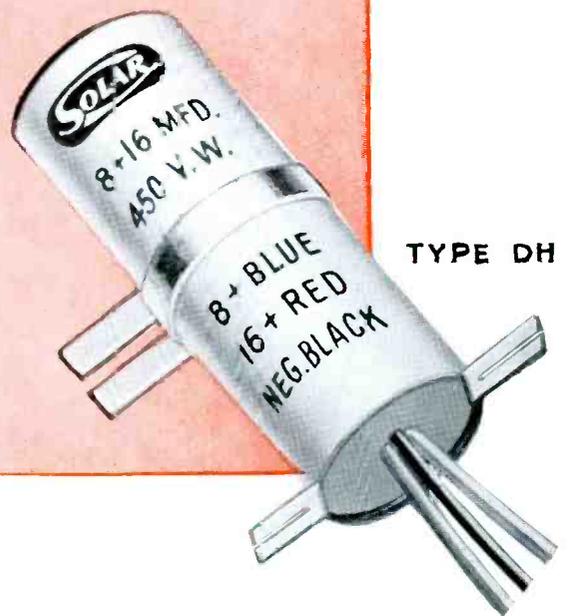
To immediately offset this handicap, Solar presents two effective and economical types as practical substitutes, available promptly from your Solar distributor.

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Processed cardboard containers. Provided with both mounting strap and mounting feet, for horizontal or upright mounting. Available in a wide range of single and multiple capacity units at all voltages.



TYPE DH

Write for Catalog 11
and helpful "Alternatives" guide SA-1.



MANUFACTURING CORPORATION, BAYONNE, N. J.





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These factors help explain why practically the entire production of RCA Test Equipment is today being supplied on Defense orders for War needs and War material manufacture. Tomorrow's users, however, will benefit, not only through RCA's increased facilities for production but, even more so, through the far-reaching experience gained in the application of this Equipment along almost unlimited lines.



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