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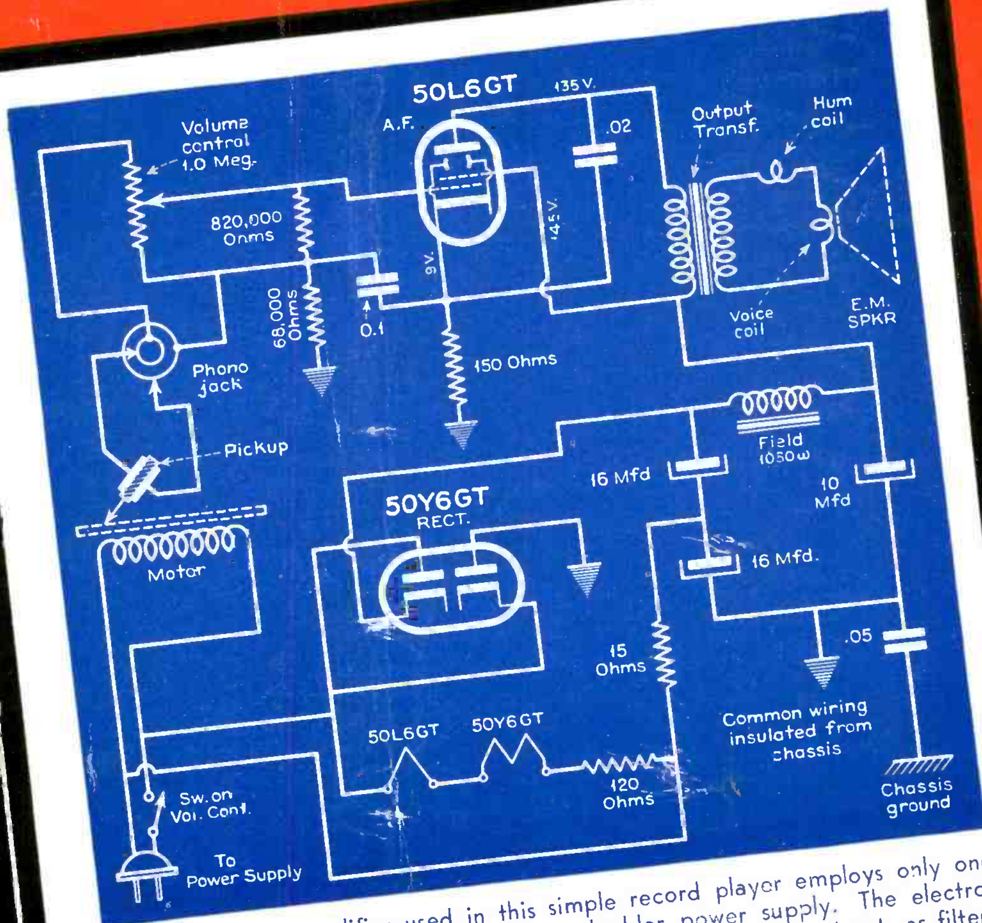
SERVICE



The phonograph amplifier used in this simple record player employs only one amplifier stage together with its voltage-doubler power supply. The electro-dynamic speaker field is connected in series with the B supply and acts as filter. (*See page 19.*)

APRIL
1942

RADIO — TELEVISION

VOL. 11, NO. 4 - APRIL, 1942

SERVICE

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

ROBERT G. HERZOG, Editor

MEMBER AUDIT BUREAU OF CIRCULATIONS

OUR EXPERIENCES in the field of late seem to indicate that manufacturers, jobbers and Service Men have not taken the trouble to study the priorities and allocations system in connection with their orders and purchases. Some manufacturers and jobbers, for example, have been accepting orders for equipment, which to obtain, requires a priority of the highest type. Somehow they hope that there still is a possibility of obtaining it. On the other hand, Service Men have been peeved at other jobbers who have refused to take such orders. In general, there are complaints all around over very slow deliveries on items that can be obtained.

With the country at war, we have been told again and again by our leaders that business as usual is no longer possible. We must put up with all types of inconveniences, delays and sacrifices to enable full use of the country's facilities for war production. And, too, we should study the situation to determine just what types of things we can't get for non-military use, what we can get for essential civilian use, and what items we can possibly substitute for those we can't get.

AIRCRAFT engineering departments are sorely in need of electrical meters for design and test work. With meter manufacturers overloaded with orders, however, even the aircraft industries' A-1-A priority rating can't get deliveries quick enough to permit this vital part of our war effort to go full-speed ahead.

The aircraft producers are willing to pay good prices for any such meters that they can purchase, and have enlisted the aid of SERVICE in an effort to obtain them from our readers. D. E. Gaskill, of the purchasing department of Lockheed Aircraft, suggests that all owners of meters of any type submit lists of such equipment to SERVICE Magazine. The lists should contain all details such as make, model, range and case style, and should also indicate the condition of the instrument.

After the war, when amateur and private activity can be resumed an ample supply of new instruments, undoubtedly of highly improved design, will be available. It therefore seems advantageous to all concerned for you to turn in every spare item immediately.

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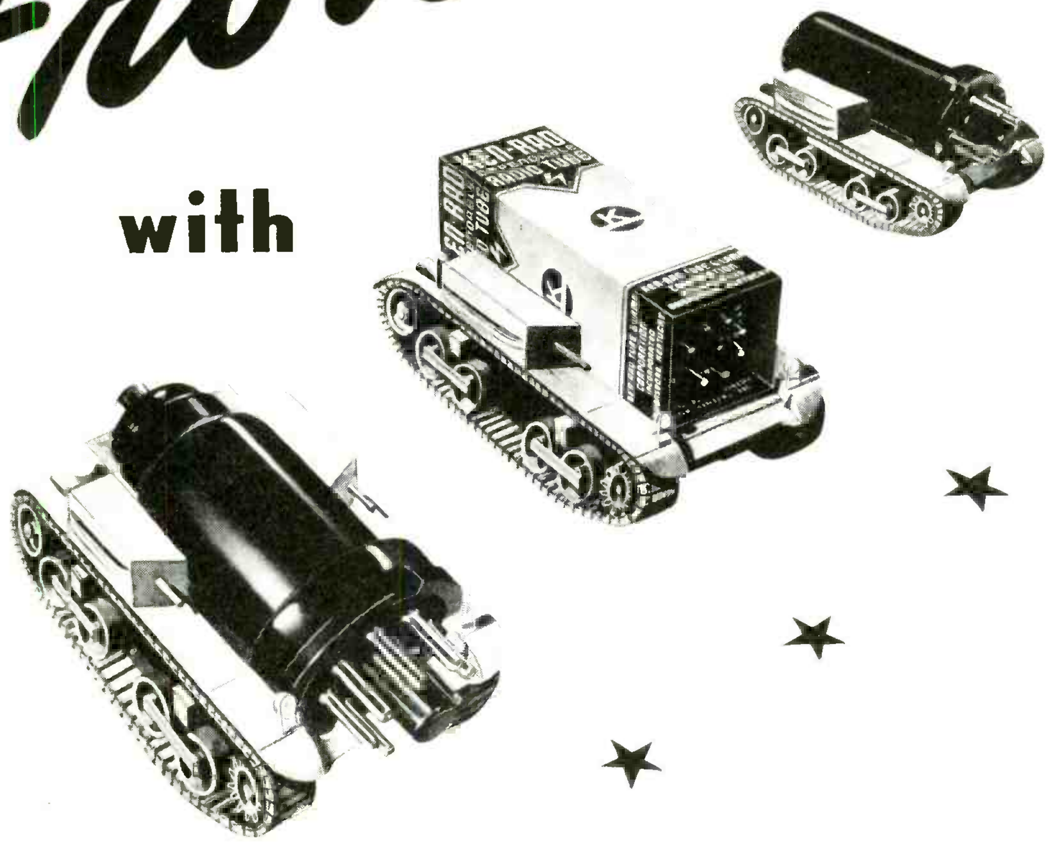
OUT IN *Front*

with



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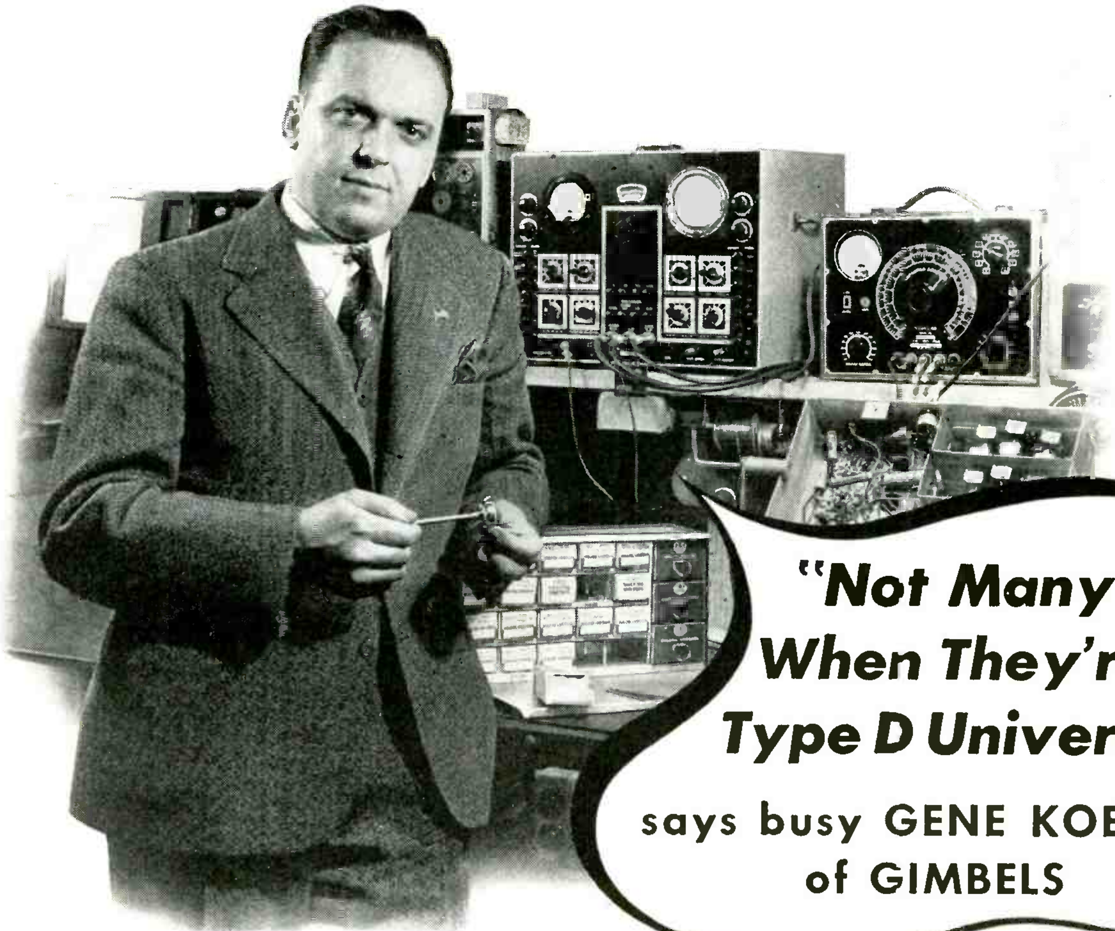

"Not Many!... When They're IRC Type D Universals,"

says busy GENE KOEHLER of GIMBELS

Probably one of the busiest radio service departments in the East, is that of Gimbels department store in Philadelphia, managed by Gene Koehler—and there you'll find the IRC Volume Control Cabinets with their 18 Type D Universal Tap-in Shaft Controls on the job in a big way.

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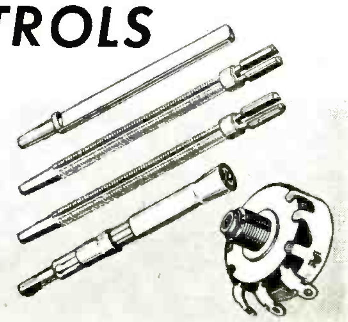

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SERVICE

A Monthly Digest of Radio and Allied Maintenance

ROBERT G. HERZOG, EDITOR

RAILROAD SOUND

By A. B. ARMISTEAD

INSPECTOR OF TELEPHONES, TELEGRAPHS AND SIGNALS
NORFOLK AND WESTERN RAILWAY COMPANY

IT GOES without saying that the railroads have been sorely pressed in these serious times to keep up with the demand for their services. Many have expanded their facilities and others have reopened lines that have been unused for over a decade. In all these cases intercommunications facilities perform in a major role. Loudspeakers, intercommunicators, carrier-call systems, telephones and the like are doing their share to help the railroads do their best job for our war effort.

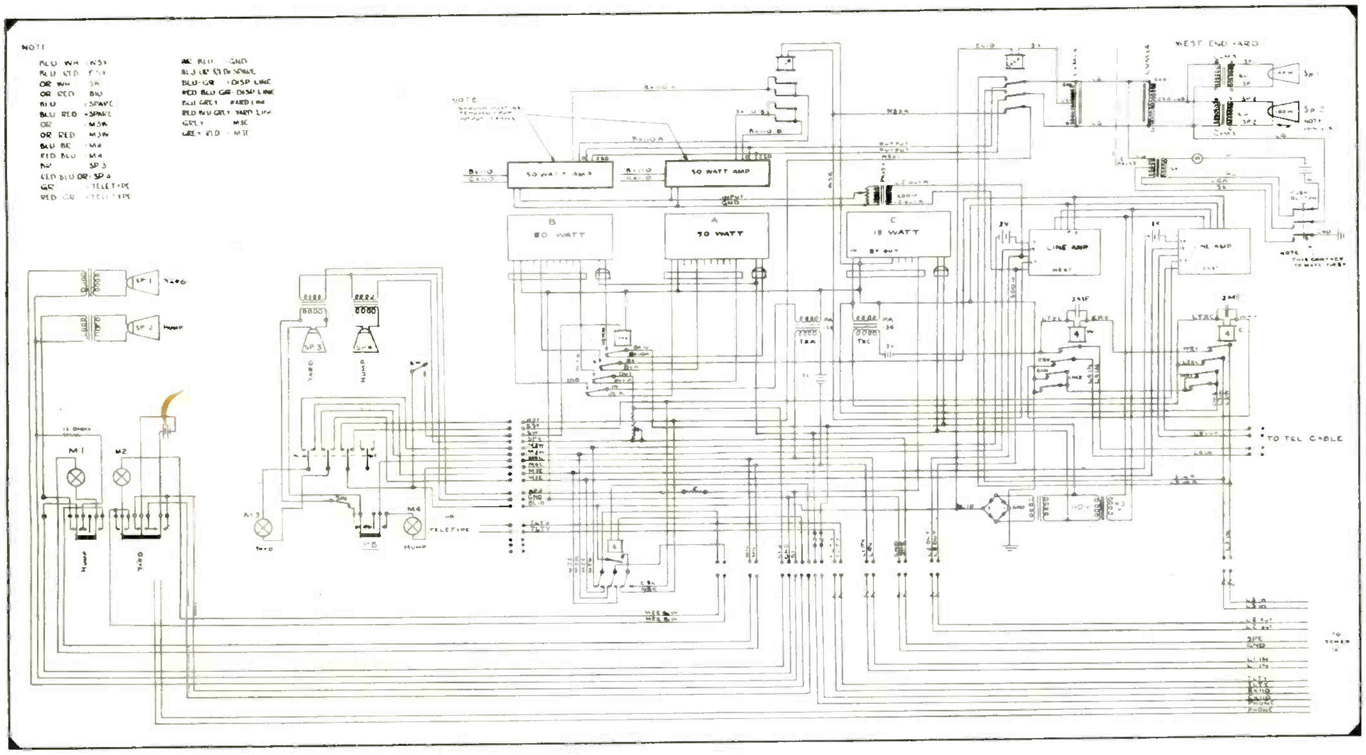
In connection with the construction of a new classification yard by the Norfolk and Western Railway at Roanoke, Va., recently, several types of communications systems were installed. These included PBX telephones at all important locations, teletype printers in the yard office and retarder towers, a two-way carrier telephone between the hump conductor and the engineer of the hump locomotive, and a two-way loudspeaker system serving the yard offices, retarder towers, hump conductor, switchmen and brakesetters.

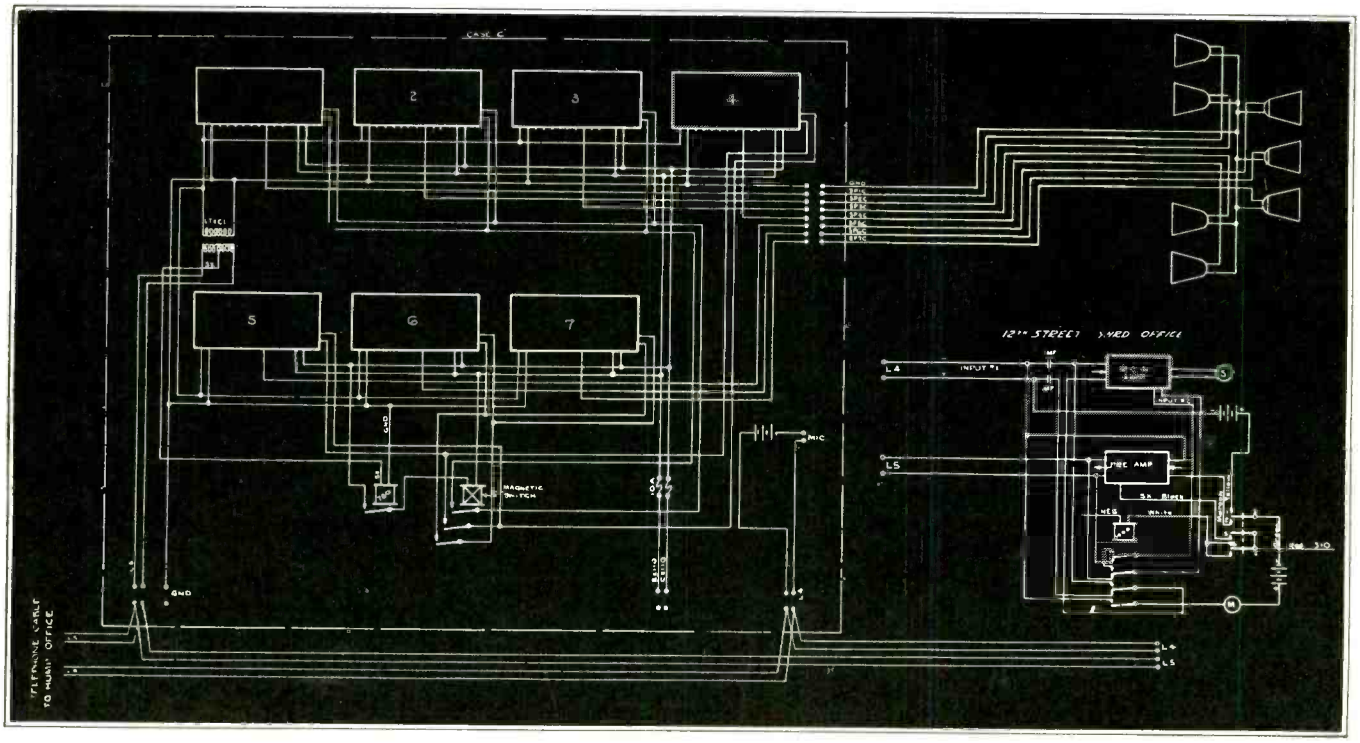
The utilization of an extensive loudspeaker system for the purpose of maintaining communication between the various members of the operating personnel of a classification yard, while not new, involves some interesting considerations. From the technical standpoint the requirements in this case are fairly simple: First, the system must be highly reliable. Second, there must be enough power output from the yard speakers to give adequate coverage and at the same time overcome such background noises as hissing steam, exhaust noises from the locomotives, clanking of coupling cars, etc. And, too, the system must be flexible in regard to selecting called stations, switching, etc.

A complete intercommunication system has recently been installed in the classification yards at the Norfolk and Western Railway Company in Roanoke, Va.

Flexibility

In order to meet the requirements of flexibility, the RCA 50-watt amplifiers purchased, were co-related with pre-amplifiers and appropriate starting, switching and selecting circuits. The latter devices and connections were all





The loudspeaker system in the classification yards is completely interconnected by means of an efficient switching system.

designed, constructed and installed by the railroad company's engineers.

In this installation intelligibility is considered to be the paramount requisite and high-fidelity is not necessary. The tower speakers, especially, being mounted close to the operators, must be clear and crisp but not too loud. For this reason, in constructing the preamplifiers, special design features were included to cut-off all frequencies below approximately 300 cycles. The results achieved well warrant the effort spent in design. Speaker cone travel is reduced and all booming noise is absent from the output. Thus cone life is increased and a high degree of intelligibility is obtained.

The accompanying illustrations show the general layout involved in this installation, together with a diagram of connections and a circuit of the switching system. Upon the layout is indicated the locations of the various buildings, instrument cases, and towers utilized in this communication system installation.

The diagram of connections shows the relationship between the microphones and loudspeakers of the several groups; all related parts are indicated as tied to the same line. The physical location of each microphone-loudspeaker group is shown by the broken line extending to the associated track layout. The typical circuit diagram is illustrative of the electrical connections between the several elements of each microphone-loudspeaker group.

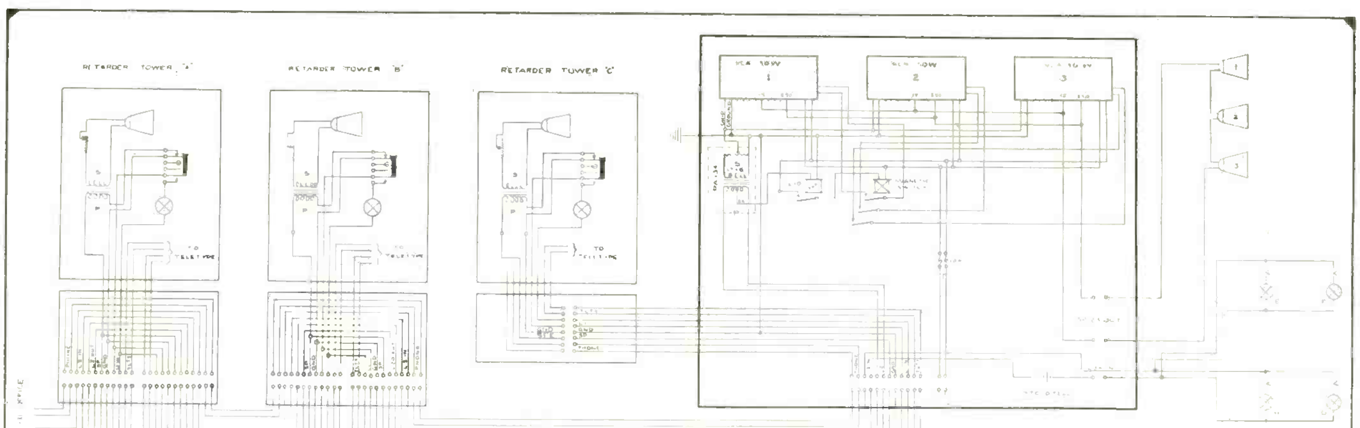
Standard equipment has been adapted and used throughout the loudspeaker system in the classification yards in this Southern railway.

As shown by the diagram of connections, microphones at both the hump and the yard office simultaneously control the clustered loudspeakers on Towers Nos. 1 and 2. The same two microphones may be switched to simultaneously control the clustered loudspeakers on Tower No. 3, and the loudspeaker in the Twelfth Street yard office. Microphones located at the Eastbound switchman's shanty, and scattered across the distribution yard, control the loudspeakers at the hump and in the yard office.

Equipment

All the equipment mentioned, other than the microphones and loudspeakers, is contained in steel cases and is connected to the various control points and loudspeakers through underground cable. Care is being taken to prevent

(*Continued on page 20*)



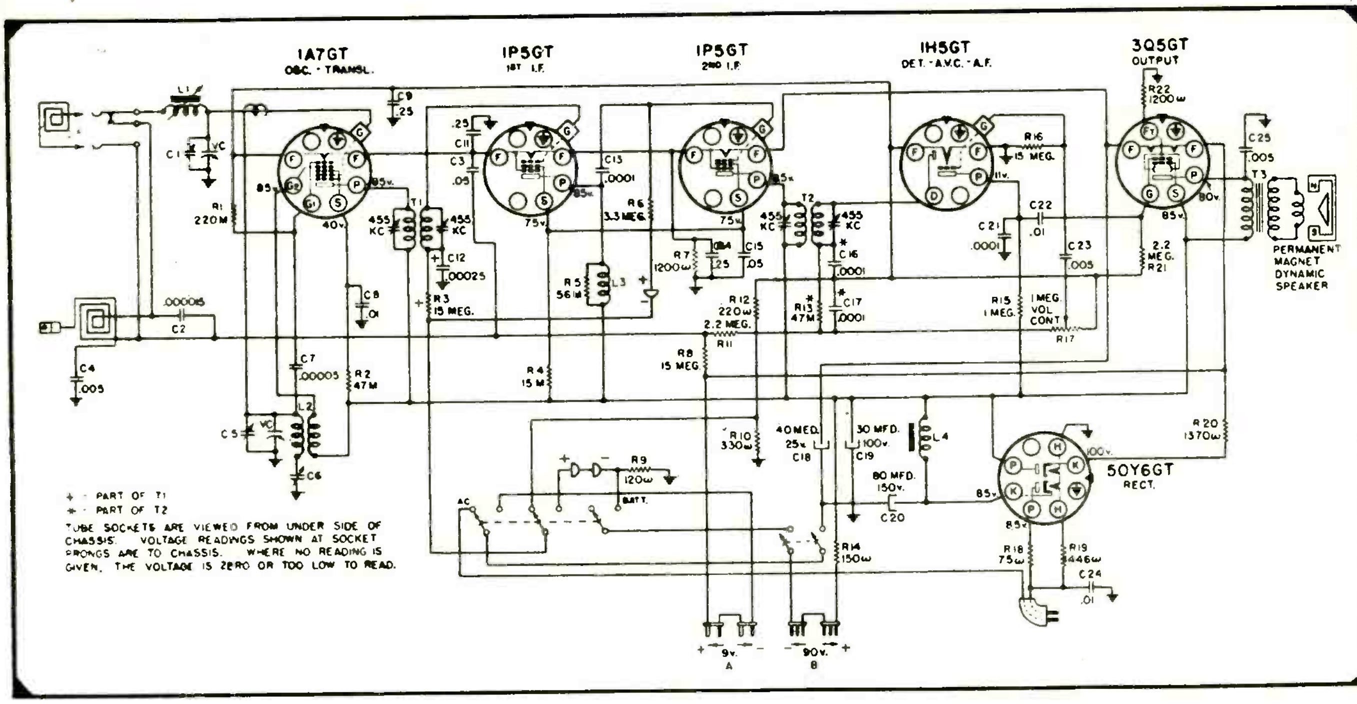


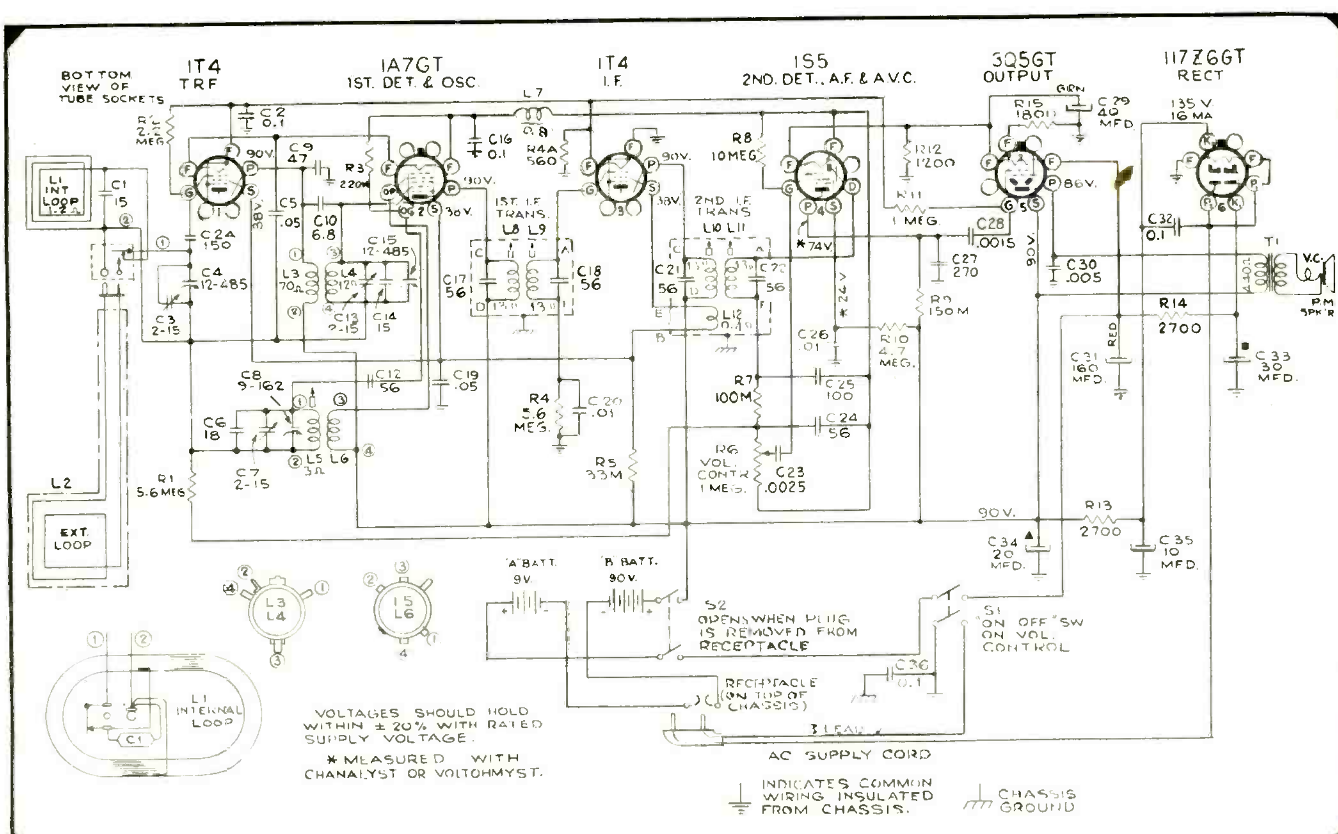
Fig. 2. Silvertone 7083, 7087, 7089.

SER-CUITS

By HENRY HOWARD

With the arrival of spring, battery portables again take precedence—not that they have been up in the attic during the winter—for, since the introduction of combined battery-line operation a few years back, these have been versatile all-year sets. Fig. 1 shows a typical 5-tube and rectifier well-designed, sensitive, portable RCA Model 26BP. This receiver uses a genuine 3-gang tuning with a complete r-f stage. Only the 1A7GT converter is served by avc, the r-f stage having a 2.2-meg grid leak supplying bias while the 1T4 i-f stage uses a 5.6 meg leak.

Fig. 1. RCA 26BP combination line and battery portable. A 117-volt rectifier supplies power for both plate and filament supply during line operation.



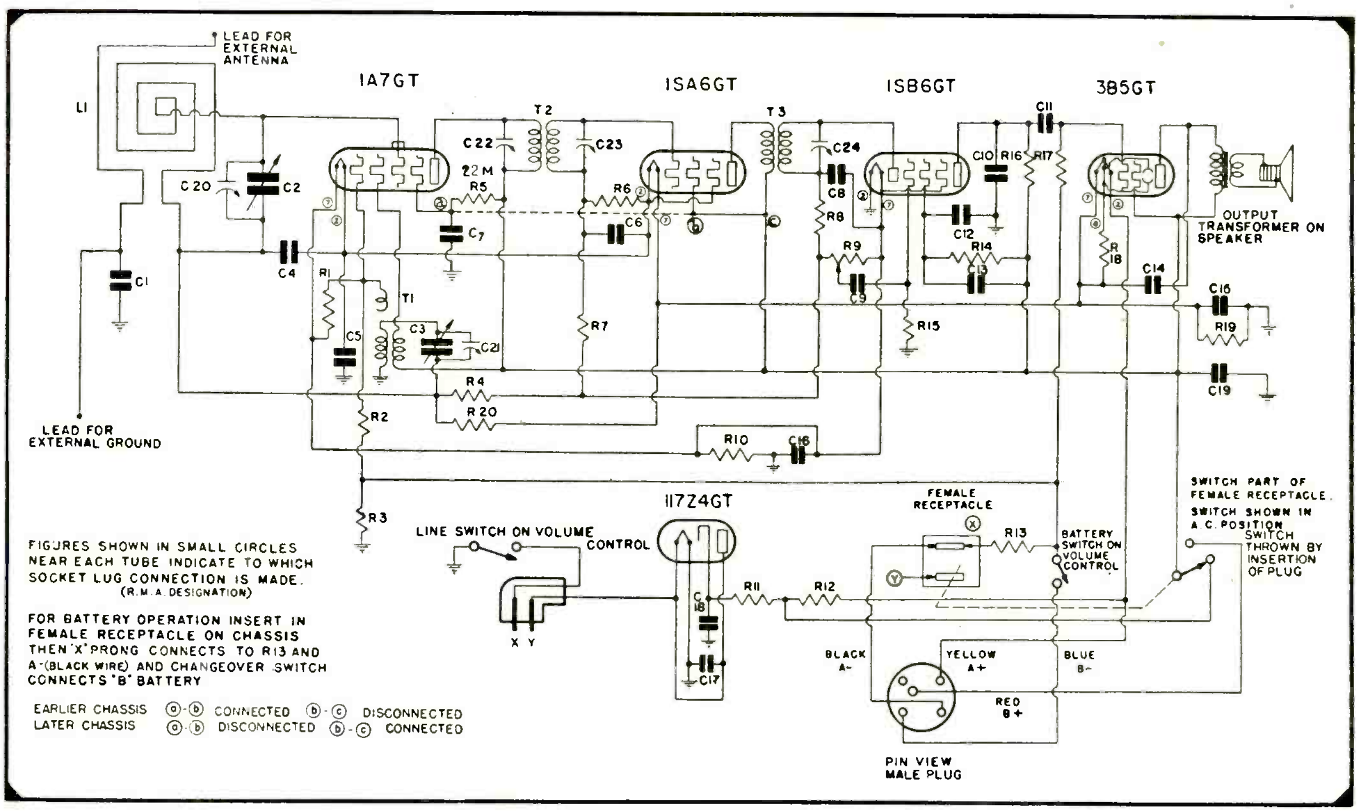


Fig. 3. Emerson FV426, FV433.

Note the arrangement in this stage with the 0.01-mfd by-pass. The i-f gain is increased by the use of a tickler coil in the screen-grid lead which we have mentioned in previous articles.

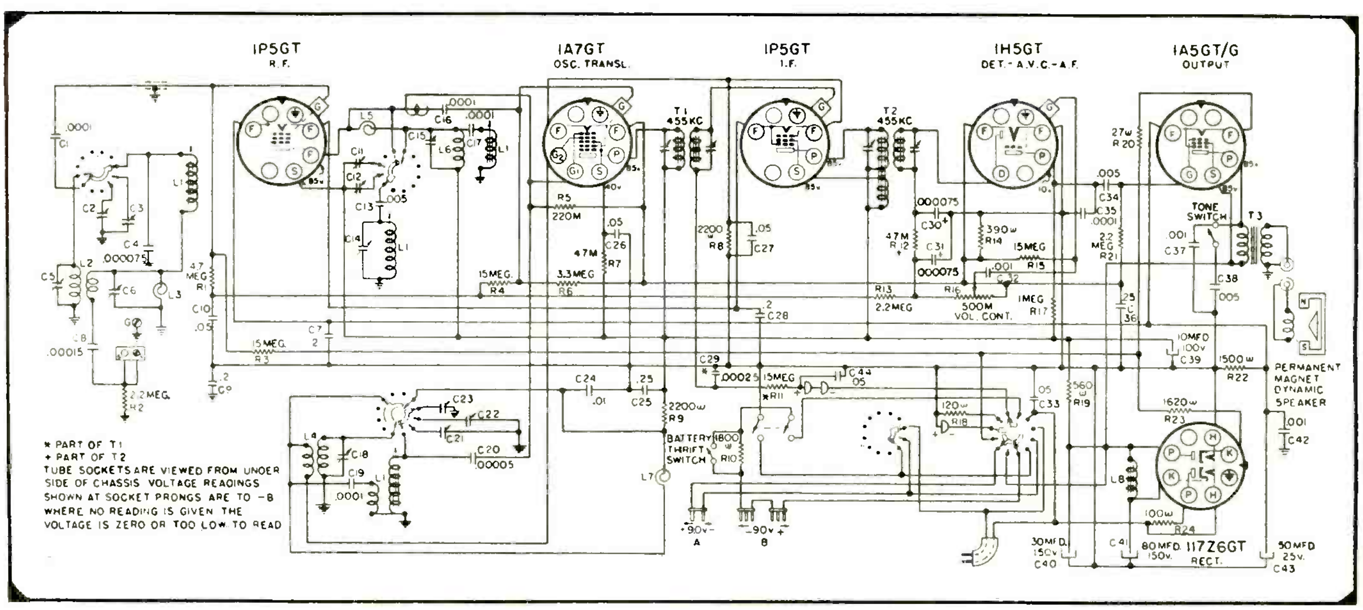
The filters in this receiver are rather complete. The filament supply comes from one section of the 117Z6GT rectifier through a filter consisting of 30-mfd, 2,700 ohms and 160-mfd. Another 40-mfd condenser is used after the first tube, the 3Q5GT. Note the 1,800-ohm equalizer resistor from the filament tap to ground. Between the i-f and converter filament an r-f filter is used. This consists of an r-f choke and 0.1-mfd by-pass condenser. A 560-ohm equalizing resistance is also used at this point. The B-supply filter is conventional. The detector-avc filter uses 100 mmfd, 100,000 ohms, and 56 mmfd. An external loop may be bought as optional equipment when it is desired to operate the set in difficult locations.

Silvertone 7083, 7087, 7089

Silvertone Models 7083, 7087 and 7089 of Sears, Roebuck are 6-tube jobs with two i-f stages. Instead of the popular resistance coupling between the i-f tubes, this group of receivers use a form of impedance coupling in which the first i-f plate load consists of a choke and a resistor in parallel. (See Fig. 2.) The second i-f grid return is through a 3.3-meg grid leak and a bias cell with *positive* towards the grid. This is part of the sensitively compensating circuit for low battery operation in which both i-f tubes are forced to draw plate current by keeping the grids from going too negative. Note two more bias cells in series which are applied to both i-f stages.

The rectifier circuit is quite unusual. One diode of the 50Y6GT is used as a half-wave rectifier while the other is used as a filament resistor. An 80-mfd condenser, filter choke, and 30-mfd, sec-

Fig. 4. Silvertone 7112.



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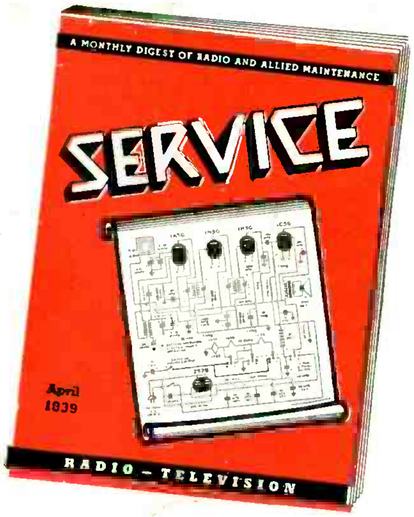

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Henry Howard's circuit analyses each month with diagrams and parts values.

—Sound—Case Histories—Shop Notes . . . . .

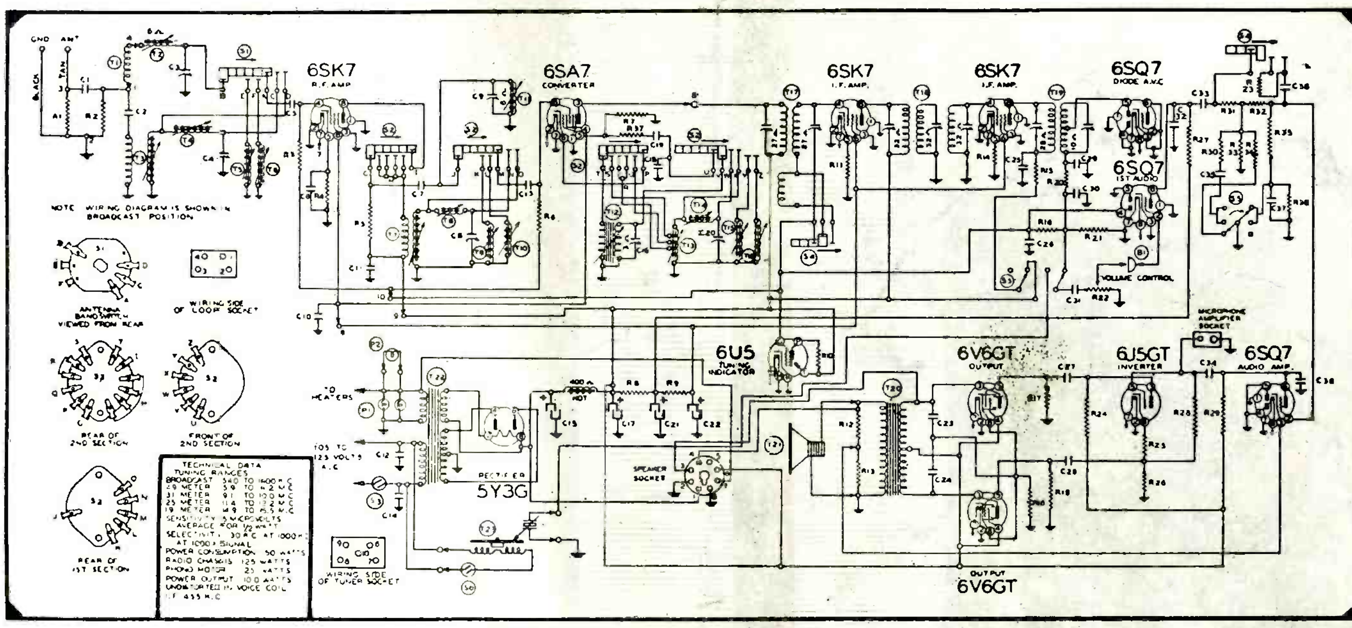
★

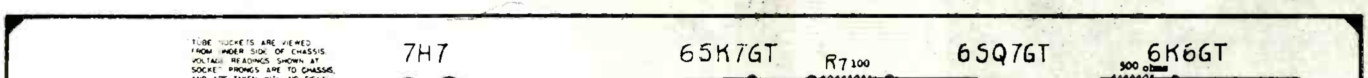
Remember that until further notice the Group Rate ($1.00 Yearly instead of the regular $2.00 Yearly) is still in effect.

ond condenser form a 60-cycle filter for both A and B supplies. Another 40-mfd condenser is used after the 3Q5GT filament as a further filament filter. The equalizing resistor in this output tube is 1,200 ohms.

In addition to the electron coupling from oscillator to converter which is inherent in the use of the Type 1A7GT first detector tube, additional capacity coupling is provided to the control grid. These sets also use iron-core loop-load-

At the right is shown the RCA AVR100 aircraft receiver. Directly below is shown (Fig. 5) the circuit of the Belmont 12A52. At the bottom of the page (Fig. 6) Silvertone 7056.





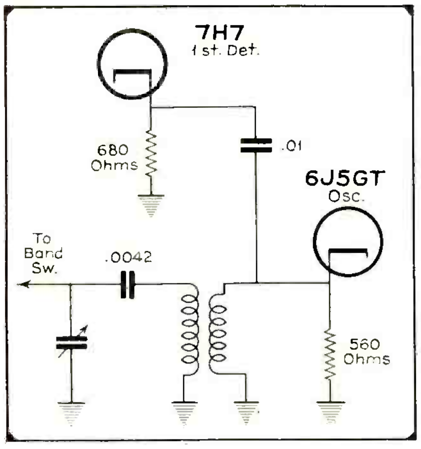


Fig. 7. Silvertone 7071.

ing coils and external loops may be plugged in when desired.

Emerson FV426, FV433

Emerson Models FV426 and FV433 are standard 5-tube battery and line portables which use a 117Z4GT rectifier. The 3B5GT beam-power tube derives its bias from oscillator r-f voltage taken from the grid circuit as shown in Fig. 3. Paralleling the 220,000-ohm grid leak is a network consisting of a 1-meg and 0.47-meg resistors in series, with the power tube grid return connected to the junction. The bias voltage is the half-wave rectified r-f of the oscillator frequency. Filtering action is obtained from the series resistors mentioned plus the 3.3-meg grid leak of the power tube combined with the r-f by-pass condenser (60 mmfd) from the first audio plate to ground. The audio coupling condenser is so large compared to the by-pass that it offers negligible impedance to the r-f.

The volume control has a dual on-off switch which opens both battery and line circuits. For battery-to-line switching a female receptacle is arranged to take the line plug, the insertion of which causes the change-over.

Silvertone 7112

Permeability tuning and 3-bandspread ranges are featured in Silvertone Model 7112, 6-tube battery and line receiver. Fig. 4 illustrates the r-f end showing the tuned r-f stage and the method of tuning to the 4 wave bands. Paralleled coils are used in addition to shunting condensers. Iron-cored i-f transformers are also featured and the second transformer has a tickler coil.

A 117Z6GT is employed as rectifier for line operation with a filter choke in the A and B filter. For economical operation from battery power a thrift switch is provided which cuts in an 1,800-ohm resistor in the minus B lead.

RCA AVR100, AVR101

A bit off the beaten path but of unquestionable interest, we believe, are two midget aircraft receivers for light planes—the RCA AVR100 and AVR101. These are extremely compact battery sets using five common portable series tubes: 1R5 mixer, two 1T4 i-f amplifiers, 1S5 second detector a-f and 1S4 output. Filament drain is 300 ma; B drain is 11-15 ma at 67½ volts, depending upon the volume control setting. The normal frequency range of the AVR100 is 550-1500 kc, 195-405 kc. 278 kc (aircraft traffic control frequency) is claimed without disturbing the dial setting by throwing the waveband switch to a third position. Model 101 is only a beacon receiver covering 195-405 kc. The i-f of both sets is set at 490 kc.

The sensitivity of these midgets is equivalent to average commercial airline performance and the sets are designed to use both loop and standard antenna and one or two pairs of phones. When a beacon antenna is used, ignition shielding is not required in many installations. However, for loop reception, shielding is almost a necessity. The signal voltage, especially when operating on the null for direction finding, is much lower on the loop. Internal shock mountings permit operation under severe conditions. Weights are 3 lb, 7 oz with a battery of 4 lbs and cable of 6 oz. Where a transmitter is carried, the receiver battery may be eliminated.

Belmont 12A52

Belmont Model 12A52, a 12-tube, 5-band combination a-c receiver-phono job, has permeability tuning with a t-r-f stage, two tuned i-f stages with a triple-tuned transformer between them, and a 3-stage audio system with feedback and separate bass and treble tone controls. The i-f system has a wide-band response for high-frequency repro-

(*Continued on page 29*)

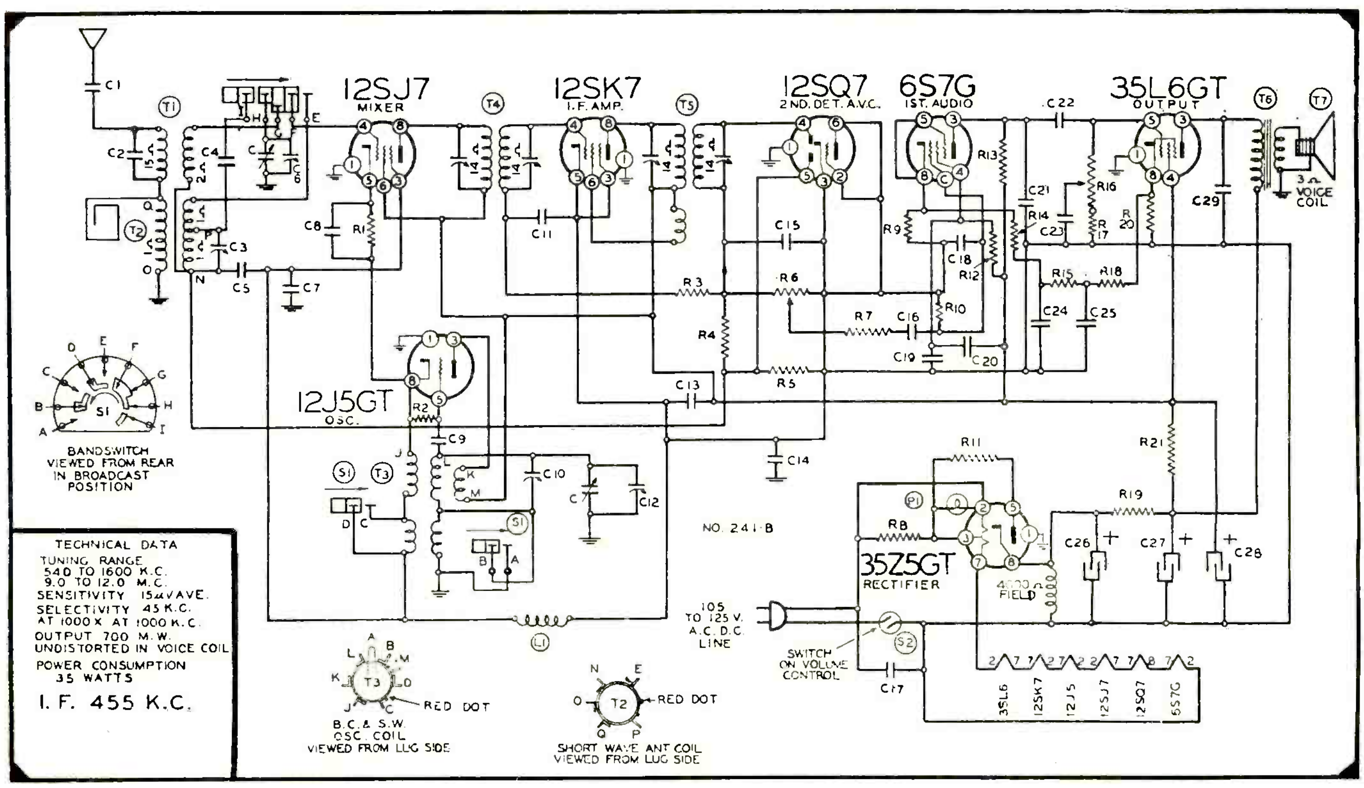


Fig. 8. Airline 14BR736B.

SOLVING SHORTAGE PROBLEMS In A-F Circuits

By Robert G. Herzog
EDITOR

IN THE PAST few months we have been presenting, in these columns, information covering the basic fundamentals of superheterodyne circuits. Typical circuits have been shown and their variations explained. It has been the purpose of this series to give the reader an understanding of underlying theory, in order to enable him to make slight alterations in the circuit constants and in design without impairing receiver performance, in the event of shortages of particular parts. Every attempt has been made to give complete information in simple form so as to cover as wide a scope as possible.

Various receiver circuits from the antenna input through the second detector and avc circuits have been covered in previous articles. This month's article deals with the audio-frequency portion of the receiver.

Resistance Coupling

In the early days of radio, audio stages were coupled by means of transformers. More recently resistance coupling has become practically the only method of interstage audio signal transfer. Almost without exception modern receivers use transformers only to couple the loudspeaker to the output tube.

Even in push-pull stages, resistance coupling is used universally in present-day receivers. To obtain proper conditions for push-pull operation phase inverters are used. These devices were discussed at some length in the September, 1941, issue of SERVICE.[1]

Audio Circuits

Audio amplifiers are generally well understood, although the reasons for the choice of certain values of resistance or capacity in coupling the audio stages are not always clear. In Fig. 1 the plate resistance for the triode amplifier tube, which is generally combined with the second-detector tube, is designated as R_p. The coupling condenser C and the grid resistor R_g are drawn in a rather unusual arrangement, primarily to show that these two components in series form a parallel circuit across the plate load resistance R_p. The a-c resistance of C and R_g together are almost always greater than R_p. Values for C range between 0.006 and 0.02 mfd in different makes of receivers; R_g from 100,000-ohms to 3 megohms in different models. The condenser C and the resistor R_g are paired and the choice of the value of one more or less designates the value of the other.

It cannot be stressed too greatly that the coupling condenser (C) must be of the highest quality obtainable. Any leakage in this unit will put a positive bias on the output tube. Such a bias will cause the tube to draw extremely excessive current and can lead to injury of the tube, and often, to the rectifier and power transformer as well.

The control grid of the output tube is connected between the condenser C and the resistor R_g. These two elements can be compared to a potentiometer with the control grid of the output tube connected to the potentiometer arm. It will be recognized with this type of illustration that if condenser C is of small capacity, having a high impedance to low frequencies, the low-frequency signal fed to the grid of the output tube will be much smaller than the proportion of high-frequency signal which is passed along from the detector. Consequently, for good quality R_g should have high resistance and condenser C should be reasonably large.

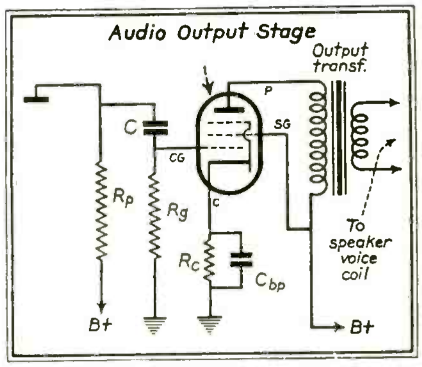


Fig. 1. A popular method of obtaining bias for the output stage is by means of a self-bias resistor connected in series with the cathode.

Individual Variations

Figs. 1 to 4 inclusive show typical output stages. In Fig. 1, bias for the

Fig. 2. Bias for the output tube is taken, in some receivers, from the drop across a resistor connected in the negative B supply return.

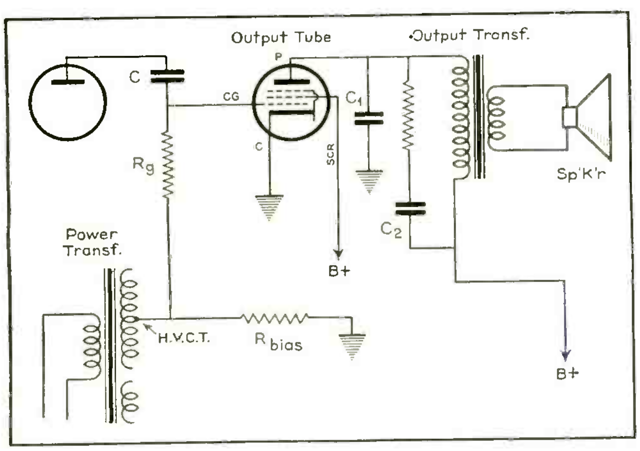
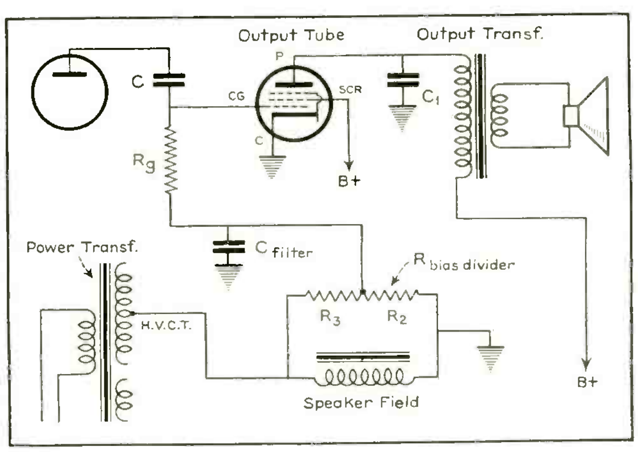


Fig. 3. Part of the voltage drop across the speaker field is often utilized to give bias for the output stage by means of a voltage divider.



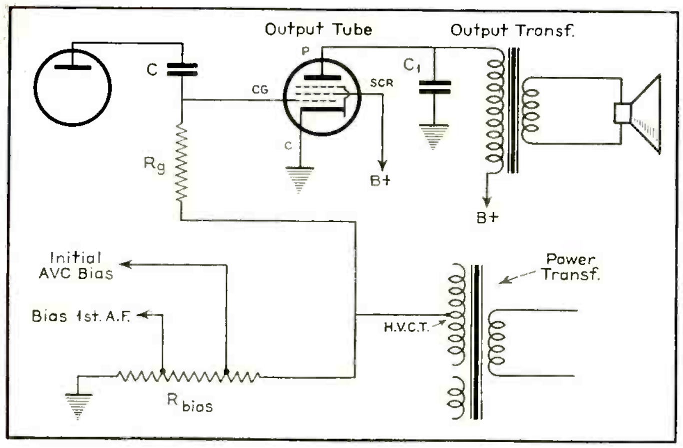


Fig. 4. Full advantage of the voltage drop across the resistor, connected in series with the B-supply return, is taken in the circuit shown. Bias is supplied to the output stage and to the first a-f and avc circuits as well. Some such circuits provide a by-pass condenser across the whole resistor.

output tube is obtained by the common means of employing a resistor in series with the cathode. The plate and screen current returning through this resistor cause a voltage drop across it. This drop is such that the cathode is at the positive end and, if properly chosen, provides suitable bias for the tube. The value of this resistor, of course, depends upon the current through it and the bias voltage required for the proper operation of the output tube. Its value can be calculated by applying Ohm's law if the voltage and current are known. Tube manuals generally contain charts which list the proper bias resistor for commonly used output tubes for a variety of operating conditions.

In a single tube output stage degeneration will occur at the expense of part of the output stage gain, unless a condenser of rather high capacity (5-mfd or more) is used across the cathode-bias resistor. In some models the condenser is deliberately omitted to provide the advantages of degeneration in spite of the loss in gain.

Because of the large plate and screen current which the output tube draws, the cathode resistor is required to have quite a high power handling ability and is generally larger than the average resistor used in other parts of the receiver circuits. Its tolerance is also somewhat closer than that of cathode resistors used in other stages.

Condenser C_1 is used to by-pass high harmonics of the audio signal and any parasitic oscillations that have come through the circuit before they are fed to the speaker. Its value varies from 0.004 to 0.03 mfd, depending on the output tube.

In Fig. 2 the high-voltage center tap from the power transformer is connected to the chassis through a resistor of low value (R_{bias}). The entire B voltage must return through this resistor. The high-voltage center tap is therefore at a slightly lower *negative* voltage than the chassis. This negative drop is used as bias for the output tube and the tube's grid return is connected to the negative end as shown in Fig. 2. Because of the large current which passes through R_{bias} its wattage rating is usually higher than that of the ordinary carbon resistor found in radio receiver circuits. It is usually of the wire-wound voltage divider type. Its value is somewhat critical.

The resistor and condenser shown in series across the primary of the output

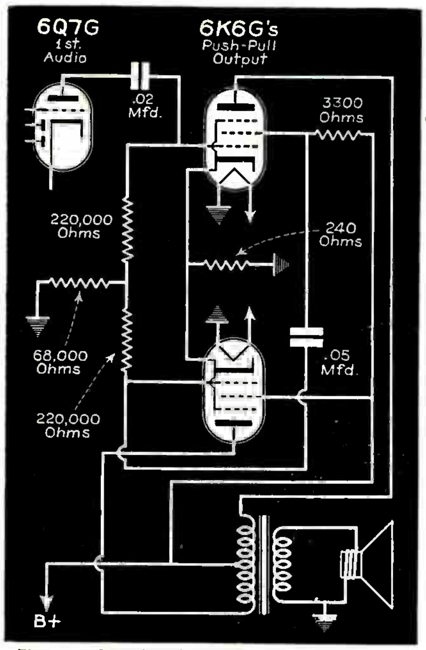


Fig. 7. Simple phase inverter uses signal voltage across a resistor connected in series with screen.

transformer in Fig. 2 are employed in some circuits to present a better impedance match to the output tube, over the audio-frequency range. The values of these components are not critical, and depend on the type of tube and speaker used.

In Fig. 3 bias for the output tube is also obtained by connecting the high-voltage center tap of the power transformer to a point below chassis potential. In this case, however, to save the voltage normally lost across the speaker field, this field is used to provide the negative drop. Since the drop is usually larger than that required for the output tube bias, a resistance divider is required across the speaker field. The ratio of R_2, to $R_2 + R_3$ gives the bias. Both R_2 and R_3 are usually quite large, of the order of a megohm or more. High values are used so that there will be no appreciable hum by-passing effect across the speaker field.

When pentode output tubes were first introduced speaker fields were provided with a tap (at approximately 300 ohms for a 1,800-ohm field) to provide this bias, and the resistors were omitted.

Fig. 4 also shows bias for the output tube from a resistance in the negative return of the B supply. In this circuit a part of the drop is used to bias the first a-f stage and to provide initial avc bias as well. Otherwise the circuit is similar to those of the other figures.

Phase Inverter Circuits

Figs. 5, 6, 7, 8 and 9 show various methods commonly employed to provide phase inversion for proper operation of push-pull output stages. One of the earliest methods used is shown in Fig. 5. In this circuit the input signal, applied to tube A, is amplified and passed on to one of the output tubes in the normal manner. Part of the signal (after it has been amplified by tube A) is taken off the grid load of the output tube and applied to tube B. This latter tube is commonly called the phase inverter. The portion of signal applied to tube B would depend upon its amplification. For example, if the amplification of tube B were, say 10, 1/10 of the signal appearing across the grid load would be applied to tube B. In this case resistor R_1 would therefore be nine times that of R_3 to provide the proper ratio. The output of tube B is passed on to the second push-pull stage. It will be noted that tube B raises its portion of the signal to the same level as the output of tube A and inverts it to the proper phase (180° out-of-phase with A) for the second push-pull stage.

In push-pull stages complementary compenents should be as nearly alike as possible, so as to provide the proper relationships for push-pull operation. Except for this specification, and for the proper selection of R_1 and R_3 in Fig. 5

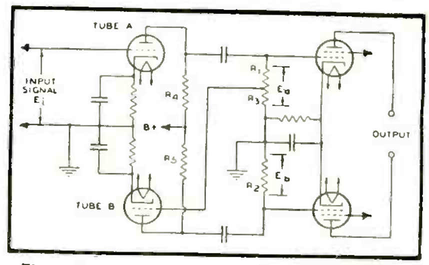


Fig. 5. A portion of a-f signal is returned through an extra tube to invert it for push-pull operation.

1. Phase Inverters, by Robert G. Herzog, SERVICE, September 1941, p. 14.

to provide the necessary signal input ratio, values of resistors and condensers in the phase inverter circuit are no more critical than those of other audio stages.

Fig. 6 shows a type of phase inversion that has enjoyed some popularity in the past few years. In this type of circuit the phase inverter tube acts as a sort of signal divider. The audio signal for the first push-pull stage is taken from the plate of this divider, while that for the second push-pull stage is taken from the cathode of the divider. The resistors R_1 and R_2 in this circuit are equal and are approximately half the value of the normal load resistor.

A single tube provides both amplification and phase inversion in the circuit of Fig. 7. A resistor of low value is connected in series with the screen of the first pull-pull output tube. The signal voltage developed across this resistance is fed to the second push-pull output tube. The value of this resistance determines the portion of the signal which will be fed to the second tube and depends upon the tube types employed.

A more recent innovation in phase-inverter circuits is shown in Fig. 8. This circuit is commonly known as the self-balancing phase inverter and permits a somewhat wider range of tolerance in the choice of circuit components. This tolerance is permitted because a certain amount of degeneration is provided. Fig. 9 shows the same circuit adapted to a fixed bias arrangement.

In these circuits a resistor (R_3) is connected between ground and point (a) and is common to the plate circuit of tube A and to the plate and grid circuits of tube B. Because of this common connection the magnitude of the signal voltage across R_3, which is applied to the grid of tube B, depends on the difference between the values of output-signal currents of tubes A and B. Hence, the effects of variations in the value of R_3 or the effects of possible variations between different tubes of the same type used in position B are very small. The circuit is degenerative, because a portion of the output of tube B is fed back to the input of tube B. Hence, the stability that is characteristic of degenerative amplifiers is obtained. It should be noted that the gain measured from the input (E_i) to tube A to the output (E_o) from the transformer's primary is only a few percent less than that obtained from the circuit of Fig. 5.

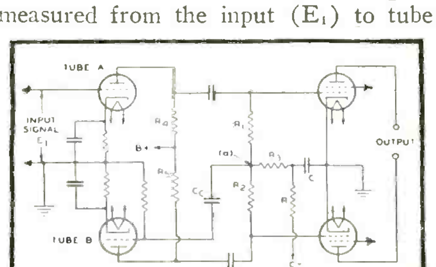


Fig. 9. The self-balancing phase inverter can be adapted to a fixed-bias arrangement.

The ratio E_a / E_b cannot be made equal to unity with this self-balancing circuit by any adjustment of the value of R_3, because of the degenerative action. However, with the values of resistors ordinarily employed in this circuit, E_a / E_b is approximately 1.1. A 10 percent unbalance in the push-pull output stage of a receiver can easily be tolerated. An analysis of the circuit shows that, as the gain of tube B is increased, the ratio of E_a / E_b approaches unity.

Values and tolerance of resistors R_1, R_2, R_4 and R_5 that are usually employed in the circuit of Fig. 5 may be used in the self-balancing circuit.

Possible Substitution

The various resistors and condensors used in the circuits shown in the illustrations this month do not always permit the large percentage of variation possible in other parts of receiver. For example, in the simple output stage shown in Fig. 1 any change larger than 20%, in the value of the coupling condenser (C) will cause a corresponding change in the frequency response of the receiver, unless a similar change is made in the accompanying grid resistor (R_g) in the opposite direction. Any great change in both of these components will alter the plate load of the previous stage, since they are connected in parallel across it. For this reason changes should be restricted to within 20 per cent of the value specified.

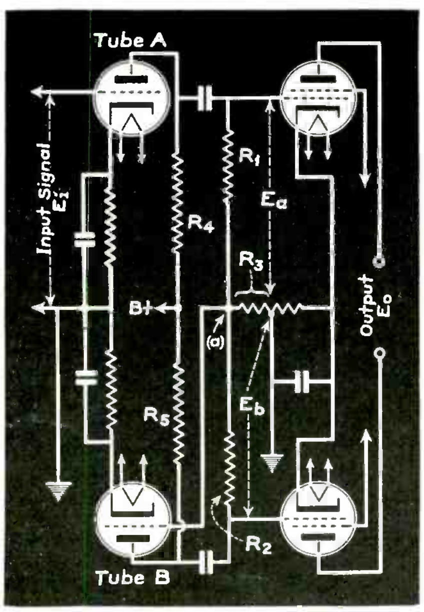


Fig. 8. Self-balancing phase inverter provides the conditions for push-pull operation.

The by-pass condenser across the cathode-bias resistor (R_c) is not critical and any value larger than that specified may be used. In some receivers manufacturers omit this condenser to provide a degree of degeneration. This procedure may be followed where the gain in the output stage is sufficient to permit it.

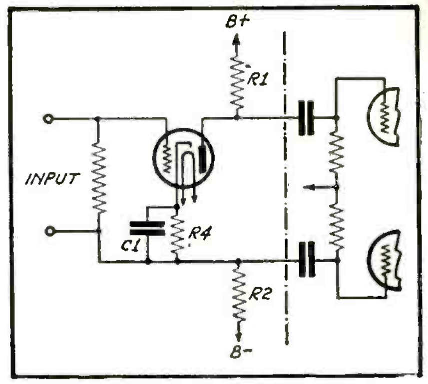


Fig. 6. This circuit divides the normal plate load between the plate and cathode circuits.

The plate by-pass condenser (C_{bl}) is not too critical and a change of 25 percent will not affect the performance noticeably.

In Fig. 2, a 20 percent alteration is permissible in the values of any of the components shown, except R_{bias}. Similar changes are also permissible in Figs. 3 and 4, except for the bias resistor R_{bias} in Fig. 4, where duplicate values with close tolerance should be employed.

In degenerative circuits a variation of plus or minus 25 percent in parts values is generally allowable, since any ill effects will be cancelled by the feedback.

Where self-bias is employed, and doubt exists as to the value of the bias resistor, it is suggested that the reader consult one of the tube manuals mentioned above. By following the specifications given in these books good results can be obtained in all but very special cases.

With the exception of the bias resistors in the various phase inverter circuits shown and the screen resistor of Fig. 7 and the resistors R_1 and R_3 in Fig. 5 a variation of 20 per cent + or — is permissible in any of the other components. It is advisable to keep the values of the bias resistors, as well as the others mentioned, to within 10 percent of those specified by the receiver manufacturers.

Summary

The fundamentals of audio amplifiers are simple and are easily mastered. The choice of values for component parts is dependent upon the types of tubes chosen, and is usually specified by the tube manufacturer. Listings showing these values are found in easily available tube manuals.

Resistance coupling in single output

(*Continued on page 29*)

Wien Bridge
AUDIO OSCILLATOR

By ROBERT STANG

MOST SERVICE MEN recognize the value of the audio oscillator as an auxiliary testing device. Many times, even during the course of routine service jobs, when the Service Man encounters an elusive cabinet or speaker rattle, he wishes he had the instrument. Frequently, after he spends a disagreeable half-hour session waiting for the rattle that occurs only momentarily on a certain note, he makes up his mind to buy the oscillator. Just as often, however, the thought is short lived and for one reason or another he puts it off.

Until recently practically all commercial audio oscillators were of the beat-frequency type. Successful construction of this latter type of unit brings with it all the problems encountered in all resonant frequency generating devices that employ coils and variable condensers. Coil impregnation is necessary, and proper component placement (which is the only method to avoid parasitic oscillations) is a headache. Drift is commonplace even in the best of the beat-frequency instruments, largely because coil inductance varies with changes in humidity and temperature.

Whenever the device is used it is necessary to reset the calibration by beating the output against the power-line frequency with a neon lamp or visual indicator tube as the null indicator. None of these problems are common to the Wien bridge type of audio oscillator.

It is not difficult to build a resistance-capacity type audio oscillator, in the average service shop, if the proper precautions are taken. In the accompanying article the author endeavors to describe such an instrument in sufficient detail to enable the reader to build it. The unit described is constructed around the RCA Stock No. 41903 electronic control, both for convenience and economy, since these controls are readily available from mail order houses throughout the country. If desired, however, the entire oscillator may be built from the basic parts as indicated in the accompanying circuit.

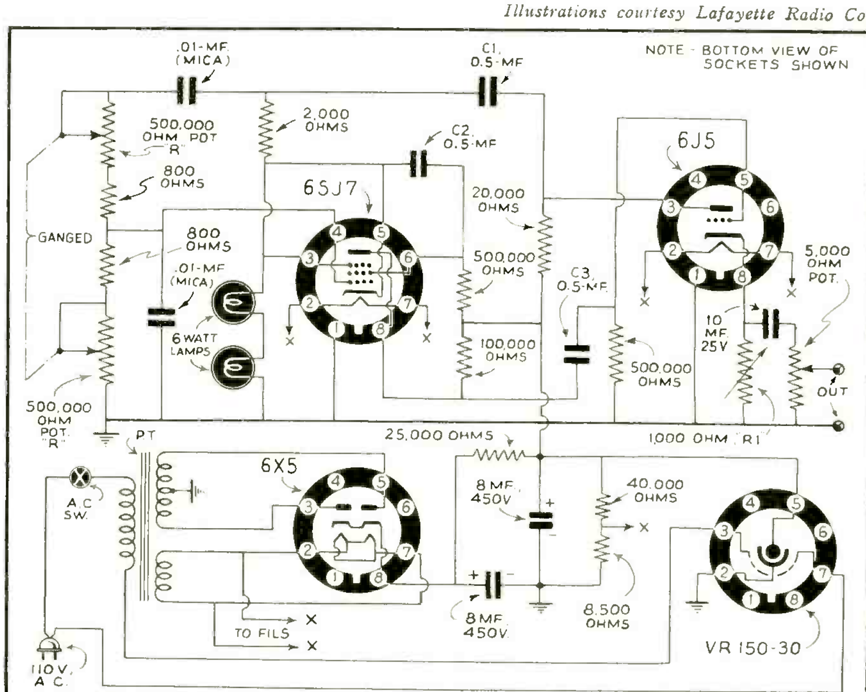
As the name implies, the fundamental circuit of the oscillator is the same type of Wien bridge that is employed in testing condensers. A dual potentiometer makes up two arms of the bridge in the oscillator circuit. One of these potentiometers is connected in the grid and the other in the plate circuits of the oscillator tube. The potentiometer in the grid circuit is shunted by a fixed condenser. The potentiometer in the plate circuit has a condenser, of the same capacity as that in the grid circuit, in series with it, and is connected to the plate circuit so that its feedback to the grid is regenerative. A circuit of this type resonates just as a combination of inductance and capacity does. The resonant characteristic is quite broad, however.

A portion of the feedback voltage is returned to the cathode of the oscillator tube, degeneratively, to improve the output characteristic from a standpoint of maintaining a constant level and also to eliminate extraneous frequencies. The cathode is returned through two six-watt, 110-volt pilot lamps, which serve as "negative-coefficient" resistors, and help to maintain output amplitude level substantially constant throughout the range of the oscillator. A type 6J5 tube functions as an amplifier and buffer. The output voltage is taken through a 10-mfd condenser from a wire-wound potentiometer which serves as attenuator. The advantage of this simple arrangement is that the output can be fed into a wide variety of impedances without serious concern about mismatch.

If desired, the network of cathode resistor, coupling condenser and wire-wound potentiometer can be replaced with a suitable matching transformer, provided with a multi-tapped secondary, for line and voice-coil connections. If the application of the instrument is to be to grid input circuits, however, the resistance attenuator would be more desirable.

The electronic control, around which the unit is designed, was originally intended for use as a capacity relay of the type employed in burglar alarms, window displays, drinking fountains and the like. Approaching an antenna connected to the device upsets the balance of a bridge circuit and operates a relay connected in the output circuit. It is not feasible to use the original bridge circuit for the R/C oscillator. The main reasons for suggesting the RCA unit as

Illustrations courtesy Lafayette Radio Corp.

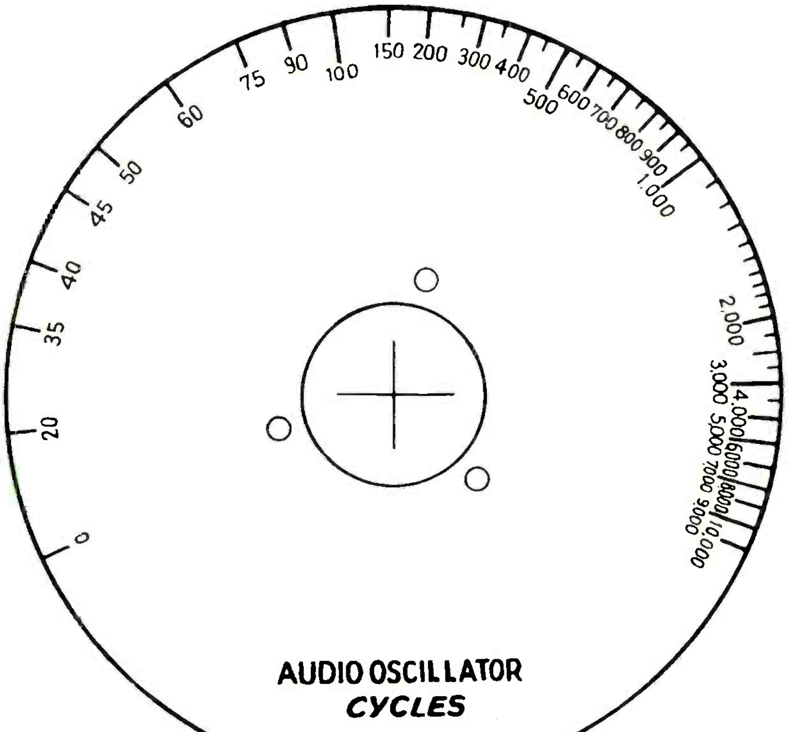


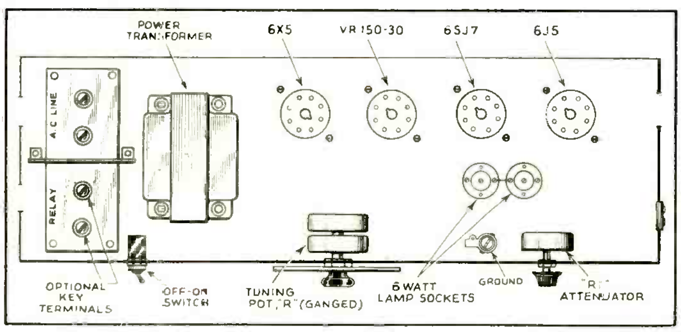
This audio oscillator uses the same type of Wien bridge circuit commonly employed in condenser testing.

a base for the audio oscillator are that it is readily available and is inexpensive enough to make it practical to use its neat chassis, case and built-in power supply. The power supply includes a VR150-30 voltage regulator tube, which makes the output amplitude more stable. The 6SQ7 and 6SF5 tubes originally employed with the unit along with their associated parts can be removed, as can the plate-circuit relay. These parts will probably serve to other good purposes around the shop. All the wiring except that for the filament circuits is disconnected from the sockets that originally received the 6SQ7 and 6SF5. The filament wire on the last socket is shifted from pin 8 to pin 2. This is the socket that will receive the 6J5 tube. Three holes are required in the panel for the dual potentiometer, off-on switch and attenuator controls. The pilot lamp sockets mount near the 6SJ7 tube (see Fig. 2). These lamps do not light or glow in operation.

In removing parts that will not be used in the new unit, note that the slot-headed 1,000-ohm rheostat is used in the cathode circuit of the 6J5 and that the 8,500-ohm candohm type resistor becomes part of the voltage-divider system of the new instrument. The three large by-pass condensers supplied in the electronic control have a capacity of 0.5-mfd each and are used in the new circuit (see Fig. 1). As mentioned previously no changes will be required in the wiring of the power supply or voltage regulator circuits, except that an 8-mfd, 450-volt electrolytic filter condenser and a 25,000-ohm, 10-watt resistor are added as indicated in the circuit diagram (see Fig. 1). Wiring of the unit in general is simple and not critical. All leads should be made as short and direct as possible, consistent with good wiring technique.

One of the 0.01-mfd mica condensers (see Fig. 1) should be placed directly between the grid of the 6SJ7 and the chassis, and the other to a terminal lug from which a wire will run up through a hole in the chassis to the dual potentiometer. The two 800-ohm fixed resistors are wired in series and connected across the terminals of the dual potentiometer as indicated. A wire from the grid of the 6SJ7 connects to their common junction. Note that the rotor arms of the individual potentiometers are wired to their respective high sides. This provides practically linear taper and suits the calibration provided herewith (see Fig. 3).





The dial calibration shown above may be cut out or copied and pasted on the four-inch dial to give reasonably accurate settings for the instrument. The layout shown to the left can be used if the RCA electronic switch is used as a basis for constructing the oscillator.

The point marked X in the circuit diagram (Fig. 1) is to be ignored unless the instrument is also to function as a code-practice oscillator. In this latter case, open all B minus connections which are shown connected to the chassis. Return all of these to one side of the terminal plate marked "Relay." Connect the other terminal to the chassis. The key is connected across these relay terminals and the output of the oscillator can be fed into a pair of phones or into a small speaker. When the device is to be used as an audio oscillator the two terminals should then be bridged.

The frequency range of the oscillator as it is described is from 20 to 10,000 cycles. The upper frequency limit is determined by the values of the limiting resistors in series with the dual potentiometer. If it is desired to extend the frequency range this may be accomplished by changing the value of these resistances in accordance with the formula:

$$R = \frac{15{,}910{,}000}{F}$$

where F is the new frequency limit desired. Instruments of this type have been made to operate as high as two megacycles.

The dial used for the oscillator is a standard 0 to 100 type such as the Crowe 4-inch unit. The printed calibration reproduced in Fig. 3 can be pasted over its face and will permit very approximate selection of frequencies. Because of the large fixed capacities used in the circuit, variations in stray capacity will not cause a great deal of variation in calibration from one instrument to the next, if components with reasonable tolerances are used. If the reader does not desire to deface this copy a tracing or photostat of Fig. 3 can serve as well.

A much more accurate calibration will result, of course, if the oscillator is individually calibrated with an oscilloscope using the power-line frequency as a comparison source and creating Lisajou figures on the c-r tube screen. Another method of calibrating the instrument is by beating its output against that of another instrument that is already calibrated. Data on these procedures may be obtained from any good radio text.

CASE HISTORIES

AIRLINE 62-196

Intermittent noise: If the 0.25-mfd condenser connected between the blue and red resistors on plate of 6B7 tube is leaking the red resistor will become noisy. Replace both. *T. Henshaw*

AIRLINE 62-236

Noisy: A defective 0.0075-mfd, 1,600-volt condenser connected on plates of 84 tube can cause excessive noise. *T. Henshaw*

AIRLINE 62-305

Intermittent: Intermittent reception can be caused if the 0.1-mfd condenser connected between terminals 4 and terminals 5, 7 and 8 of ID5G tube opens. *T. Henshaw*

AIRLINE 62-325

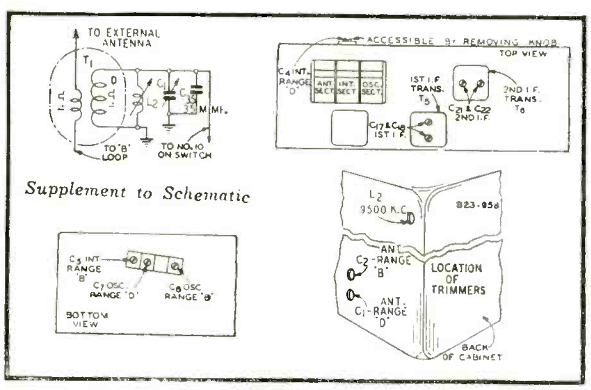
Distortion at medium or low-volume levels: Change ½-meg second-detector screen resistor to 0.7 meg to improve reproduction at low-volume levels. *T. Henshaw*

AIRLINE 62-475

Whistles around 600 *kc:* Install 0.25-mfd condenser in parallel with 8-mfd filter, which will not always by-pass r-f currents, as it becomes older. Replacing the 8-mfd unit will also cure trouble. *T. Henshaw*

AIRLINE 14WG683

Production change: In the issue B chassis, a loading coil with an adjustable iron core is connected across the secondary winding of the short-wave loop aerial as shown in the accompanying partial schematic. The interstage range D and interstage range B trimmers have been relocated.



Supplement to Schematic

CROSLEY 154

Burns out volume control: The volume control in this model is of the antenna shunt-cathode bias type. Since many people use a ground on the antenna post an a-c voltage is put across the control. At low volume this burns out the control. If a condenser of 0.01-mfd capacity is connected from the antenna post to the low end of volume control, and the old lead is removed, the control will be protected. *A. Knickiner*

EMERSON CU CHASSIS

No Volume: This receiver came in with the tubes interchanged. As a result of this the a-c filament current passed through the 6J5GT cathode resistor. The overload burned the resistor down to about 600 ohms. When the resistor was replaced with a proper ½-watt 1,000-ohm unit I noticed that there was no cathode by-pass condenser, which led to considerable degeneration. Probably this condenser was omitted from the original design to avoid overload on strong locals, but in a rural district all the pep obtainable on these t-r-f jobs is needed. A by-pass improved the gain considerably.

As in all jobs involving design alterations considerable judgment must be exercised in applying the changes. After all, we knew this omission wasn't an oversight, but in weak locations the added condenser was definitely an improvement. *R. G. Chrouch*

PHILCO TH7

Set distorts after about twenty minutes of playing: A new 35A5 will generally make the set operate properly. *A. Knickiner*

PHILCO 42-122, CODE 121

Microphonics: To prevent audio microphonics 10,000-ohm resistor (26) was changed to 4,700 ohms. Chassis with this change are marked run 2.

PHILCO 42-126, CODE 121

Improving power output: To improve the audio power output, the 800-ohm resistor (52) ohms was changed to 680 ohms.

PHILCO 42-350, CODE 121

Fluttering: To improve filtering in the rectifier circuit and prevent flutter on the f-m band, electrolytic condenser (40)-(40A), 4-4 mfd, 400 volts was changed to 4-12 mfd. The 4-mfd section is connected to position (40A) and the 12-mfd section in position (40), across the rectifier output.

To prevent parasitic oscillation the ground lead of condenser (30) is removed from contact 4 of the 7V7 first i-f tube socket and connected to contact (8) of the same tube socket.

PHILCO 42-360, CODE 121

Production change: In some later production chassis of Model 42-360 a 7Y4 rectifier tube is used in place of an 84 tube.

PHILCO 42-1001, 1002, 1003, 1004, 1005

Converting the phonograph motor for use on 50 *cycle a-c lines:* The motor in this model is designed for operation on 60-cycle a-c lines. The motor will operate satisfactorily on 50-cycle lines. All that is necessary is to change the drive ratio between the motor pulley and the turntable drive pulley. This is accomplished by putting a coil spring (Philco Part No. 28-8999) over the motor drive pulley. Screw it on the drive pulley counterclockwise with the long pigtail at the top. The pigtail can be cut off after the spring has been placed on the pulley.

PHILCO 42-1003, CODE 121-122

Production changes: The light beam pickup arm (9) of later production Code 122 chassis was changed from metal to plastic. The counterweight, when using the plastic tone arm (Philco Part No. 318-2863) is 3 oz. A new rubber bumper is also required (Part No. 54-4167).

PHILCO 42-1012, 42-1013, CODE 121

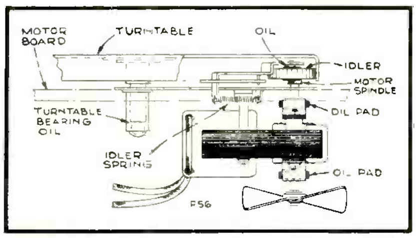
Loop repairs: If the loop aerial (broadcast and short-wave) is removed from the cabinet for replacement or repairs, it should be remounted with the side of the loop having the red or red and white lead toward the rear of the cabinet. This is necessary to increase the stability at the low-frequency end of the broadcast band and to reduce whistles.

(*Continued on page* 22)

RECORD PLAYER

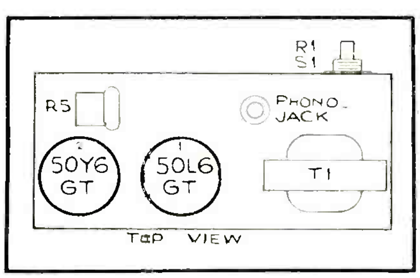
(See Front Cover)

THIS TWO-TUBE model is a complete electric phonograph using a single beam-power tube in an amplifier having an undistorted power output of 2.25 watts and a maximum output of 4.5 watts for jitterbugs (who are unconscious of quality). The high level crystal pickup has sufficient output voltage to drive the 50L6GT to full power output with standard commercial records. Some difficulty might be experienced in playing home recordings which are usually of somewhat lower level than commercial pressings.



A fan-cooled induction motor mounted directly to the top of the 11½ by 8¾-inch fabricoid covered cabinet drives the small turntable by means of a rubber tired idler wheel.

Note the amplifier input circuit. Instead of the a-f cathode being by-passed in the usual manner, with a large electrolytic or, as is being done more and more lately, or left completely unby-passed to provide degenerative feedback, an R/C decoupling system is used. The low side of the 1-meg volume control is run to cathode through a 0.1-mfd condenser and to ground through 68,000 ohms The cathode resistor of 150 ohms does not require by-passing to prevent degeneration because most of the input voltage is routed through the 0.1-mfd condenser direct to the cathode—so it does not get to the ground and cannot get through the cathode bias resistor. There will be a slight output audio voltage drop in this resistor, however, but this is negligible when compared to the tube plate resistance drop.



The simple amplifier together with the 5-inch electrodynamic speaker is contained in the small open-top cabinet. The entire unit (motor plus amplifier) draws only 50-watts from the power lines.

The high power output is made possible through the use of a 220-volt power supply which is obtained from a voltage-doubler, rectifier-filter circuit. Voltage multiplier circuits have inherently poor regulation. Hence, they are best used in circuits demanding constant current and, preferably, not too much. Stated another way, the best operating conditions demand a high-impedance load. We consider the voltage doubler well adapted to this single stage phonograph amplifier, which does not demand excessive current.

The voltage doubler charges two condensers individually, then takes an output voltage from both in series. The condensers here are 16 mfd, so the filter circuit consists of 8 mfd, the speaker field and 10-mfd output condenser. Note the 15-ohm surge suppressor in series with the line connection to the voltage doubling condensers.

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RAILROAD SOUND

(*Continued from page* 6)

crosstalk by proper selection of the pairs carrying input and output circuits.

The power amplifiers used in A, B, and C (see illustrations) are 50-watt, RCA Type No. MI-4288 and feature pushpull 6L6s in the output stage. These are driven from a pair of 6C5s in push pull. The amplifiers are arranged to supply plate and heater voltages for the preamplifier circuits.

The microphones are Western Electric Type F1, carbon-button units. Microphone current is utilized in some of the circuits to operate starting relays. This type of microphone has been selected because the signal output level is high, eliminating the necessity for high-gain preamplifiers. As a precaution against induction noises on long lines, signal levels are maintained as high as practicable without adding complications to the circuit and connections.

Reliability

In order to meet the requirement that the system must be highly reliable, every consideration was given to such problems as proper power levels and proper tube loads. Each amplifier is operated conservatively. The two amplifiers which drive the tower loudspeakers, for example, have resistors in series with the 110-volt input power lines which feed the plate power transformers, in order to control the voltage fed to the amplifiers. Only one of the tower amplifiers is used at a time. The second unit is always available through a changeover relay, should trouble develop in the amplifier in use. The changeover relay is controlled by a switch on the yard office control panel. This arrangement is used because both heater and plate voltage is applied to these amplifiers continuously. All other amplifiers in the system have heater voltage only applied continuously. The plate voltage in each case is switched on as required, by means of the relays in the microphone circuits as mentioned above.

From the standpoint of servicing, any amplifier can be removed without taking the system out of service. Routine servicing includes regular checkup on tubes, batteries and connections. All the main power amplifiers are standard and may be interchanged or replaced by spares if trouble develops.

Power Output

In order to meet the second requirement, that of sufficient power output, each 100-watt RCA loudspeaker is driven by an individual 50-watt amplifier. Enough of these amplifier-loudspeaker combinations are provided to more than fulfill the power requirement. No amplifier or loudspeaker need be operated at its maximum level.

In attempting to cover a large area of this sort with adequate sound level, two methods are possible. A number of small speakers can be placed at intervals, or a number of large speakers can be placed in clusters, arranged so as to cover the required territory. In the former method the problem of voice distortion arises due to the fact that sound from the several speakers reaches the listener at different times and often in such phase relationships that words are partially cancelled or distorted.

To offset this phase distortion the latter method, namely, placing larger speakers in clusters was selected. The resulting two-way communication system covers the new yard and in actual operation has fulfilled all the requirements.

Since instant communication is provided throughout the yard much time is saved in switching and classifying the large freight traffic handled through this terminal. This enables expanding the amount of business that can be handled with the available facilities.

DISPLAYS

• • • • A program to enable radio dealers to take a forceful part in promoting the Victory theme was launched in Mid-March by Zenith Radio Corp., Chicago. The program, according to J. J. Nance, vice-president and director of sales, has a three-fold

purpose: First, to give dealers colorful display material for windows and store floors that will enable them to take an active part in promoting the Victory theme. Second, to explain why radio sets will not be available, after present distributors' and dealers' stocks have been exhausted, by dramatizing how Zenith production has been commandeered by the nation's armed forces. Third, to continue the close association in the public mind of Zenith dealer and manufacturer.

IRON TO GLASS SEAL

TIGHT SEALS between iron and glass, eliminating the need for nickel and cobalt, critical war metals, are now being made with a new development of General Electric scientists, it is said.

From the early days of the electric lamp, a problem of construction has been to make a tight seal between metal and glass. It is also involved in making radio tubes. Even with tubes in which the glass is replaced by one of metal, the lead-in wires pass through glass insulating bushings. The difficulty is that most kinds of glass expand with heat at a different rate from that of the metal. Glass and metal may be tight at one temperature, but when they are heated the glass will either crack or pull away from the metal, because the change in their dimensions is not the same.

Platinum was used in the first electric lamp, since it has nearly the same rate of expansion as the glass then employed. Various substitutes for platinum were devised, which were satisfactory for lamp seals, though they were not adapted to the large seals used for powerful vacuum tubes, for example. However, special nickel-iron-cobalt alloys were developed for this last application.

Since nickel and cobalt are used in many ways for war equipment, and their supply is extremely limited, the new invention is an important one. For certain applications it permits tight seals to glass without the use of critical war materials.

General Electric engineers, Drs. Albert Hull and Louis Navias, have devised a series of glass compositions which can be used with iron and certain iron alloys. The rate of expansion of these glasses is very close to that of iron. In seals using these glasses a further development of Dr. Navias also proves useful. When a glass containing lead is sealed in contact with iron, some of the lead atoms migrate from the glass into the metal. This weakens the joint, and may let air leak into the tube. Dr. Navias proposed placing a thin layer of lead-free glass directly over the metal, then sealing the lead-containing glass to that. The thin glass layer prevents the lead from reaching the iron, yet it is not thick enough to crack and let air in.

CASE HISTORIES

(*Continued from page* 18)

RIM DRIVE PHONO MOTORS

60 *to* 50-*cycle conversion:* A spring sleeve is used to increase the diameter of the motor-drive spindle, to compensate for the slower speed of the motor when used on a 50-cycle line. To apply the spring sleeve to the motor spindle, lock the rotor manually and press spring gently over the end of spindle, twisting the free end of spring counterclockwise (to unwind coil) until the end of spring is flush with end of spindle.

The ends of spring should not protrude, and all coils should be close together, allowing a flat, even surface on the motor spindle to contact the rubber drive. *RCA Service Note*

RCA 16X4

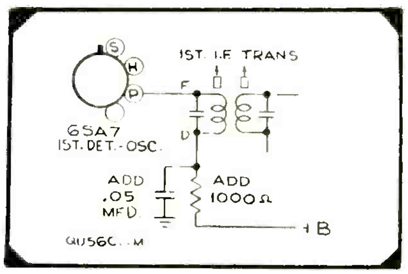
R-f plate load resistor change: In some production, the load resistor in the plate circuit of the r-f tube is changed from 3,900 to 2,200 ohms.

RCA 28X5

Insufficient push-button range: In Model 28X5 if the push-buttons have insufficient range, realign the r-f at exactly 455 kc. If this does not correct the trouble, replace the main oscillator coil (RCA Stock No. 38685) and realign the set. The correct coil has no number stamping; do not use the coil stamped 95106-501.

RCA QU56C, QU56M

Instability: Development of appreciable r-f impedance in the electrolytic filter capacitor, as the condenser ages, creates common coupling and may cause oscillation. To eliminate this possibility,



an R/C filter is connected in the +B lead of the first detector plate circuit, as shown in accompanying sketch.

RCA T80

Push buttons hard to operate: Loosen the dial pointer cable and the bind will disappear. Also put a little lubricant on the dial pointer tracks.

A. Knickiner

RCA 158 AND 160B CATHODE-RAY OSCILLOSCOPE

Filter circuit change: In some first production of Model 158 and 160B cathode-ray oscillographs, numbered in the 2,000 series, the 0.1-mfd first-filter capacitor may short due to a starting-voltage surge. To prevent recurrence, replace the 27,000-ohm input filter resistor (R38 in 158, R33 in 160) with a 120,000-ohm, 1-watt resistor. This change should be made when the shorted 0.1-mfd capacitor is replaced.

RCA 160 CATHODE-RAY OSCILLOSCOPE

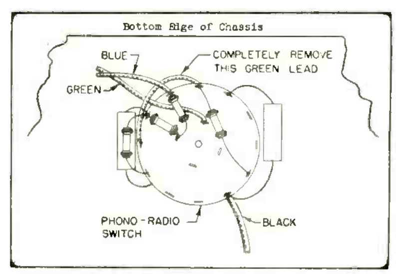
Vertical "Bounce": The 160 oscillograph has extremely good low-frequency response, passing a 4-cycle square wave with good fidelity. It is possible to encounter instances in which a line-voltage meter, due to its inertia will indicate little or no variation of voltage, whereas the oscillograph will exhibit noticeable vertical "bounce" due to line-voltage fluctuations.

If you desire to retain the normal low-frequency response of the 160 yet have a power line which varies in voltage appreciably, it is necessary to provide voltage regulation, such as TMV173 voltage regulator. However, if the extreme response of the 160 is superfluous for the particular application in mind it can readily be reduced, affording a reduction of the "bounce" to an unobjectionable value. This is accomplished by removing the present coupling condenser, C20, and substituting a 0.05-mfd, 400-volt unit. The response is then down a few percent with a 15-cycle sine-wave input. (The 160B incorporates filtering circuits to eliminate vertical "bounce.")

For applications in which it is desired to connect directly to the cathode-ray tube deflecting plates, such as the observation of a modulated r-f envelope from a transmitter, it is possible to completely eliminate the vertical "bounce" by merely disconnecting either side of the coupling capacitor, C23.

SILVERTONE 7069

Improving phonograph operation: Chassis of this model, identified by the number 101.658, can be improved with respect to the operation of phonograph records by cutting the green wire on the phone switch as shown in the accompanying diagram.



Chassis which have had this change made in production are identified by the suffix number -1, or a subsequent number.

SILVERTONE 7079

Chassis Nos: Chassis identified as 101.620-3 are the same as 101.620-2, except that the loop is wound directly on the cabinet frame and covered by the cabinet covering. The loop is of low impedance requiring the addition of an antenna loading coil. Slight filament circuit revisions are also incorporated.

KEEP THEM LISTENING

The data listed below, covering the percentage of homes in 30 states owning radio receivers, should prove useful to the Service Man in reviewing his market. The average radio receiver requires attention every 192 days according to a survey made by the publishers of SERVICE. *With the average charge per call about $3.50, Service Men in the states mentioned can figure the total probable revenue in their own neighborhood.*

THE ACCOMPANYING table from the Second Series Housing Bulletins presents data on radios in homes for 30 selected states and the District of Columbia, for which the tabulations have now been completed. Similar statistics for states, counties, metropolitan districts, and urban places will be presented in the Second Series Housing Bulletins, by states. Data for additional states will be presented in further releases in this series as the figures become available.

Nearly three-fourths of the homes had radio sets in the states listed, according to data from the Census of Housing of 1940 released by Director J. C. Capt of the Bureau of the Census, Department of Commerce. Radio ownership was highest in Connecticut and Rhode Island where sets were reported in 95.7 percent of the occupied dwelling units. Less than two-fifths of the homes in Mississippi reported receivers. The proportion of homes with radio sets was highest in the urban areas of the selected states, in which 85.1 percent of the occupied dwelling units had receivers as compared with 71.5 percent in the rural-nonfarm areas and 52.4 percent in the rural-farm areas.

Between 1930 and 1940 tremendous increases have occurred in the number of home radio sets in all of the selected states. In the total of these states the proportion increased from 26.9 percent in 1930 to 71.1 percent in 1940. It should be noted that few of the larger States are included in the present list and that the percentages based on the resulting totals are not representative of the United States as a whole. This is indicated by the fact that the United States total for 1930 showed 40.3 percent of the homes with radio receivers, as compared with 26.9 percent in these 30 selected states and the District of Columbia.

The listings below cover only 30 states and the District of Columbia. Additional data will be presented as soon as it is available.

Radio Men: Your country needs you! Get in touch with the Army or Navy recruiting station nearest your home for full details.

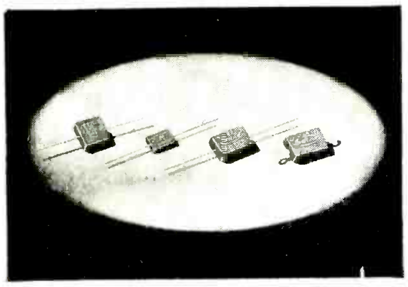
STATE	TOTAL				URBAN			RURAL-NONFARM			RURAL-FARM			PERCENT WITH RADIO, 1930
	Number reporting	With radio		Number not reporting	Number reporting	With radio		Number reporting	With radio		Number reporting	With radio		
		Number	Percent			Number	Percent		Number	Percent		Number	Percent	
Total	10,100,900	7,184,895	71.1	297,369	4,229,077	3,599,945	85.1	2,663,365	1,905,262	71.5	3,208,458	1,679,688	52.4	26.9
New England:														
Maine	213,204	184,348	86.5	5,764	86,108	80,245	93.2	87,905	73,856	84.0	39,191	30,247	77.2	39.2
New Hampshire	129,768	116,809	90.0	3,178	73,584	68,636	93.3	40,570	35,236	86.9	15,604	12,937	82.9	44.4
Vermont	90,569	80,253	88.6	1,866	31,820	30,404	95.5	34,486	30,213	87.6	24,263	19,636	80.9	44.6
Rhode Island	184,661	176,739	95.7	3,045	168,506	161,891	96.1	13,610	12,604	92.6	2,545	2,244	88.2	57.1
Connecticut	436,164	417,258	95.7	12,518	295,820	285,068	96.4	116,898	111,444	95.3	23,446	20,746	88.5	54.7
West North Central:														
Iowa	683,963	617,005	90.2	17,861	303,448	284,354	93.7	157,602	138,015	87.6	222,913	194,636	87.3	48.5
North Dakota	148,179	131,000	88.4	3,864	33,149	31,374	94.6	45,981	39,396	85.7	69,049	60,230	87.2	40.9
South Dakota	160,894	136,049	84.6	4,534	42,361	39,191	92.5	48,203	39,408	81.8	70,330	57,450	81.7	44.2
Nebraska	352,662	298,790	84.7	8,082	142,823	132,428	92.7	87,432	72,446	82.9	122,407	93,916	76.7	47.9
Kansas	496,101	411,984	83.0	15,008	217,344	196,458	90.4	124,789	102,849	82.4	153,968	112,677	73.2	38.9
South Atlantic:														
Delaware	68,870	59,921	87.0	1,671	36,109	33,331	92.3	21,398	18,513	86.5	11,363	8,077	71.1	45.9
District of Columbia	169,102	158,377	93.7	4,343	169,102	158,377	93.7	-	-	-	-	-	-	53.9
Virginia	610,878	409,978	67.1	16,654	237,564	199,670	84.0	169,708	114,756	67.6	203,606	95,552	46.9	18.2
West Virginia	434,386	326,347	75.1	10,429	136,771	122,709	89.7	188,680	142,190	75.4	108,935	61,448	56.4	23.3
North Carolina	764,144	471,863	61.8	25,515	232,226	180,456	77.7	210,757	142,468	67.6	321,161	148,939	46.4	11.2
South Carolina	422,263	209,542	49.6	12,705	120,074	80,519	67.1	122,576	73,498	60.0	179,613	55,525	30.9	7.6
Florida	504,011	326,447	64.8	15,876	285,228	217,044	76.1	147,816	81,444	55.1	70,967	27,959	39.4	15.4
East South Central:														
Alabama	650,709	321,671	49.4	23,106	219,023	152,650	69.7	152,082	82,906	54.5	279,604	86,115	30.8	9.5
Mississippi	515,369	205,613	39.9	19,587	115,976	71,289	61.5	92,692	47,177	50.9	306,701	87,147	28.4	5.4
West South Central:														
Arkansas	480,955	244,586	50.9	14,870	119,571	86,598	72.4	108,082	58,001	53.7	253,302	99,987	39.5	9.1
Louisiana	577,965	307,883	53.3	14,563	257,531	186,913	72.6	132,687	69,626	52.5	187,747	51,344	27.3	11.2
Oklahoma	589,919	405,754	68.8	20,562	244,949	204,412	83.5	135,162	87,273	64.6	209,808	114,069	54.4	21.6
Mountain:														
Montana	156,024	134,503	86.2	3,939	62,531	57,114	91.3	48,480	40,924	84.4	44,963	36,465	81.1	31.9
Idaho	137,521	118,824	86.4	4,206	49,062	44,795	91.3	40,059	33,697	84.1	48,400	40,332	83.3	30.3
Wyoming	67,687	57,126	84.4	1,687	26,767	24,489	91.5	22,370	18,603	83.2	18,550	14,034	75.7	34.1
Colorado	305,824	258,573	84.5	10,176	168,476	154,155	91.5	75,854	59,231	78.1	61,494	45,187	73.5	37.8
New Mexico	125,134	66,609	53.2	4,341	45,060	32,680	72.5	41,659	19,824	47.6	38,415	14,105	36.7	11.5
Arizona	127,250	87,781	69.0	3,883	47,602	39,234	82.4	54,162	37,508	69.3	25,486	11,039	43.3	18.1
Utah	136,747	126,418	92.4	2,740	80,248	76,243	95.0	36,342	32,771	90.2	20,157	17,404	86.3	41.1
Nevada	32,178	26,200	81.4	1,113	12,780	11,405	89.2	15,360	11,889	77.4	4,038	2,906	72.0	30.6
Pacific:														
Oregon	327,809	290,644	88.7	9,683	167,414	155,813	93.1	89,963	77,496	86.1	70,432	57,335	81.4	43.5

NEW PRODUCTS

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

SILVER-MICA CAPACITORS

Solar Manufacturing Corp., Bayonne, N. J., announce their Types MWS, MOS, MKS and MLS standard silver-mica capacitors, supplied in low-loss Bakelite. They are commonly employed



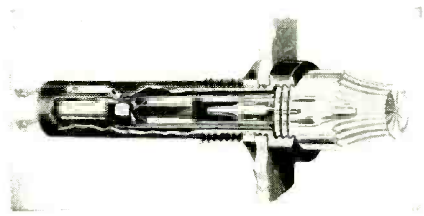
in frequency-modulation circuits, and automatic tuning arrangements where an unusually high degree of stability is essential, it is said. A unique Solar silvering process assures the permanent adherence of silver to mica, vital for long-term stability characteristics, according to Solar's engineers.

To differentiate these units from ordinary mica capacitors, these capacitors are marked with a silver dot in the center of the body identifying "silver-mica" construction.

INDICATOR LIGHT

A new indicator that lights only when the circuit is broken is announced by Littelfuse, Inc., 4757 Ravenswood Ave., Chicago. It is listed as No. 1414, and is applicable to any circuits, circuit breakers, line switches, etc.

When installed in connection with remote motor control it gives a visible signal to show "on" or "off." When the circuit breaker opens the light goes on. It is obtainable for 24- or 48-volt filament lamps, with which no resistor is



used. Otherwise, a built-in 200,000-ohm protective resistor is employed in series with a neon lamp. The resistor prevents the lamp from burning out on unexpected high voltages. The neon lamp glows on currents as low as 100 microamperes.

RECORDING DEVICE

Back talk is the specialty of the Mirrophone, new recording and reproducing device manufactured by the Western Electric Co., 195 Broadway, New York City. This is the way it works: The performer speaks into microphone. The performer's voice is recorded magnetically on a strip of metal tape. A flip of a switch and his voice comes back at him.

The Mirrophone already has a number of diverse applications to its credit. One midwestern radio station, for instance, has a Mirrophone set up in its announcers' room. As each announcer comes on duty, he reads his commercial copy to the Mirrophone, then listens to the playback. Station's executives say that the announcers, able to hear and criticize their own speech without the delay attendant on processing wax recording, have greatly improved their work.

Many universities and schools have put the Mirrophone to work in their speech departments. The device has also been found helpful to stutterers and other speech defectives. It is currently at work in the nation's crowded Capi-

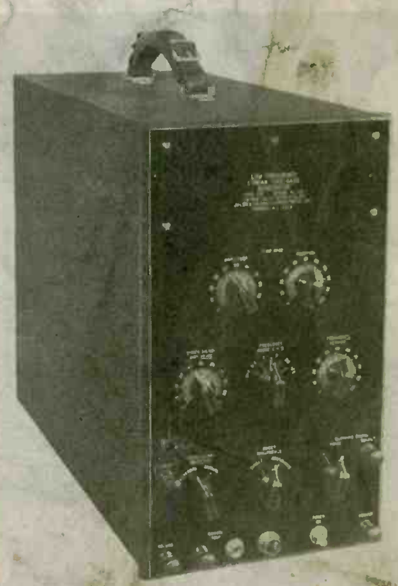
(*Continued on following page*)

tol, helping to improve the "telephone voices" of Uncle Sam's thousands of new secretaries and telephone operators.

The Mirrophone permits continuous operation. As each recording is made, the previous one is erased.

L-F TIME BASE GENERATOR

For oscillograph studies requiring sweep frequencies as low as one cycle



every few seconds, a low-frequency linear-time-base generator, Type 215, is announced by Allen B. Du Mont Laboratories, Inc., Passaic, N. J. U[illegible] junction with an oscillogra[illegible] with a long persistence [illegible] tube, or with photograp[illegible] methods, this accessory [illegible] opens up new fields of inve[illegible] low-frequency transient and [illegible] phenomena. Vibration studie[illegible] and strain measurements, low-fre[illegible] electrical observation, electrocardi[illegible] phy and electroencephalography, are [illegible] cilitated by this new unit. The frequency range of the instrument, from 0.2 to 125 cps, corresponds to rotating speeds of 12 to 7500 rpm, thus permitting the use of an oscillograph for the visual study of certain characteristics of rotating machinery at low and medium speeds. Transient observation is provided for a single-stroke sweep circuit. The maximum undistorted output signal is approximately 450 volts peak-to-peak, balanced to ground. The single sweep is initiated either manually or by observed signal.

EXPANSION

• • • • Paul Tartak, president of Cinaudagraph Speakers, Inc., has released the information that his company completed the task of moving to their new factory building at 3911-3929 So. Michigan Ave., Chicago. According to Jerome S. Gartner, secretary of Cinaudagraph, this move was made in anticipation of the need for additional floor space for production of radio and electrical equipment for the United States Signal Corps and other branches of governmental service.

Mr. Gartner advises that Cinaudagraph's present line of speakers will be available to distributors as long as materials are available. Cinaudagraph Speakers, Inc., were formerly located at 921 W. Van Buren St., Chicago.

CATALOGS, BULLETINS ETC.

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

• • • • A bulletin describing the Du Mont Type 215 low-frequency linear-time-base generator and its applications, is avail-

(Continued on page 28)

SOLVING SHORTAGE PROBLEMS

(*Continued from page* 13)

stages as well as in push-pull stages is universal in present-day receivers. Phase inversion is used to obtain the necessary conditions for push-pull operation. Various common-phase inverter circuits are shown in Figs. 5, 6, 7, 8 and 9.

Some of the components used in resistance coupled stages are somewhat more critical than those employed in other parts of the receiver, and should be kept to within 10 percent of the manufacturer's specified value. Several of the components, however, permit a greater variation.

SER-CUITS

(*Continued from page* 10)

duction which is controllable by the treble tone switch. Note the first i-f transformer in Fig. 5 which is designed to broaden the pass band in the treble position. Note also that the diode detector is tapped down on the third i-f transformer which looks like a sacrifice in voltage, but which reduces the loading and actually improves the gain at high signal levels where the diode current runs high. Another application of impedance matching.

Three 6SQ7s are used; one for a diode, one for first audio and one for second audio. The second audio cathode is connected to the voice coil winding such that it receives about one-eighth of the output voltage, providing considerable feedback. This flattens the electrical response of the amplifier, greatly aiding the attainment of high fidelity. The 6J5 inverter is a degenerative type with a split cathode resistance. Note the elaborate tone control system in the output circuit of the first audio; also the bias cell as first audio bias.

Silvertone 7056

Sears Roebuck has a unique oscillator injection means in the converter stage of Silvertone Model 7056, a 7-tube phono combination. Shown in Fig. 6, the 7H7 converter is connected to a tap on the oscillator coil. A bias resistor of 1,000 ohms is also in the cathode lead and this resistor is shunted with a by-pass condenser to pass both signal and oscillator frequencies.

By providing a tap on the bleeder, the cathode resistance of the first audio is reduced to 330 ohms and is left unbypassed. Further degeneration is provided in the 6K6GT output stage with a 500-ohm cathode resistor. This set has an automatic phono-radio switch which connects the phonograph when the pickup arm is raised.

Silvertone 7071

Fig. 7 shows another method of cathode injection in the mixer circuit as used in another Silvertone set, Model 7071. The first detector cathode is tied to the oscillator cathode through a 0.01 by-pass. The oscillator cathode is above ground potential by the drop in the cathode tickler coil. Both cathode resistors are necessarily un-by-passed. The plate is shunt fed to the oscillator transformer and a stabilizing resistor is used in the plate circuit.

Airline 14BR736B

Cathode coupling is applied in an entirely different vein in Ward's Airline Model 14BR736B, 7-tube, a-c/d-c set. As shown in Fig. 8, the first a-f tube has a 1,000-ohm cathode resistor; the output tube a 150-ohm resistor, both un-by-passed. Between these cathodes a low-pass filter provides feedback. The first-audio screen-drop resistor is by-passed with a 0.04-mfd condenser. The screen is also by-passed to B— by a 0.1 mfd. A 4,000-ohm field is connected across the rectifier output. This receiver uses an open loop as a self-contained

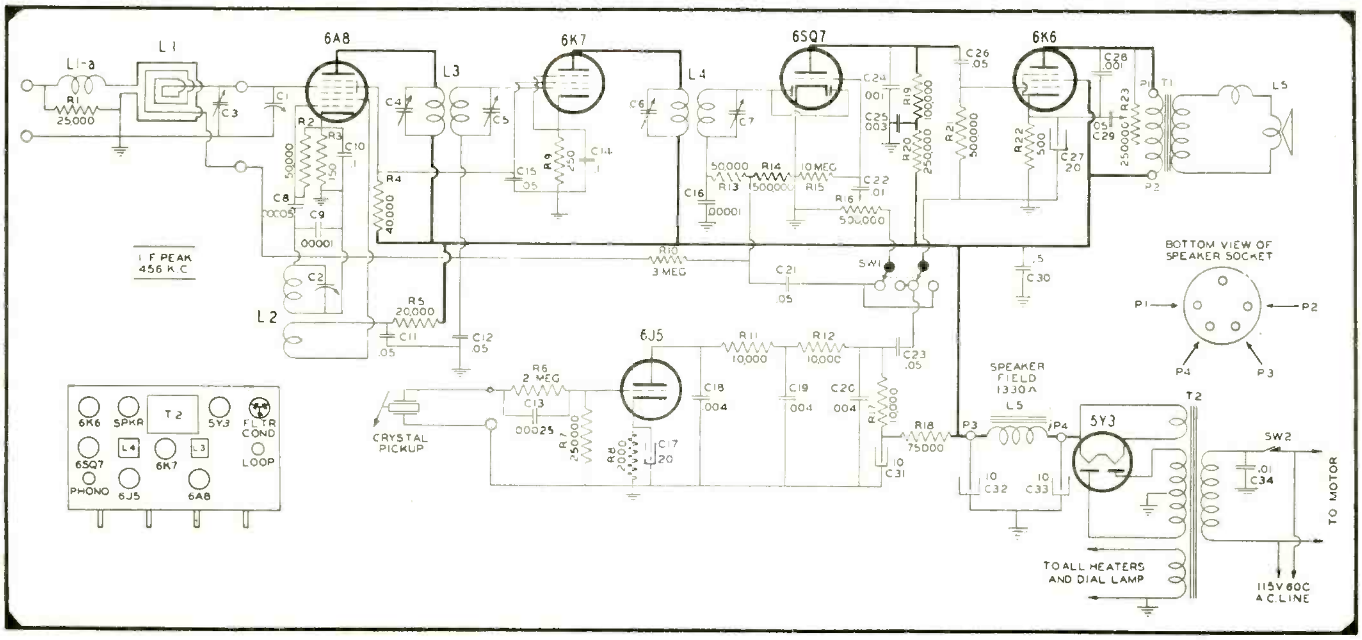
(*Continued on following page*)

antenna for both short wave and broadcast.

Wilcox Gay A105

The audio filters used in Wilcox-Gay's Model A105 make an additional stage of amplification necessary for phono operation. Fig. 9 shows the crystal pickup equalizer including the ¼-meg load connected to the 6J5 grid. Coupling the 6J5 plate to the 6SQ7 is a 2-section pi-type low-pass filter designed to cut off the high audio frequencies sharply, acting as a scratch filter. The loss in highs that results is probably not obvious but the reduction in noise certainly is. Plenty of the new higher priced piano and concert recordings seem disappointingly noisy, and require such precautions.

Fig. 9. Wilcox Gay A105 recorder combination.



BOOK REVIEWS

HANDBOOK OF CHEMISTRY AND PHYSICS, Twenty-Fourth Edition, 1941-1942, *prepared and published by Chemical Rubber Publishing Co., Cleveland, Ohio,* 2521 *pages, price* $3.50.

Ordinarily a book of this type would be of interest only to chemical engineers and the like. However, because of the preponderance of information useful to all fields, which is contained in this volume, and because of its very low cost, it can be recommended to the readers of SERVICE as a good buy.

There are five general divisions of subject matter in the handbook. These are separated for convenience by divisional guides. On each guide is listed an outline of the contents of the particular section.

The first division contains some 30 mathematical tables. These alone are worth more than the cost of the entire volume, and cover all commonly used listings.

Properties and Physical Constants; General Chemical Tables; Specific Gravity and Properties of Matter; Heat and Hygrometry; Sound; Electricity and Magnetism; Light; as well as a host of other subjects, are covered in the other divisions. Of particular interest to our readers will be the "Musical Scale" on page 1825, and a section on plastics starting on page 1210.

Those who have continued to postpone the purchase of a general handbook because of the cost of such a book should investigate this volume.

R. G. H.

ELECTRONICS, by Jacob Millman and Samuel Seely, published by McGraw-Hill Book Co., Inc., 330 *W.* 42 *St., New York City,* 720 *pages, price* $5.00.

This book has been prepared as a text for the advanced student in electronic principles and applications. A knowledge of higher mathematics is presupposed by the author.

The early chapters of the text deal with the motion of charged particles and with basic electron theory. The major portion of the text covers vacuum tubes rather thoroughly and coordinates the physical theory and the theory of operation of electronic devices. Many unique and original methods of presentation are employed, and complete treatments are given all subject matter generally covered but briefly in other texts.

It is this reviewer's opinion that this text is one of the best treatments on the subject of electronics that has come to his attention. R. G. H.

RADIO LABORATORY JOB SHEET MANUAL, by Sol Prevsky, published by Radiolab Publishing Co., 652 *Montgomery St., Brooklyn, N. Y.,* 78 *pages,* 9x12 *inches, wire bound, price* $1.80.

This book contains a collection of 24 "Experiments" covering various phases in the radio and electronic fields and is designed for the student. However, in no sense can the collection be considered as a course of study for a radio class of any kind since there is no relation between one experiment and those preceding it except in one or two cases. Moreover, the various jobs or projects do not follow one another in order of learning difficulty. In twenty-four jobs the learner is taken from simple soldering to the construction of a complex superheterodyne receiver—a jump which normally covers approximately three years of trade school study.

In spite of all this adverse criticism, however, the book has exceptional merit, in that as individual experiments (with few exceptions) the jobs are quite well chosen and are well written. The arrangement of data in each job is good and the questions listed at the end of each job are timely.

We do not hesitate to recommend the Radio Laboratory Job Sheet Manual to all radio teachers as a help in planning and executing their course of study. R. G. H.

PRINCIPLES OF ELECTRON TUBES, by Herbert J. Reich, published by the McGraw-Hill Book Co., Inc., 330 *W.* 42 *St., New York City.* 398 *pages, price* $3.50.

This book is chiefly an abridged edition of a recently published book by the same author, which sold for $5.00. It is intended as a text on electron tubes for the student above the secondary level.

Inasmuch as there is no new material presented in this book, over the $5.00 edition, and in view of the slight difference in price, by comparison to the much greater amount of material in the first book, it is this reviewer's opinion that the older book is preferable in every case. R. G. H.

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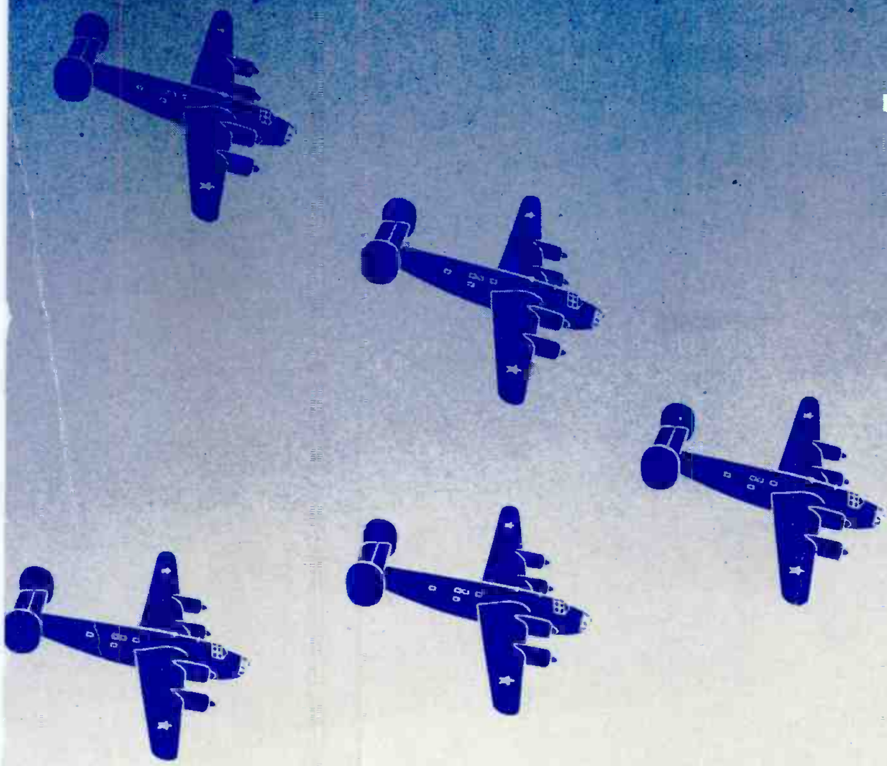

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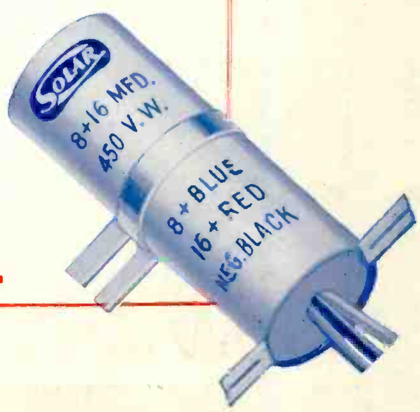

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