

HICKOK

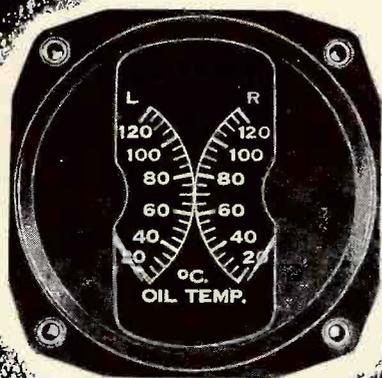
33 Years of Progress..

1910..

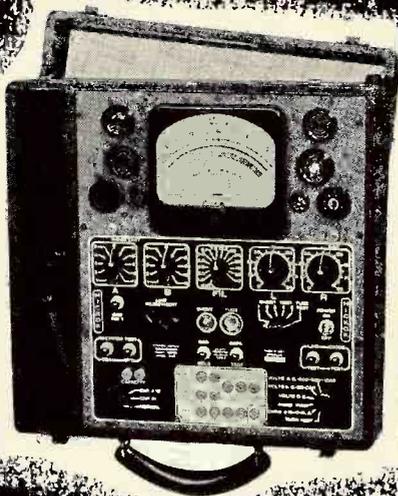
1 SMALL PLANT
1 EMPLOYEE
2 STYLES OF METERS

1943..

2 LARGE PLANTS
NEARLY 1000 EMPLOYEES
HUNDREDS OF STYLES OF METERS
AND TEST INSTRUMENTS



HICKOK METER



**HICKOK DYNAMIC MUTUAL
CONDUCTANCE TUBE TESTER**

From its organization in 1910 until now The Hickok Electrical Instrument Co. has always been in the forefront of those companies who have contributed most to Electrical and Radio Instrument progress.

Quality has always predominated over quantity of production—building a reputation for highest grade instruments that is now reflected in the enormous demand for Hickok Meters for Aviation and other War Time uses. The meter illustrated is typical of these War Time Instruments.

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New Hickok Meters and Instruments are being designed, or are already in production for the use of our Armed Forces. They will be available to everyone as soon as the present emergency is over.

So keep your eye on Hickok for the newest and best in indicating meters and radio service equipment.

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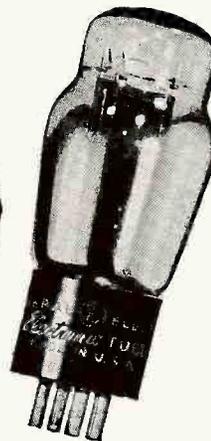


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★ Advertisements like the one shown above are appearing regularly in leading national magazines. Look for this dramatic G-E series in the following publications:

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There's scarcely an electrified home in the land today which is not on excellent *lighting* terms with General Electric MAZDA Lamps! "G-E MAZDA Lamps" is a household phrase. The buying public has complete and unquestioning confidence in all that it stands for!

Into millions of these same homes, the big-circulation consumer magazines now are repeatedly carrying powerful General Electric advertisements like the one shown on this page . . . each displaying a G-E Electronic Tube . . . building a new public confidence in still another General Electric product!

Radio service dealers cannot fail to recognize the tremendous sales boost for G-E *Electronic Tubes* that this adds up to!

When peace comes, and war-weary radio sets are gasping for new tubes, your service customers will be *pre-sold on G-E Electronic Tubes* as thoroughly as they are today pre-sold on General Electric MAZDA Lamps! . . . *Electronics Dept., General Electric, Schenectady, N. Y.*

Tune in on Frazier Hunt and the News every Tuesday, Thursday, Saturday evenings over C. B. S. On Sunday night listen to the "Hour of Charm" over N. B. C. See newspapers for time and station.

GENERAL  ELECTRIC

EDITORIAL

THAT news item, for which all Service Men have been waiting for ever so long, has finally come from Washington. And fortunately it is good news. For Service-Men now have the assurance that a V line of parts . . . long a hope, prayer and dream . . . now becomes an actuality. The list of parts is not very long, as we can see on page 9 of this issue. But it's long enough to permit effective servicing of quite a few receivers.

Just how soon the new parts will be available, now that the list has been approved, is the problem. At least 30, if not 60 days, will probably pass by, before these V line components will be on the dealer's shelves. But the wait has been a long one anyway. And so an extension of a month or two isn't too painful, as long as the parts are provided!

THERE'S an urgent need for test instruments and meters at the Aircraft Radio Laboratory at Wright Field. They can use cathode-ray oscilloscopes, beat frequency oscillators, output meters, signal generators (internal modulation and with connections for external modulation), vacuum tube voltmeters, wavemeters, ohmmeters, voltmeters (d-c . . . 0-10, 0-100 and 0-500), milliammeters (d-c . . . 0-10 and 0-100), voltohmmeters, chanalysts, multi-range testers and various types of laboratory precision equipment. If you can help, do so, and at once. See page 32 of this issue for details.

ONE of the casualties of the war seems to be the taxicab radio. Formerly receiving the best service, these radios now receive practically no service. Unfortunately, the independent owners and most associations, don't seem to have the time or the inclination to maintain these receivers. But they are a vital car accessory and should be serviced now, before they become impossible to service at all! It seems to be up to the Service Man to see what he can do to iron out this problem.

SERVICE

A Monthly Digest of Radio and Allied Maintenance

Reg. U.S. Patent Office

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March, 1943

ALFRED A. GHIRARDI

Advisory Editor

	Page
An Analysis of Filament Switching in A-C/D-C Battery Portables. By Barry Kassin	12
Electronics and Ionics. By Dr. Joseph Slepian	30
Eliminating Electric Sign Radio Interference. By Frederic U. Dillion	10
Replacing Screen-Grid Tubes With Variable-Mu Types. By Frederick E. Bartholy	5
Ser-Cuits. By Henry Howard	19
V Line of Replacement Parts Approved	9
Case Histories	
Stewart Warner 206FA, 386 and 358	25
Stewart Warner 208C	39
Charts	
V Line Parts	9, 33
Circuits	
Airline 14BR-523A	19
Belmont 671B	19
Belmont 11AE2	20
Belmont 7H31	22
DeWald 814	23
Firestone S-7350-1	20
Philco 42-365	22
RCA 288P	12
Sea Pal Marine Portable	14
Setchell Carlson 501	25
Silverstone 7085 and 7090	14
Westinghouse M-101-111	23
Westinghouse WR-62K1-62K2	25
Wilcox-Gay A-113-114-115 (Cover)	25
Cover Diagram	
Wilcox-Gay A-113-114-115	25
Index to Advertisers	
	40
Manufacturers	
News	36
New Products	35
Jots and Flashes	40

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There's Still Time to Qualify in the



"Here's How"

VOLUME CONTROL

Contest



SHARE IN \$500.00 WAR BONDS!
Closing Date April 10th

Yes, there's still time to put yourself in the running for one of those FIVE \$100 U.S. War Bonds, as announced in last month's issue of this magazine. *But there's no time to lose!*

If you saw the original notice and have been putting it off . . . well, this is the **LAST CALL!** Contest closes and entries must reach IRC by April 10.

If you have overlooked this "golden" and patriotic opportunity . . . if you are a radio man living within the United States . . . if you would like to have one of those \$100 Bonds inscribed with your name and delivered to you, the field is still wide open and you stand as good a chance as anyone!

HERE'S WHAT TO DO

IRC feels that radio service men today are doing a fine job in keeping the Nation's radios functioning in the face of unprecedented difficulties. Often unable to get exact duplicate replacement and repair parts you would ordinarily require for the job in hand, you are showing amazing resourcefulness.

All right—write IRC an informal, simple letter telling in your own words—

How you were able to replace a volume control and get the radio set working satisfactorily—when you couldn't obtain the volume control you would ordinarily have considered necessary for that particular make and model of radio.

Please be specific. Name the make and model instrument you were working on. Tell what the VOLUME CONTROL trouble was. Describe exactly what you did, and why; whether you made certain mechanical changes in the substitute control to adapt it to the set, and/or certain electrical changes in the circuit.

BONDS for IDEAS

It's your factual story that counts in this contest—not your spelling, your "literary style" or anything else. What we're after is a straightforward account of a VOLUME CONTROL problem you ran up against, and how you licked it. *Your* story, unexciting as it may seem to you, may be the very one to cop one of those awards!

PRIZES WILL BE AWARDED

by an impartial board of three—Joseph Kaufman of the National Radio Institute, William Moulie of "Radio Retailing Today" and IRC's Chief Engineer Jesse Marsten. The judges' decision as to the five winning entries will, of course, be final and if in their opinion winning ideas of equal merit are presented, duplicate awards will be made.

RADIO INDUSTRY TO BENEFIT

Though all ideas entered in this contest become the property of IRC, contestants have the satisfaction of knowing that their worth-while ideas will be passed along to the entire service profession. Thus, while you extend a hand to others, they too will help you to keep radio sets in operation that might otherwise be retired from service and become lost jobs for you.

HAVE YOU WON A BOND ALREADY?

Some VOLUME CONTROL jobs you have already done may be good enough to win a \$100 Bond, if you write us about it NOW.

DON'T PASS UP THIS CHANCE!

Remember, you have as good a chance to win as the next fellow. Fill out that coupon right now! Write your letter tonight! Don't put it off—and later kick yourself for passing up an opportunity. A \$100 bond would sure come in mighty handy at maturity, wouldn't it? O.K.—*let's go!*

Uncle Sam's Men, Too

If you're now in Government service, in or out of uniform, you're eligible in this contest too. Maybe the job you have in mind was done before you went into the Service.

CLIP THIS—FILL IN—SEND IN WITH YOUR ENTRY

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad St., Philadelphia, Penna.

• Gentlemen: Here is my entry in your \$500 U.S. War Savings Bond Contest.

MY NAME _____

COMPANY _____

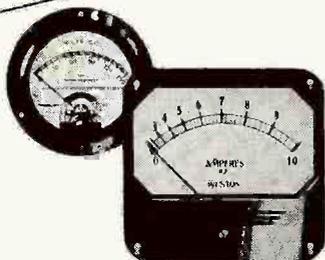
ADDRESS _____

CITY _____ STATE _____

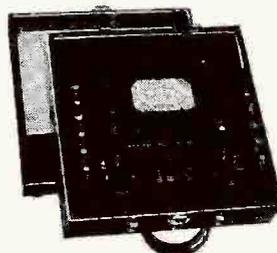
MY REGULAR DISTRIBUTOR IS _____

FOR ELECTRONICS
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the Standards are Weston



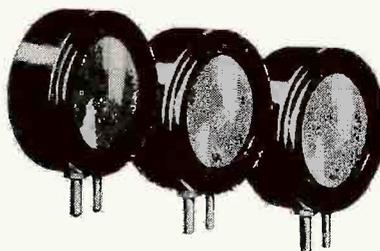
Panel Meters for Electronic applications



Electronic Circuit Testers



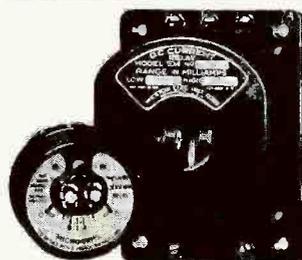
Ultra-Sensitive Laboratory Portables



*Photronic (photo-electric) Cells



Electronic Tube Checkers



Sensitive Relays

In the field of electronics, too, the measurement tools bear the name most familiar to you. For just as WESTON pioneered fundamental electrical measurement, as well as the special measurement needs of radio, so WESTON has provided simple, precise instruments and devices for the problems encountered in electron-

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*PHOTRONIC — A registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corporation.

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FOR OVER 54 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

REPLACING SCREEN-GRID TUBES WITH VARIABLE-MU TYPES

By **FREDERICK E. BARTHOLY**

AS a rule, even the trained and skilled Service Man considers a job well done when he locates the trouble and applies the exact remedies called for in the specification. This done, he sits back and whirls the dials with the feeling of satisfaction that the set is just as good as it was when it was new. The question may be asked . . . how good was the set when it was new in comparison with sets of later models, or those of today? Generally we can find room for improvement and often these improvements can be made simply with little additional cost, and in some cases there may be a saving involved. As an example, practically all receivers built prior to the use of variable-mu tubes can be improved to a great extent by changing the circuit to accommodate tubes of the remote cutoff type in place of conventional screen-grid tubes. A number of advantages result from this change. The local distance switch can be eliminated. The exact duplicate type of double volume control generally hard to get is replaced with a single standard C-bias control. The set will have a smoother range of volume control action; cross-talk interference will disappear, and there will be no distortion when strong stations are tuned in at a low volume level.

Doing a little more than just ordinary "repair" requires some engineering which, in most cases, need not be beyond the Service Man's capabilities, provided he knows his fundamentals and can apply common sense. Today more than ever, the old set becomes worthwhile not only to fix but also to improve. Changes will have to be made at times because replacement parts or tubes are not obtainable. As a rule, even the more complicated remodeling or modernizing of a set requires no elaborate calculations. Once we have decided what we intend to do, there are many practical ways to solve the problem. However, it is a good policy to do a little paper work. There is a great amount of satisfaction when

the paper and pencil work turns out in practice just as we have calculated. Preparation of this kind also saves time and the practical final check will show up our mistake. After all, one learns by his own mistakes and as long as we learn we shall benefit. It will be seen that we need not be too critical in figuring out the circuit constants for the intended changeover. Variations within plus or minus five or even ten percent will not affect the general performance in most cases.

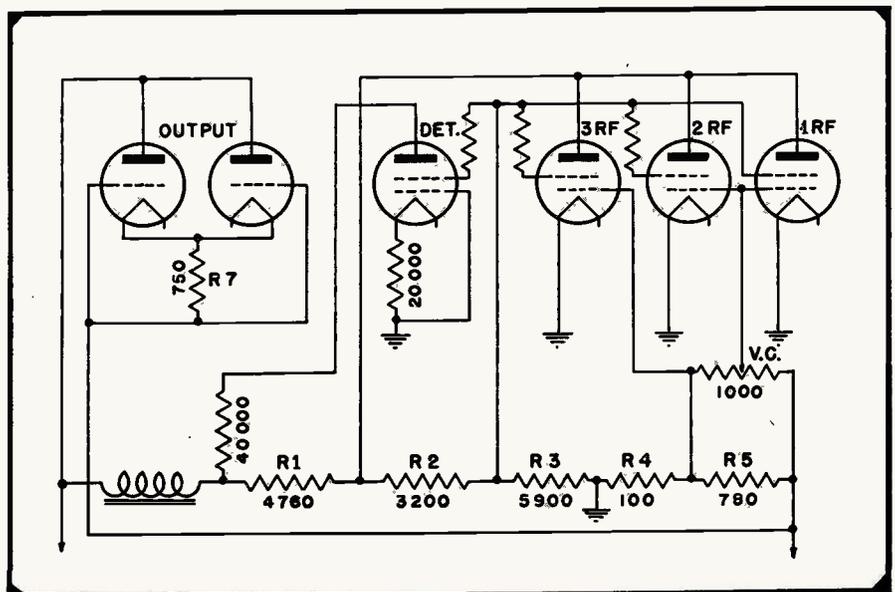
Changing Screen Grid R-F Amplifiers

Among the screen-grid tubes, the type 24A will be most commonly encountered. When the 6.3 volt tubes were first introduced, pentodes had replaced the tetrodes and sets generally employed pentodes in the r-f stages with remote cutoff characteristics. The 24A's can be replaced quite easily with type 35 tubes. In certain cases, 6.3 volt tubes can also be used in place of the 24A's

provided there are facilities to obtain additional filament voltage. A small filament transformer is inexpensive. The five-prong sockets need not be changed if we choose type 39/44's, in which the suppressor grid is tied to the cathode within the tube.

The first item which we must consider in changing over to variable-mu tubes is the need for higher negative grid bias for control purposes. While the 24A will cut-off at approximately 15 volts bias, the 35 requires over 40 volts. There are two alternate ways to provide grid bias, namely, by applying a voltage to the grid which is negative with respect to the cathode, or by raising the voltage of the cathode positive with respect to a reference point to which the grid electrode returns. The first-mentioned way is preferable in that it will not change the plate and screen grid potentials with respect to the cathode. However, it requires a source of bias in addition to the voltage source used for the anode and screen grid

Fig. 1. The voltage distribution circuit of the Stromberg-Carlson 10 and 11 receivers.



electrodes. The source can be any voltage drop in the power supply circuit which is negative with respect to the cathodes of the controlled r-f tubes; for example, the voltage drop across a speaker field in the negative side of the supply, or the voltage drop across a voltage divider used for the power tubes when operating at a fixed bias. A number of receivers have such supply circuits where a negative bias of 40 to 50 volts can easily be obtained. In these cases, as will be pointed out by practical examples, it is necessary to remove the grid return from ground or isolate the r-f input circuit from the direct-current bias circuit of the grids.

The majority of receivers employ self bias for the power tubes and the additional negative bias of 40 volts cannot be obtained without lowering to the same extent, the plate and screen potentials of the controlled tubes. Sets of this type have the negative side of the plate supply grounded, at which point the r-f grids also terminate. The work involved in these sets, to obtain bias voltage for the grids means almost a rebuilding of the entire supply circuit. With such sets the second alternative is the simplest way and the cathode voltage is raised positive with respect to ground. The bias so obtained is taken from the effective anode and screen grid potentials which means that when the cathode is raised from the minimum bias position, generally +3 volts to +40 volts, the screen grid as well as the plate potentials will be 37 volts less than they were when the cathode was 3 volts positive. The change in screen voltage reacts on the transconductance of the tube and it will be found that cut-off is obtained at a cathode voltage less than 40 volts when the screen voltage is lowered simultaneously with the increase in cathode voltage. While this condition limits the usefulness of a super-control tube as far as volume control action, it is of no serious consequence. Moreover, in many cases, excessive variation of screen voltage can be overcome by a suitable resistor in series with the screen-grid lead, in which the variation of screen current will compensate for the voltage drop.

Circuit Changes

Let us see what changes must be effected to accommodate variable- μ tubes in typical sets originally designed for sharp cut-off screen-grid tubes. We may group the sets as follows: (1) receivers having grid bias control (2) receivers having cathode bias control where the bias is derived from the main voltage divider; (3) receivers having cathode bias control where the bias is derived purely from the plate current, and (4) receivers having screen-grid control.

Receivers with Grid Bias Control

In this group, the changeover is comparatively simple. The grids of the controlled tubes generally return to the volume control and are already supplied with a negative bias potential. The problem is to make the available bias potential larger for the super-control tubes to be used. As an example, let us take the Stromberg-Carlson Model 10 or 11 receiver (Rider's Manual, Book I, page 14). This set has three r-f stages employing 24A tubes, a 24A biased detector stage and two 45 tubes in push-pull. To begin with our design consideration, it is a time-saving policy to make a simplified sketch of the voltage distribution circuit as shown in Fig. 1. It is seen that the operating voltages for the tubes are derived from a voltage divider resistor placed across the output of the rectifier power supply. The voltage divider in the set comprises two large wire-wound ceramic covered resistors with a number of taps which are indicated in the circuit diagram. We should first determine what the voltage drop is across each section. This can easily be accomplished when the set is in operative condition by measuring the voltage across each portion of the divider. However, the Service Man usually has a defective set on hand to start with, which in most cases would have to be restored to its original condition before voltages could be measured accurately. If it is a simple repair job, it should be done before making the changeover. On the other hand, the data supplied in the service manual is generally sufficient to do the design work and tackle the repair at the same time when the changeover is made.

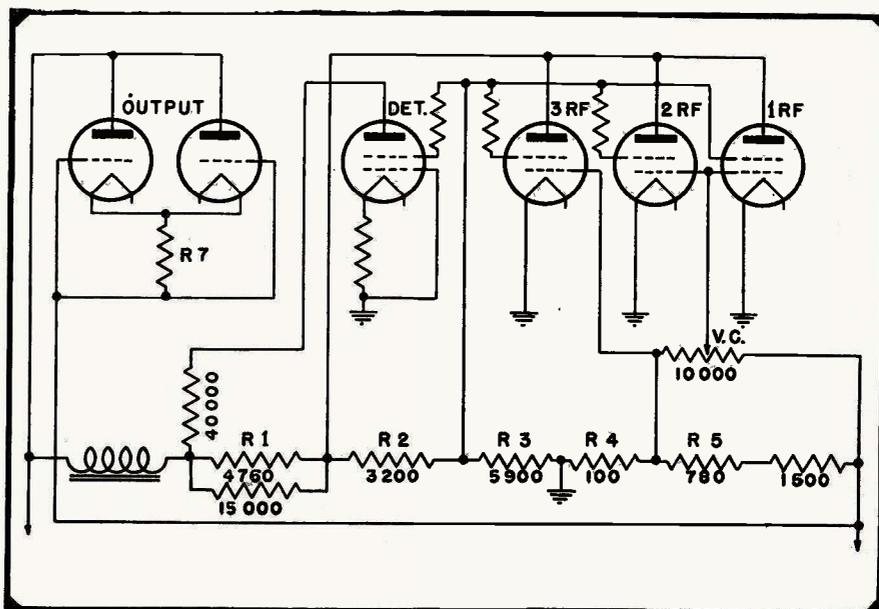
Referring to the table in the Service

Manual giving voltage data, we read that in the radio frequency stages the tubes operate at a plate voltage of 135 and with the volume control at maximum, the grid bias is 2½ volts. This gives us a clue immediately, for the current in a portion of the voltage divider. The minimum bias is taken off from the 100 ohm resistor indicated R_4 in Fig. 1, and since this voltage drop is 2½ volts, the current will be .025 ampere. The negative portion of the voltage divider, taking the cathode of the r-f tubes as a reference point, carries the total current of the radio frequency tubes and the initial bleeder current. Since the grids take no load, the voltage utilized for control purposes will be the voltage drop across the 780-ohm resistor R_5 . The latter is bridged by a 1000-ohm volume control. The current in this branch will be the same as in the 100-ohm minimum bias resistor. Therefore, if we calculate the joint resistance of the parallel branch, we can determine the maximum bias voltage available. By the simple formula

$$R_1 \times R_2 \\ \text{mula the joint resistance } R_J = \frac{R_1 + R_2}$$

Substituting, we have $R_J = 780,000$ divided by 1780. This gives us 438 ohms approximately. Multiplying this with the current we have a voltage of 11 volts. This added to the minimum bias voltage of 2½, gives a total of 13½ volts. In order to obtain at least 40 volts for controlling the new tubes, we need 26½ volts more. For good measure, we can round out this to 30 volts. The 30 volts which we need in addition must be taken from the total voltage applied to the tubes. It becomes apparent when we follow the plate returns, that we have extra available volt-

Fig. 2. Illustrating the method of obtaining the required resistance values with the modified voltage divider.



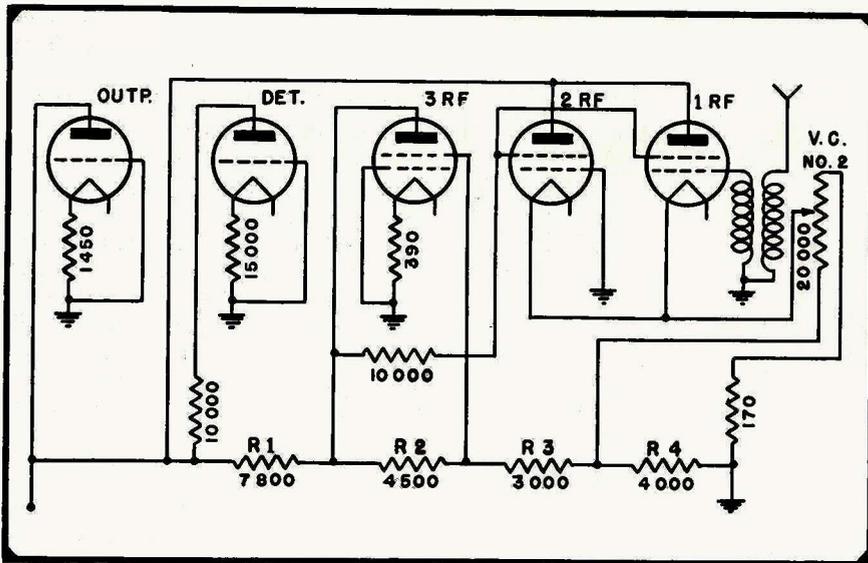


Fig. 4. The simple changes made in Fig. 3 to provide variable-Mu tube substitution.

indicated. The first two r-f tubes are now replaced by type 35 tubes. The short and long antenna jumper can be placed in the position which will give the best overall performance for the particular locality or antenna used. The improvement will be very noticeable, especially if comparison can be made with the set as it was originally.

Receivers with Cathode-Bias Control

A good example for sets belonging to the second group, volume by cathode-bias control, is also a Stromberg-Carlson receiver which was very popular in 1929 and still is a fine set for tone quality. I am referring to Models 641, 642, 652 and 654. There are few Service Men who will not remember this set, which uses a double volume control on a long shaft and has caused many a headache from a service standpoint. The sudden action of the control makes volume adjustment difficult and it often becomes noisy, causing fading. Effective repair meant generally a standard replacement control which was usually more critical than the original. Yet nothing is simpler than to change this set to use 35's in the controlled r-f stages instead of 24A's. It can be done in 10 minutes with the addition of only a one-watt resistor and what a difference! The circuit diagram of the set is found in Rider's Manual, Book I, page 8. The voltage distribution in a simplified form is shown in Fig. 3, together with the antenna portion of the volume control. At first inspection, it is seen that the first two r-f stages are controlled by volume control No. 1 in such manner that the cathodes are raised positive with respect to ground. At the same time, the antenna is progressively shorted to ground by way of a 20,000-ohm potentiometer. Volume

control No. 1 comprises an 800-ohm potentiometer in series with a 170-ohm minimum bias resistor shunted across the 4000-ohm portion, R_4 , of the voltage divider.

To illustrate a purely practical method of changeover, the following considerations are given. The portion comprising R_4 with volume control No. 1 in parallel must necessarily offer a lower resistance than the 800 ohms of the volume control No. 1 alone. Calculating this resistance, as we have done before, we obtain 780 ohms. This indicates that as far as the voltage divider is concerned the volume control portion is the one which largely determines the voltage drop across R_4 . Since 24A tubes are used, this drop may be assumed to be about 13 to 15 volts. It becomes immediately apparent that if we remove the volume control No. 1 from R_4 , there will be a much larger voltage drop across the latter because of the higher resistance. It is true that such a procedure will change the bleeder circuit, but in most cases, it will be found that this does not cause any serious difficulties.

When volume control No. 1 is disconnected, the voltage drop will be 50 volts, which is ample for our purpose. Our problem is now to make this voltage available for raising the potential of the cathodes of the first two r-f tubes. We could replace the 4000-ohm section of the voltage divider with a 4000-ohm potentiometer, to be the volume control. This would call for a special control, wire-wound, to carry the bleeder current as well as the current which flows through the r-f tubes. It is much simpler to use a standard control of comparatively high resistance with respect to the resistance of R_4 in parallel with the latter. The next thought is, why could not the 20,000-ohm antenna

section volume control No. 2 be used for this control, inasmuch as with 35's there is no need any more for controlling the antenna circuit? Presto, we remove the connections from volume control No. 2. In doing this, we must make sure that the antenna coil return is properly connected to ground and also that the antenna coil input is connected to the antenna post. These connections have been made before at terminals of the control. The cathode returns of the two radio frequency tubes are connected to the rider of the control and the two terminals thereof across the 4000-ohm portion of the voltage divider R_4 in series with the 170-ohm minimum bias resistor. In making this connection, care should be taken that when the control is turned clockwise, the rider should go towards the minimum bias resistor, and when it is turned to the left, it should increase the positive voltage on the cathodes.

The additional bias so obtained when the cathodes are at the maximum positive potential will lower the screen and plate voltage of the controlled tubes and the lowering of the screen voltage will reduce the gain considerably. Therefore, the controlled tubes should operate preferably at higher plate and screen voltages. This can be accomplished very easily by moving the plate return of the first and second r-f tubes one tap ahead on the voltage divider and the screen return of these tubes over to where the plate return was before. A series resistor in the screen grid circuit will give a better regulation of the screen voltage. This can be determined experimentally by turning the volume control to maximum and adjusting a variable resistor in series with the screen grid circuit, until the screen voltage reads 90 or 100 volts. It was found that 10,000 ohms gave satisfactory regulations. Fig. 4 shows the simple changes made in the circuit of Fig. 3.

Receivers with Standard Cathode-Bias Control

In the two examples given, we have considered receivers with grid bias control and cathode bias control both taken from the main voltage divider circuit. In the third example we shall consider even simpler circuits which, due to their popularity, may be called the standard cathode-bias volume control circuit. It is found in a great many receivers which use 24A tubes and even in those using 35's, before the advent of automatic volume control, now in practically every receiver. For this reason, no specific receiver need be considered as an example. Instead, let us

(Continued on page 26)

V LINE OF REPLACEMENT PARTS

APPROVED BY WASHINGTON

AN approved, simplified list of replacement paper and electrolytic capacitors, volume controls, power and audio transformers, and reactors has just been announced. It was formulated by the ASA War Committee on Replacement Parts for Civilian Radio at the request of the Office of Price Administration, after consultation with the Radio and Radar Division of the War Production Board.

These standards cover only the electrical values of the listed parts. The committee, after consultation with the radio industry, deems these values adequate for maintaining in operation the great majority of home radio receivers. Special variations in these parts which are necessary for the repair of certain receivers are not included on the recommendation of the Radio and Radar Division of the War Production Board. It is expected such special units will be made available as the necessity arises.

This standard will be augmented by compilations of other parts from time to time as the work of the committee proceeds. It will be progressively supplanted by complete standards for each type of part which will also include minimum performance, construction, and dimensional requirements.

Certain components, such as loud speakers, which fail relatively seldom, and of which rather large stocks are now on hand, are not included and it is not now intended to include them. Likewise, other parts such as knobs, gears, etc., which do not lend themselves to standardization, will not be included. They will be handled as special cases should the need arise.

In identifying the new group of parts, the symbol *V* and three dots and a dash, will be used. This will appear in a circle. The manufacturer's symbol, approved by the War Production Board, the words "Made in U.S.A.," and the part number will also appear, in addition to electrical data.

The approved list of parts is as follows.

Volume Controls	
<i>Untapped Composition Element Type</i>	
Resistance	Taper
10,000 ohms	reverse
25,000 ohms	reverse
250,000 ohms	audio
500,000 ohms	audio
1 megohm	audio
2 megohms	audio

Volume Control Switches		
Single pole, single throw		
Double pole, single throw		
Single pole, double throw		
4 pole, single throw, shorting		
<i>Tapped Composition Element Type</i>		
Overall Resistance	Tapped Resistance	
500,000 ohms	150,000 ohms	
1 megohm	300,000 ohms	
2 megohms	15,000 & 500,000 ohms	
2.25 megohms	500,000 & 1 megohm	
<i>Wirewound Element Type</i>		
Resistance	Taper	
10,000 ohms	linear	
Transformers and Chokes		
<i>Audio Transformers</i>		
Interstage Transformers		
Transformer	Voltage Ratio	Maximum D-C Primary Current in Milliamperes
A	3:1	10
B	1:1, 3:1 or 6:1 (Single or push-pull input and output)	10

Driver Transformers			Maximum D-C Primary Current in Milliamperes
Transformer	Voltage Ratio		
A	1:1, 1.5:1 or 6:1 (Single or push-pull input and output)		35
Output Transformers			Maximum D-C Primary Current in Milliamperes
Transformer	Rated Wattage	Impedance Ratio	
A	4	2,500 to 15,000 ohms primary impedance to 2, 4, 6, 8 and 15 - ohm voice coils	50
B	8	2,500 to 13,000 ohms primary impedance to 2, 4, 6, 8, and 15 - ohm voice coils	70
C	15	2,500 to 13,000 ohms primary impedance to 2, 4, 6, 8, and 15 - ohm voice coils (push-pull input only)	70

(Continued on page 33)

Power Transformers						
Low-Voltage Windings*						
Transformer	High-Voltage Winding		Filament		Rectifier Filament	
	Volts	Milliamperes	Volts	Amperes	Volts	Amperes
A	325-0-325	70	2.5	9.0	5.0	3.0
B	325-0-325	120	2.5	(12.5)	5.0	3.0
			2.5	(3.5)		
C	210-0-210	50	6.3	2.0	5.0	2.0
D	300-0-300	70	6.3	3.0	5.0	3.0
E	300-0-300	120	6.3	5.0	5.0	3.0
F	350-0-350	200	6.3	6.0	5.0	3.0

*All windings center-tapped.

Primary windings . . . units for domestic service to have 117-volt primary. Units for export service to have two 120-volt primaries, each tapped at 90 volts. All units to be designed for 50-60 cycle service.

Chokes			
Choke	Inductance in Henries	Maximum D-C Current in Milliamperes	Resistance in Ohms
A	6	50	300
B	8	120	350

ELIMINATING ELECTRIC SIGN RADIO INTERFERENCE

By **FREDERIC U. DILLION**

ELIMINATION of interference caused by electric signs provides an effective business medium for the Service Man.

The problem of eliminating radio interference from electric signs is relatively simple, if we apply certain fundamentals. It is possible to prevent the radiation of interference from even the most complex spectacular signs.

Three Causes of Interference

There are three general causes of interference . . . defective equipment or installation; primary circuit flashers; luminous tubing, including high power animators and multiple-path tubing. Most cases can be traced to dirty and burned contacts on the flashers. The solution is to replace or repair the defective contacts. All loose lamps and connections must be tightened, since any connection of this kind will cause interference and will decrease the effectiveness of any filter that might be installed. Leaky transformers, tube supports or leads in the luminous tube installations and any such defects must be corrected. Another cause is the operation of too great a footage of tubing for the voltage rating of the transformer being used.

The spark that occurs when we break an electric circuit acts as a miniature radio transmitter with the associated wiring acting as an antenna and oscillatory

circuit. This action is similar to the old spark transmitters of the early wireless days. The radio signals so generated are not of a single frequency but consist of many different frequencies, rich in harmonics covering a large portion of the broadcast band. It is similar to a multi-vibrator.

Since we are not dealing with a single frequency, the simple resonant wave trap will not work; so we must resort to a "brute force" type filter, in order to cover a wide-frequency range.

Filter Characteristics

Such a filter consists of an inductance and a capacity or inductance alone. It is usually designed to have a necessary degree of attenuation at the lowest frequency at which it is desired to eliminate the interference.

The inductance is connected in series with the line and the capacity is connected either across the line or from one side to ground. A filter connected on the line of the mechanisms prevents the interfering frequency from being carried along and radiated from the supply line, but it does not prevent the radiation of interference from the portion of the line from the switch to the sign proper. Therefore you must install a similar filter on the sign side of the switch mechanism. All wiring between the two filters and the point

where the spark occurs acts as a radiator of the interference. Therefore all filters should be installed as close to the switch contacts as possible.

The chokes must have a current carrying capacity equal to the maximum rating of the sign. The condensers should be of the first rate quality and of the non-inductive type. The alternating current rating of the condenser must be at least twice the line voltage.

Capacitor Requirements

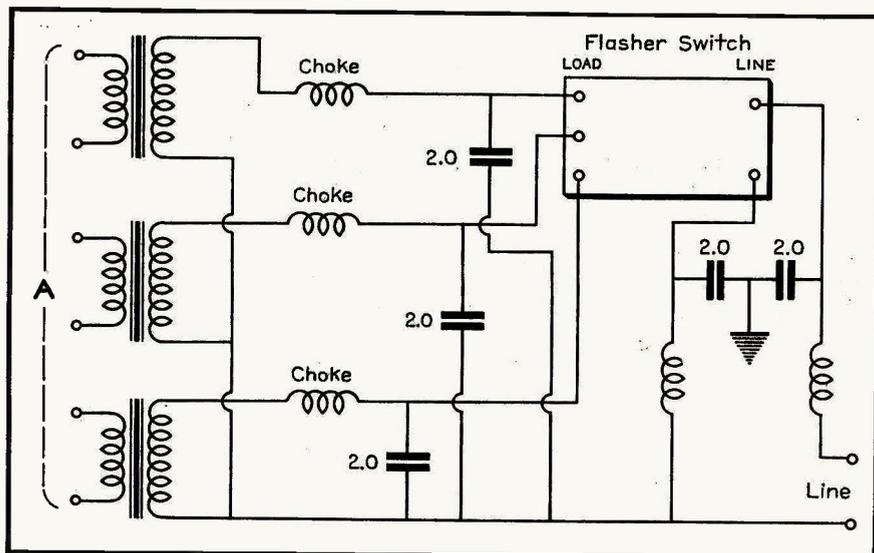
It has been found that two mfd is satisfactory in most installations, when used with commercially available types of filter chokes. Sometimes larger capacities are required for direct current circuits.

The construction of the chokes used is very important to the effectiveness of the filter. It must have a wire size that will not only carry safely the full current in the circuit, but will also not drop the voltage in the line too much. For 110 volt lines the total drop should not be over two volts. In direct current circuits, the drop is the product of the current and the resistance. In alternating current circuits the voltage drop is the product of the current and the impedance. The alternating current impedance is the square root of the sum of the squares of the resistance and the square of the inductive reactance at sixty cycles. The table shown gives inductive reactance at sixty cycles of some of the commonly used chokes.

As the current capacity of the choke increases, the inductance is decreased in order to avoid excessive drop due to inductive reactance; thus the resistance of the choke is decreased.

For best results the distributed capacity of the choke should be as low as possible. Among the various types of windings the single layer solenoid has the lowest distributed capacity. Its disadvantage is requiring too much space and thus it is seldom used for high current application. The multi-layer coil of approximately square cross-section gives the greatest amount of inductance and the lowest resistance in the least amount of space. But this type has an extremely high distributed capacity. Duo-lateral types of windings combine the low distributed capacity of a single

Fig. 1. Low-voltage neon sign filter.



layer coil with the small space required by the multi-layer windings.

When filters are used for multiple circuit flashers, a choke and condenser should be used for each make and break contact. This is the secret of successful radio interference elimination. Proper grounds are essential; a long ground lead is bad as it will act as an antenna. It is better to determine the best ground connection by experiment. Using the metal frame of the flasher is often okeh. As this frame is usually grounded to the conduit, when this is not the case a wire not smaller than No. 8 B&S gauge should be run from the frame to the nearest water pipe or to the steel frame of the building.

If the interference filter is not effective when connected as outlined above, disconnect the ground wire from the two connected on the line side of the flasher and connect this wire to some other ground, metallic object, such as a water pipe or vent pipe. If the filter is still ineffective, it is an indication that the grounding facilities are of high radio-frequency resistance and it will probably be necessary to install a separate grounding system connected to a pipe or a rod driven into the ground at least six feet. If this is not practical, it might be possible to operate the sign without a ground connection on the interference filter and still have satisfactory reduction of the noises. Only in rare cases is difficulty of this nature encountered in modern installations.

Luminous Tubing Interference

Radio interference in luminous-tubing signs of the steady burning type might be caused not only by leaky insulators, tube supports, or wiring and excessive footage, but also by double-backs and the metal framework and moulding used in the construction of the signs. Noise caused by double-backs can be eliminated by closely wrapping the back portion with bare copper wire of from numbers 24 to 28 B&S gauge, and grounding one end of the wire to the metal frame right in back of the double-back. This interference is easily detected by its crackling noise that accompanies any corona discharge. Similarly, noise due to loose portions of the metal work can be located. This can be remedied by securely tightening all bolts and screws in the assembling and by grounding. If necessary, solder together any overlapping sheet metal joints where the corona is occurring.

Radio interference produced by multiple-path tubing is due to transients caused by breakdown of continuously changing ionization paths. Since the interference is generated within the tubing and is a function of the operation

of this type of luminous tubing, the only corrective measures are to prevent this interference from being fed along the high power wiring to increase the interference field. Special high-power chokes adapted for this purpose should be connected, each in series with each tubing electrode terminal, and placed as closely to the tubing as practical. The chokes prevent interference energy from getting into the high power wiring and thus limits noise radiation to the tubing itself which in most cases is not serious.

In installations where animated luminous-tubing signs are used with primary circuit flashers, radio interference that might be encountered can in most places be eliminated by the same methods used for any type of primary flasher. However, in some cases it is necessary to resort to a corrective treatment system. In this respect, it is of primary importance that the tubing footage be not greater than that which will give flickerless operation on the lowest line voltage that might be encountered.

High Power Animators

Until recently the use of high power animators nearly always resulted in radio interference and seemed to defy all efforts to eliminate this interference. The use of a choke and condenser in the primary is useless since practically all the interference radiation occurs in the secondary circuit. An effective condenser connected across the secondary circuit is impractical due to the excessive cost of a high voltage condenser. And any appreciable capacity will result in serious damage to the transformer due to the high reactive current that would flow in the secondary circuit. A specially designed sectional wound high power choke of high inductance and low distributed capacity is remarkably successful. While these chokes are used in circuits having a maximum voltage of

fifteen thousand volts, they have been tested at over one hundred-thousand volts, before flash-over occurs between sections. It is important that a choke be used for each contact on the animator and one in the common lead of the transformer secondary and connected to the high-tension terminal on the transformer.

Antennas And Signs

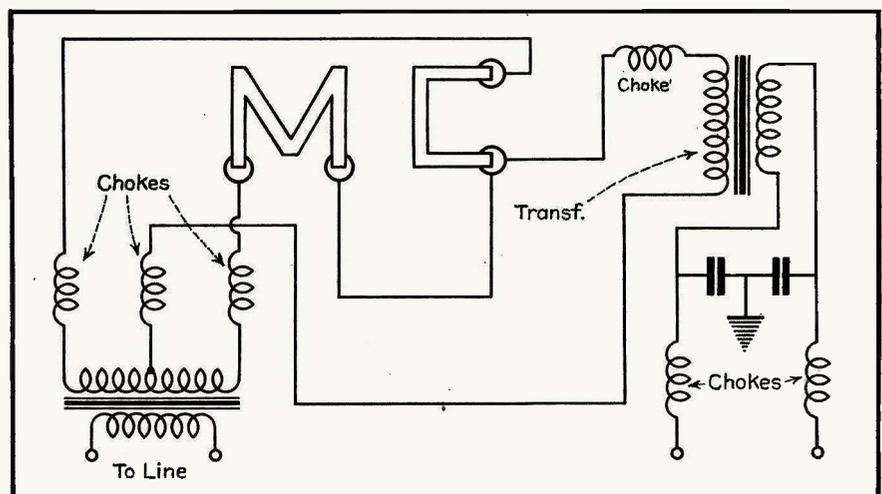
The antenna of a radio receiver in the vicinity of a sign installation should never be near or attached to the sign. A radio owner is generally glad to cooperate to the extent of installing the antenna away from the sign and instances have been found where this is all that was needed to clear up the complaint. First determine whether or not the antenna or lead-in is near the sign flasher. If so, move the antenna away from the sign and at right angles to it or run it near to the open supply lines feeding the sign. While this may work in only a few cases, it is well to try it first in order to save the expense of installing an expensive filter in the sign.

Receivers with loops may eliminate some sign pickup by turning until the minimum sign pickup. The Faraday shield may also be tried.

The following table gives the inductive reactance, at sixty cycles, of some of the commonly used values of inductances.

INDUCTANCE	INDUCTIVE REACTANCE
150 Microhenries	.056 Ohm
200 Microhenries	.075 Ohm
300 Microhenries	.113 Ohm
400 Microhenries	.150 Ohm
500 Microhenries	.188 Ohm
600 Microhenries	.223 Ohm
750 Microhenries	.281 Ohm

Fig. 2. High-voltage neon sign filter.



AN ANALYSIS OF FILAMENT SWITCHING IN A-C/D-C BATTERY PORTABLES

By BARRY KASSIN

Most battery-line portables use a series filament connection because of the much simpler switching methods. Either parallel or series operation will perform satisfactorily if the necessary design factors are considered. Since production tolerances of various tube manufacturers must be allowed for, tubes must differ in the required filament voltage for a given value of filament emission or temperature. Then changes take place in aging—the filament slowly evaporates, becoming thinner. When an old tube is placed in a series string of new tubes, it will usually take a beating and die fast. Hence, receivers powered by batteries only will always use parallel filaments. But, as we will see later, a-c/d-c battery sets with parallel filaments on battery operation have quite complicated switching systems. This is due to the fact that no simple method or equipment is known for operating filaments in parallel on line operation with a reasonable efficiency and safety factor. Let's con-

sider this situation a bit further.

A series arrangement of modern battery tubes takes only 50 milliamps for filament heating. Taking the simplest 4 tube superhet with a 50 ma, 1½ volt power tube, and converting it to parallel filaments, would demand 200 ma. Most popular sets demand 250 or 300 ma. None of our popular type rectifier tubes can deliver this much current continuously. It would take at least two tubes in parallel. Then comes the filter problem. The size of a filter condenser is directly related to the current demanded. Hence, five times the current would require five times the capacity in each "A" filter condenser. Thus we have our first problem. But this isn't the worst of them. The matter of voltage regulation must be considered. For, if a tube should burn out, it is imperative that the voltage be held to a safe value.

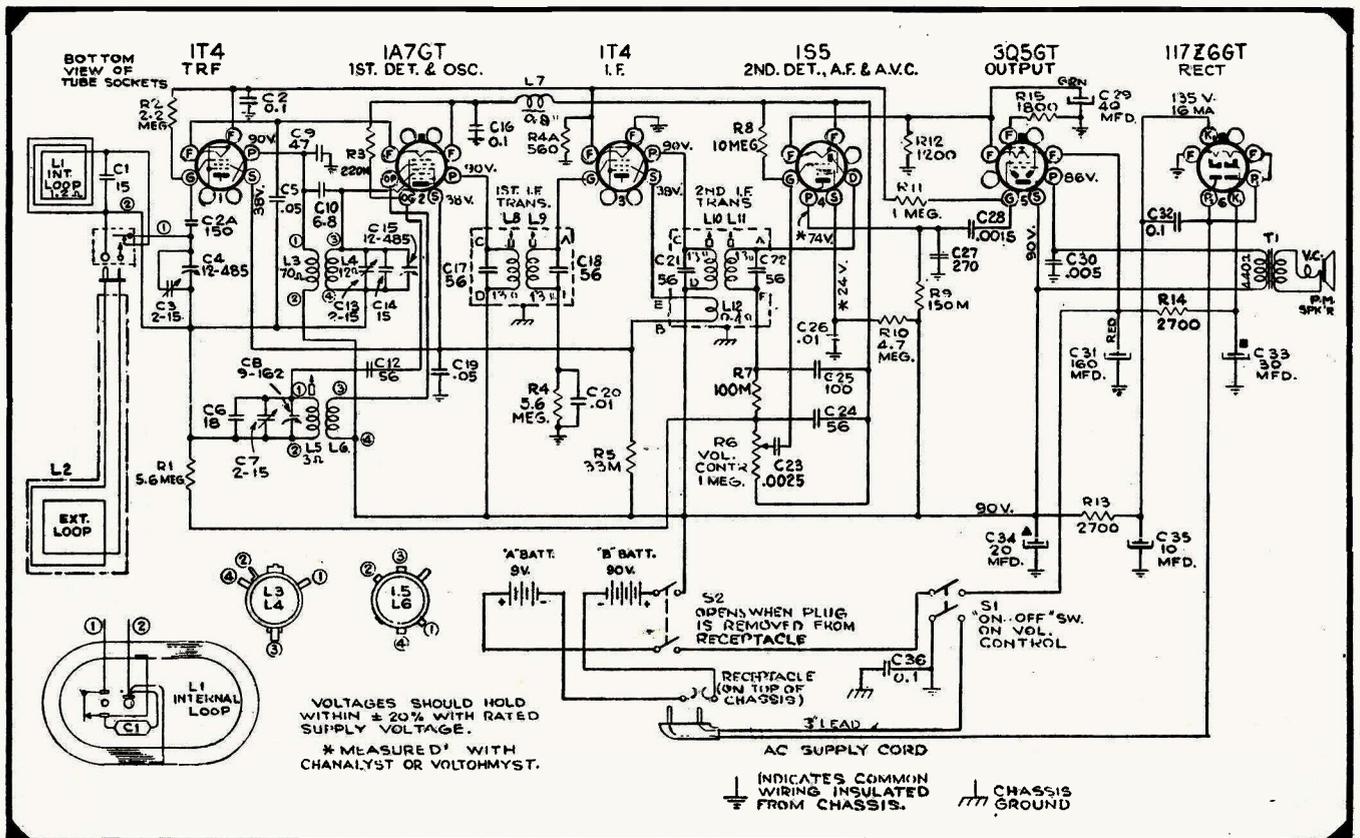
This is usually accomplished through the use of a heavy shunt bleeder resistor which is a sheer waste of power calling for still higher condenser values.

On a-c only, a step-down transformer could be used with a disc type rectifier of the copper oxide, sulphide or selenium variety, with a saving in power. However, a filter choke would be required since resistor filters require higher voltage. The full-wave output of these rectifiers considerably eases the filter problem. The voltage regulation would be considerably lowered, requiring less bleeder current. But this solution hasn't been used in portables because of the weight, bulk and expense of the transformer, choke and large 1000 mfd filter condensers.

Series Filament Circuits

Many considerations are involved in running filaments in series which complicate a seemingly simple circuit arrangement. Tube filaments are not con-

Fig. 1. RCA 26BP, with typical filament circuit lineup.



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I'll pay cash or trade tubes and parts for old phonograph records (in new condition)—your whole stock or white elephants. Yates M. Hoag, RD1, Utica, N. Y.

WANT TO BUY

—AC-DC multi-tester or a pocket volt-ohm milliammeter signal generator and tube checker. State condition and price. A. V. Larson, 822 4th St., Madison, Minn.

WILL TRADE

—books, mikes, and many other items including photo equipment for oscilloscope, f-m receiver, condenser tester, photo equipment or what have you. Joseph Zielinski, 1637 Blackhawk St., Chicago, Ill.

INSTRUMENTS, etc. FOR SALE

—Meissner analyst; tube tester; Kray-O-Meter; C-B signal generator; condenser tester; manuals; v-o-m and socket selector; radio course; radio books; electrolytic condensers; tubes, resistors, etc. Would like to sell all to one person. Write for details. W. Kay, 319 Main St., Niagara Falls, N. Y.

CHANALYST TO TRADE

—Will trade RCA-Rider Chanalyst in brand new condition for an oscilloscope and vacuum tube voltmeter (A-C and D-C) or will buy same for cash. J. A. Silvestro, 2009 Roanoke St., West Hyattsville, Md.

WILL TRADE

—Will trade three National coils 29-80- and a 40-meter band spread; also a National 2-gang tuning condenser for these coils and a coil socket. Need a Chanalyst or a good signal generator. B. W. Flemming, 1123 Bayard St., Baltimore, Md.

WANTED FOR CASH

—Superior or other makes of multi-testers, signal generators, vacuum tube voltmeters, and channel analyzers. Hobart Radio Service, 4259 Washington St., Rosindale, Mass.

TUBES TO SWAP OR SELL

—Have plenty of the following tubes to sell for cash or trade: 12SA7, 50L6, 12SK7, 12SQ7, 35Z5, 5Y3, 6K7, 6A8, 6F6, 6H6, 6Q7, 6X5, 25L6, 35L6, 35Z3, 48, 32, 34. What have you? Hoepfners Radio Shop, 1613 W. 4th St., Davenport, Iowa.

WANTED

—Small universal output transformers and 5 or 6 tube power transformers 6.3 volt type. Will trade for tubes or buy outright. Give full details. Radlectric Labs., Hudson, Wis.

TUBES AVAILABLE

—What am I offered for 150 assorted tubes in the following types: 1C7G, 1D5G, 1F7G, 1H6G and 1J6G? Will swap 150 Delco type 4 prong vibrators, or sell at 40c each. I need a small bench metal lathe with back gears, Jacob's chuck and tail chuck. Forest Radio & Appliance Service, 148-150 Forest Ave., Buffalo, N. Y.

TUBES & RADIOS TO TRADE

—Philco table models PT3, PT96, and 321T; also Zenith 6G601 and 7G605. Also have some much wanted numbers in tubes on same deal. Write for details. We want solid shellac scrap records. Will allow 5c per pound against 40% off of Western list on above radios. The Emporium, Radio Dept., San Francisco, Cal.

WANTED

—Superior model 1280 set tester or 1250 multi-tester. State price and condition. John O'Reilly, 1823 White Plains Rd. Bronx, New York, N. Y.

FOR SALE OR TRADE

—Used Wurlitzer 12" and 16" record coin-operated phonographs; also RCA portable recorder MI-12701 complete with mike. Could use new radio tubes of the needed types, Rider Chanalyst, or late test instruments. Tomalino Radio Service, Glendive, Montana.

FOR SALE

—110 D.C. amplifiers, 8-tube phono type, used. 48's P.P.P. Output tubes supplied. Have special relay which keeps filaments warm 'til ready for use, then applies full voltage at flip of switch. Sold "as is" or re-conditioned. Will swap three for 225 watt rotary converter. P. F. Alphen, 6 Halifax St., Jamaica Plain, Mass.

WILL SWAP

—1 Hickok signal generator and decibel meter com.; 1 custom made amp. about 25-watts; two pairs of 6L6's; 1 18-watt 12" Pm. speaker (new); 1 Crosley table model radio for multi-testers, tube testers or multi-testers. Ward Smith, 7122½ Flecia Way, Homewood, Pittsburgh, Pa.

WILL BUY

—F-M receiver, 'scope, meters, etc. Will also buy tubes. State what you have for sale. Charles Sovatsky, 209 Taaffe Place, Brooklyn, N. Y.

WANTED

—Junior voltohmyst or other high grade ohmmeter unit. Would consider Superior Giant ohmmeter or similar type, either battery- or A.C.-operated. Metropolitan Radio Service, 4314 Elston Ave., Chicago, Ill.

CONDENSER TESTER WANTED

—Must be standard product in good condition — no home-made job. Describe, and name price. Radio Service Assoc., 7 Washington Place, East Orange, N. J.

WANTED

—Oscilloscope, Philco signal tracer, 0-1 milliammeter, and condenser analyzer. Have radio courses, old radio chassis, refrigerator parts, electric motors, watch, and books to exchange. Hiawati Radio Service, 1434 W. First St., Oil City, Pa.

WANTED

—Signal generator, volt ohmmeter, analyzer and Sky Champion receiver. Only local replies considered. E. Dunn, 4031 Park Ave., Bronx, New York, N. Y.

WANTED

—R.M.E. LF-90 inverter; Hallcrafters HT-7 frequency standard Abbott TR-4 transmitter. Walter Kryger, 912 W. 151st St., East Chicago, Indiana.

FOR SALE

—BC-3 Bliley crystal, 2030.5 Kc. In perfect condition. Send offer. Will answer all letters. Charles Nelson, Route 2, Wayzata, Minn.

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—Have ten Philco AR-50 and two AR-40 radios. Swap or sell. Court Radio, 91 Prince St., Newark, N. J.

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—Have Supreme analyzer in good condition for sale. Would like to obtain 35Z5 tubes, or 50L6, 12SA7 (G or GT), 12SK7 (G or GT) or 80's in original cartons. G. R. Runyan, 522 Main St., Arkadelphia, Arkansas.

WILL BUY

—Veedolyzer, traceometer, or chanalyst in good condition. Have for trade or sale a Model 15 Scott all-wave receiver in perfect condition. D. M. Clutter, 28 Maplewood Pl., Athens, Ohio.

FOR SALE OR TRADE

—New Capehart model 112M-2 f-m and a-m 20-tube combination (\$775 list). Will sell or trade for equal in new radio tubes such as 12SK7 and 35L6GT. Could also use chanalyst, v-t voltmeter, and 6 or 32-volt radios. Tomalino Radio Service, Glendive, Montana.

VOLTOHMMETER TO SWAP

—Will trade Weston Model 564 volt-ohmmeter; also Hallcrafters Sky Buddy S19R, good as new; also two auto radios in good condition. Want good capacitor analyzer or what have you? Charles H. Wallace, 532 Foster Rd., Princes Bay S. L., New York.

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—Must be in good condition. Will pay cash. Have for sale Giant Racon units at low price. National Sound Eqt. Co., 625 Main St., Worcester, Mass.

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—Rider's Manuals Nos. 1 to 12 (except No. 2) all in first class condition. \$60. Lee H. Peabody, 1319 S. Osage, Sedalia, Mo.

LIST PRICE FOR TUBES

—Will pay list price for the following tubes (in original cartons) any quantity: 35Z5; 50L6; 12SA7; 12K7; 12SK7. Greenwald Specialty Co., 58 S. Royal St., Mobile, Ala.

HAVE TUBES, METERS, etc.

—also keys, filter blocks and cabinets. Want 8 mm. projector and films. Will add cash to above if necessary. G. Samkofsky, 110 Wilson St., Brooklyn, N. Y.

WANTED

—2½ meter transceiver, portable or stationary. Will trade for same, or will buy. Charles Halas, 1229 So. Wisconsin Ave., Berwyn, Ill.

WANTED

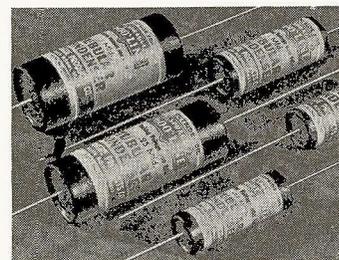
—6 foot steel relay rack for stand-ard 19" panels. Richard Berry, Service Engineer, Thomas A. Edison, Inc., 110 Arlington St., Boston, Mass.



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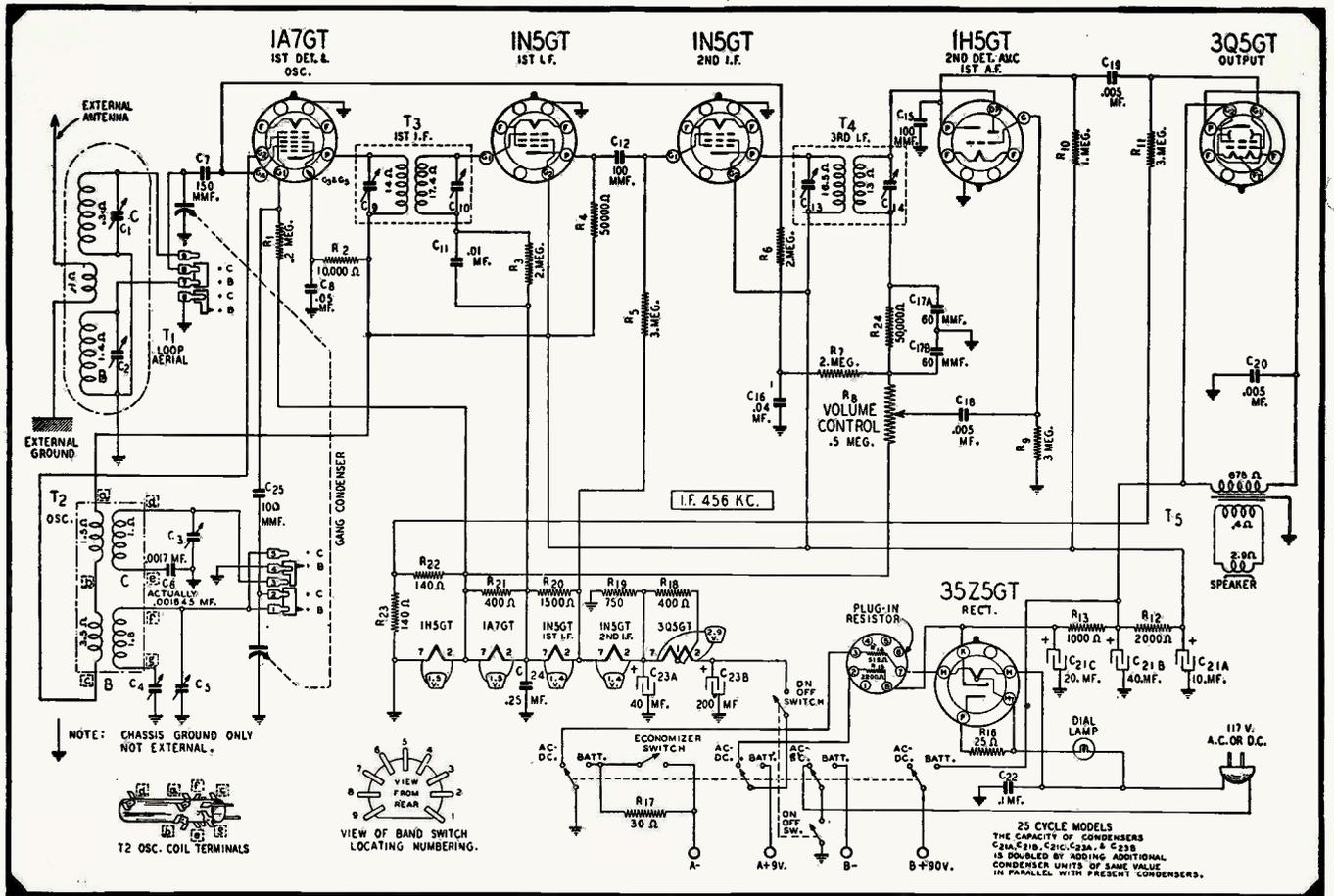


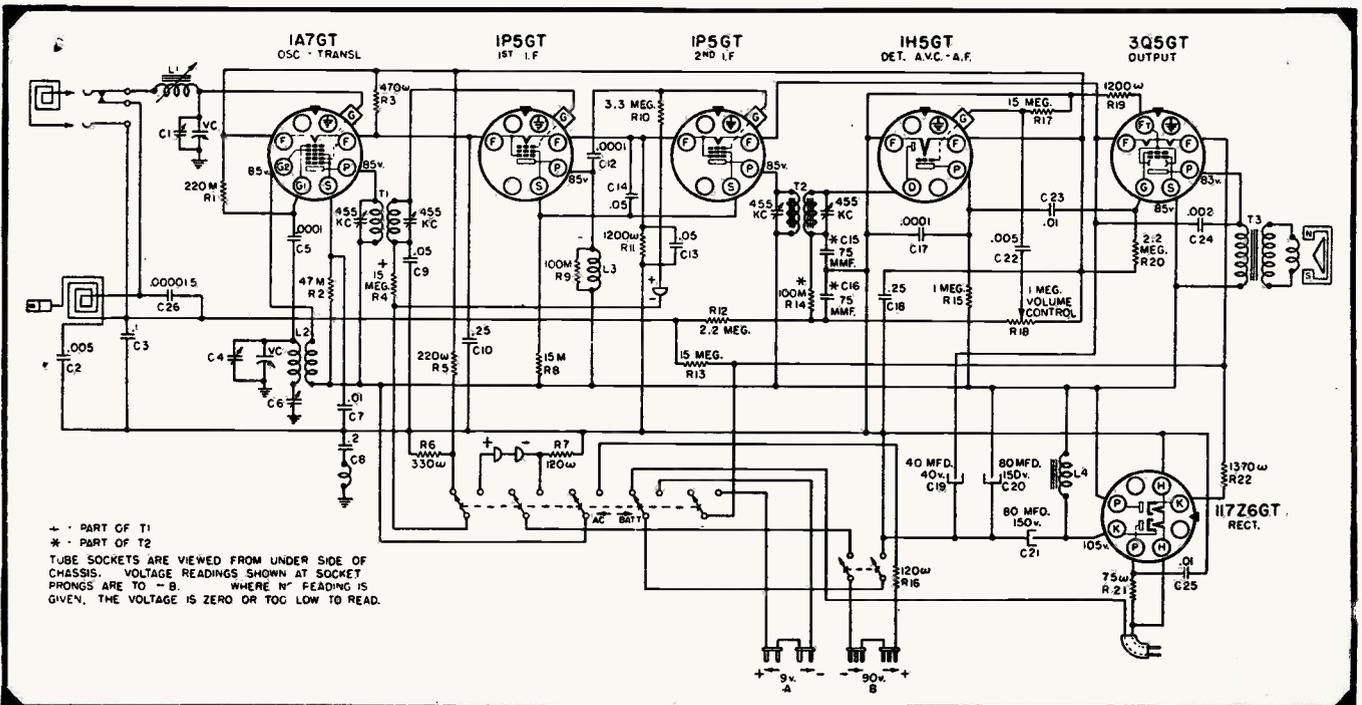
Fig. 2. Sea Pal marine portable wherein filament voltages are equalized.

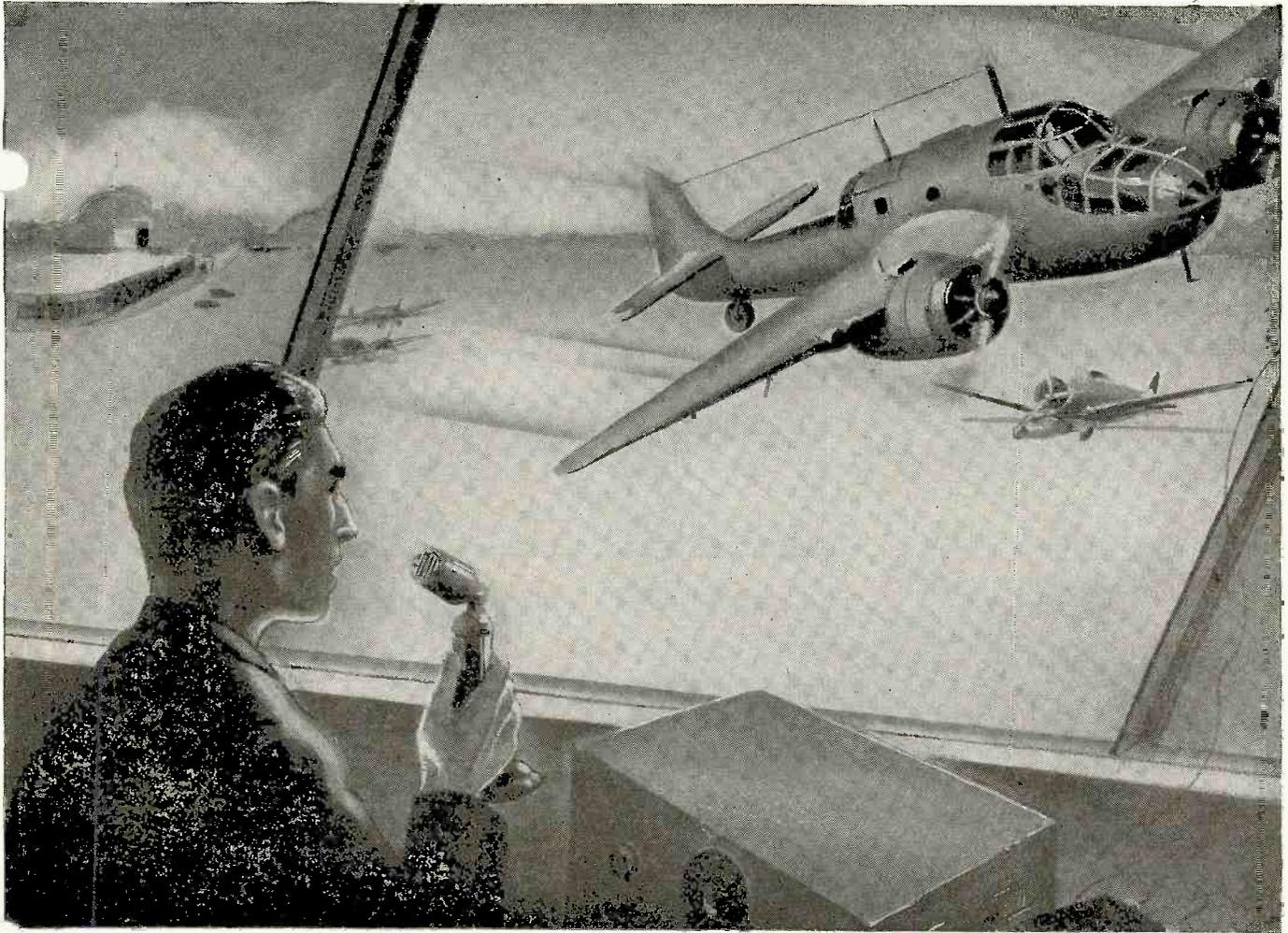
nected in any manner. Plenty of thought and experimenting has gone into the adopted order. All engineers seem to agree that the power tube filament should be at the positive end of the series in order to obtain grid bias from the drop across the remaining filaments. There are two definite disadvantages to this positioning, however.

First, the plate current of the power tube must flow through the filament string on its way to "B-", necessitating an equalizing resistor to shunt this

Fig. 3. Silvertone 7085 and 7090 with bias cells linked to switching circuit.

steady plate current to "B-". Without this resistor, the remaining filaments would be considerably overloaded—about 15%. When a type 3Q5GT output tube is used, an additional equalizing resistor is used to balance the drop across both halves of the filament. This can be either a shunt resistor to "B-" or a lower value resistor in parallel with





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The smooth frequency curve, rising with frequency, gives extremely high intelligibility even under adverse conditions. Desk mounting incorporates easily accessible switch which can be operated by thumb of either right or left hand. Microphone may be moved without danger of pressing this switch. If you have a microphone problem, we invite you to consult our engineering department.

If, however, your limited quantity requirements can be met by any of our standard model microphones, with or without minor modifications, may we suggest that you contact your local radio parts distributor? He may be able to supply your immediate needs from remaining stocks. In all instances, his familiarity with our products and many of your problems will enable him to serve you well. Our distributors should prove to be vital links in expediting your smaller orders.

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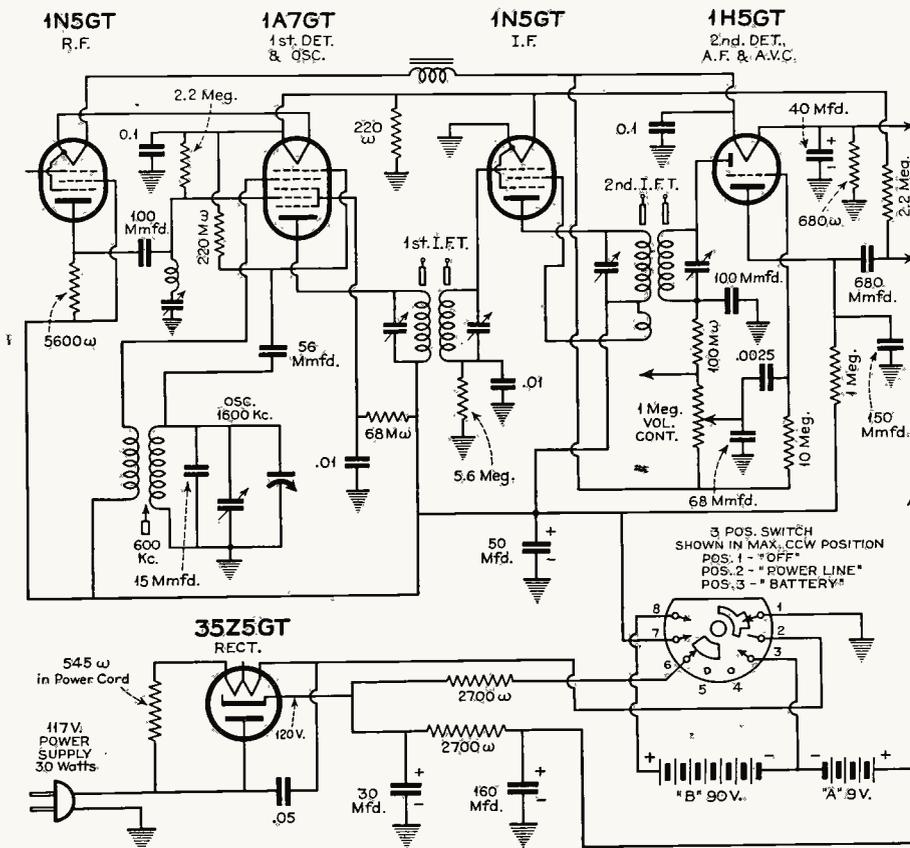
the negative half of the filament circuit.

The second disadvantage in placing the power tube at the positive "A" terminal is due to the audio plate current flowing through the remaining filaments, causing audio regeneration. Any signal travelling through the filaments will appear as modulation when a carrier is tuned in. An audio filter is required to keep signal voltage out of the filament string. A simple electrolytic bypass condenser from the negative side of the power tube filament to "B—" is usually sufficient. Values of this condenser run from 40 to 200 mfd., which may appear to be large, but this bypass also serves as an "A" hum filter component, in conjunction with the power tube filament (which acts as a filter resistor).

Series Filaments in RCA 26 BP

Fig. 1 shows the RCA model 26BP which illustrates the several points mentioned above. Note the 1200-ohm resistor and 40 mfd. bypass, from the negative 3Q5GT filament to ground; also the 1800 ohms from filament tap to ground. Completing the tube lineup, we have the 1S5 detector, 1A7GT converter, IT4 r-f and IT4 i-f. Between the 2nd detector and converter tubes is an r-f filter; also a 0.1 mfd. bypass condenser and 560-ohm resistor across the i-f filament. An equalizing resistor

Fig. 5. Filament circuit using three-position rotary switch.



should theoretically be used on each tube to take care of the plate currents of all tubes more positive but, practically, some may be omitted because of the low values of the current drawn. Many sets place the i-f tube at the ground end of the string to give maximum stability but this position does not allow avc to be used. In this receiver, a bypassed 5.6 megohm grid-leak is used in the grid return to prevent overloading.

Battery to line switching is automatic in this model. The power supply cord fits into a receptacle on top of the chassis which closes the battery circuit

Fig. 4. Filament system using three-pole double-throw switch.

("B+" and "A+"). When the plug is removed from the receptacle, the battery switch opens. A double pole switch on the volume control opens one side of the supply cord as well as the "A" battery.

Fig. 2 illustrates the method of equalizing the different filament voltages very well. This is the diagram of the Sea Pal marine portable. Note the different line-up of tubes and the complete treatment of each one. The 3Q5C filament tap is bypassed to the negative end, instead of to "B—" as in the previous receiver. The first i-f and converter are similarly treated. The shunt on the 1H5GT is split for the power tube grid bias. In most instances this bias lead is taken from the positive end of the most negative tube. The on-off switch functions as in the previous set. The line-battery switch is more complicated, however, using a four-pole, double throw unit and, in addition, an economizer switch which cuts a 30-ohm resistor in the "A" battery circuit.

The first pole either completes the line circuit or connects the "A" battery to "A—". The second connects the filament string to the rectifier "A" supply or "A+" battery. The third completes the line cord circuit or connects "B—". The fourth opens the "B+" terminal on line operation.

The Silvertone models 7085 and 7090, shown in Fig. 3, bring in additional elements. First, let's study the 117Z6GT rectifier. The bottom diode is used in normal fashion for both "A" and "B" supply. The filter choke, L, is common to both supplies. The "A" circuit then continues through the top diode (which serves only as a resistor), a 1370-ohm voltage dropping resistor and

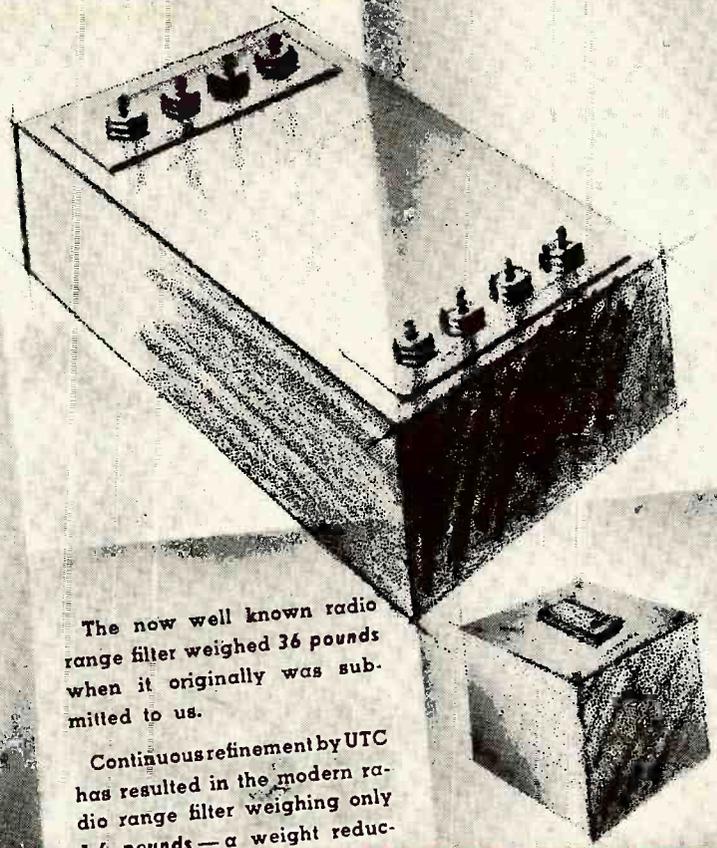
(Continued on page 38)

FILTERS— Designed for war



Unique characteristics of many UTC filters are the result of years of research on core materials and filter structures. We are proud of our part in the development of filters for wartime electronics. Here are a few typical elements, based on UTC design, which have led to UTC leadership in this field.

May we design a "Victory" unit to your application?



The now well known radio range filter weighed 36 pounds when it originally was submitted to us.

Continuous refinement by UTC has resulted in the modern radio range filter weighing only 1.6 pounds—a weight reduction of 95%.



This UTC development is a tunable inductance, adjusted in the same manner as an I.F. trimmer.



Designed for high frequencies, the Q of this coil is 300 at 20,000 cycles.



... For medium frequencies, the Q of this coil is 210 at 1,000 cycles.



... For low frequencies, the Q of this coil is 80 at 100 cycles.

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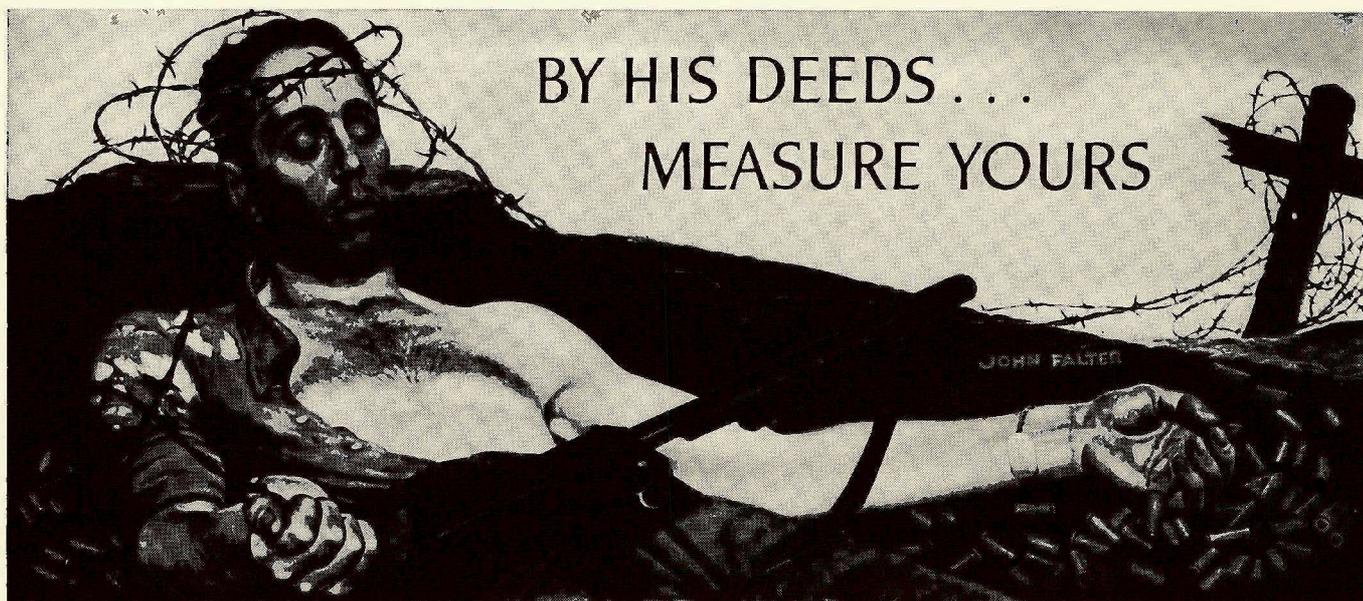
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SER-CUITS!

By HENRY HOWARD

PARTICULAR attention to antenna circuit design has been paid by many engineers in their development of even the small type receivers. In the Airline model 14BR-523A, 5-tube table model (Fig. 1), for instance, an antenna plate and a separate low impedance capacity coupled external aerial has been included. C_1 , the antenna series condenser, favors the high frequency end of the band, but C_4 , which shunts the input circuit, passes more highs than lows. This tends to flatten the response. C_1 is a 100 mmfd. mica condenser while C_4 has a value of 800 mmfd. It is easy to see how one end of the band or the other may be favored by this arrangement. We note that C_3 , the antenna trimmer, returns to the "B—" bus instead of just shunting the variable inductor. This causes less disturbance to the antenna coupling circuit. For phono operation, the screen of the 12SK7 i-f stage is opened.

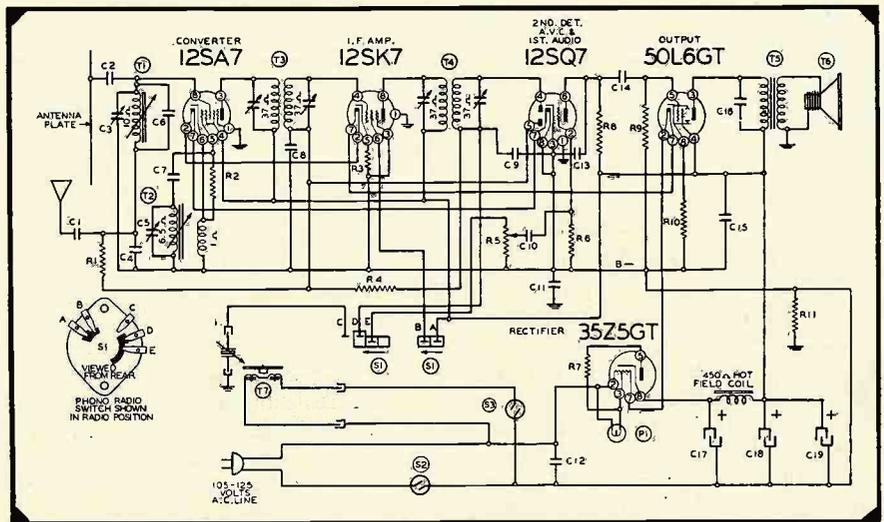
Belmont 671B

Another interesting antenna circuit is shown in Fig. 2, Belmont's model

Fig. 2. Belmont 671B two-band phono receiver with unique input circuit.

671B, a 2-band phono receiver. The loop returns to ground in this model, through part of the short-wave transformer. The loop primary is coupled to the external aerial through a loading coil and returns to ground by the same path as the main loop, allowing a bit of inductive coupling. A 4000-ohm resistor shunts the loading coil and primary to prevent peaking. On the short-wave band, an autotransformer coupling

Fig. 1. Airline 14BR-523A, with low-impedance antenna.

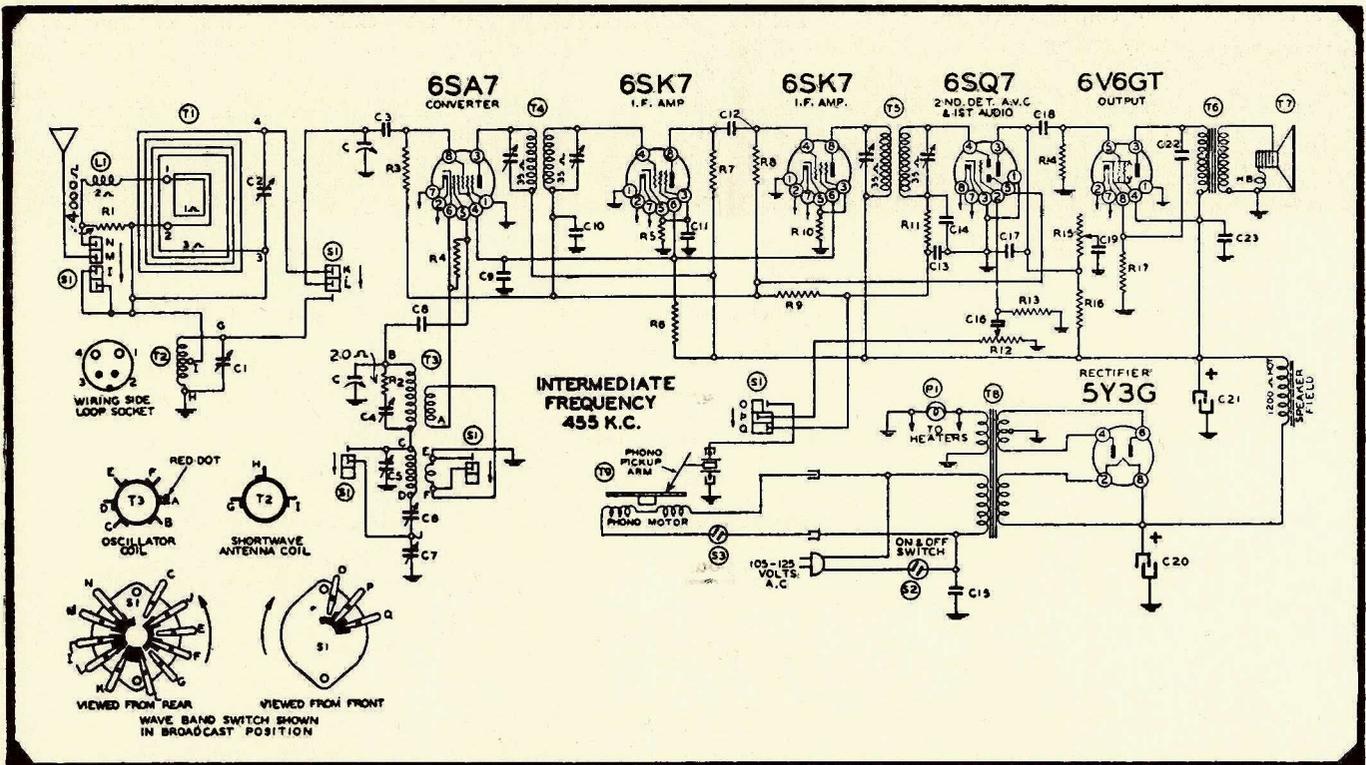


system is used, the loop and associated parts acting as an antenna plate.

In the oscillator circuit, both sets of coils are in series for the broadcast band, the larger one with its padder being shorted for short-waves. The two padders are connected in series. Cathode feedback is applied separately to both coils, the larger tickler being shorted for short-waves. To flatten the oscillator short-wave output, a 20-ohm trimmer is placed in series with the trimmer.

Belmont 11AE2

The next receiver, Belmont's model 11AE2 (Fig. 3), has a dozen features worth discussing. It has a multiple ganged permeability tuner for covering broadcast and four short-wave spread bands. A genuine 6SK7 t-r-f stage is



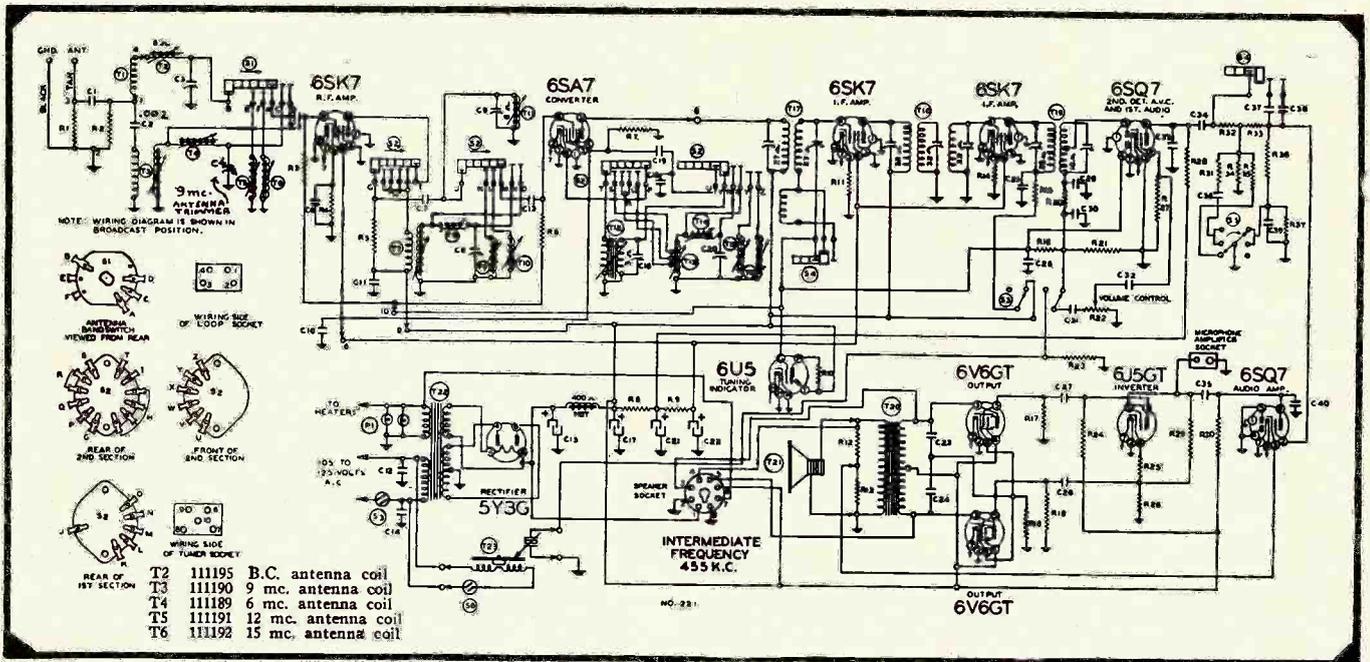


Fig. 3. Belmont 11AE2, featuring a t-r-f stage and high-pass filter in antenna system.

fully utilized. It also has high-pass filter coupling in the external antenna through an impedance coupled arrangement, directly in the loop circuit, without the use of a primary coil. The voltage is fed into the loop across a .002 mfd. condenser and the primary of the 9 mc antenna transformer. The loading coil is the main inductance with permeability tuning. T_3 alone tunes the 9 mc band while T_2 and T_4 combined, tune the 6 mc. band. The antenna coupling is less on this band, since T_4 acts simply as a loading coil. But there is another factor which determines the actual amount of coupling. That is the natural resonant period of the antenna, primary coil and ground.

Off-hand, we wouldn't worry about the 6 mc band being cheated.

On the 12 and 15 mc bands, T_4 is shorted, the tuning being done by tuning elements shunted across T_4 .

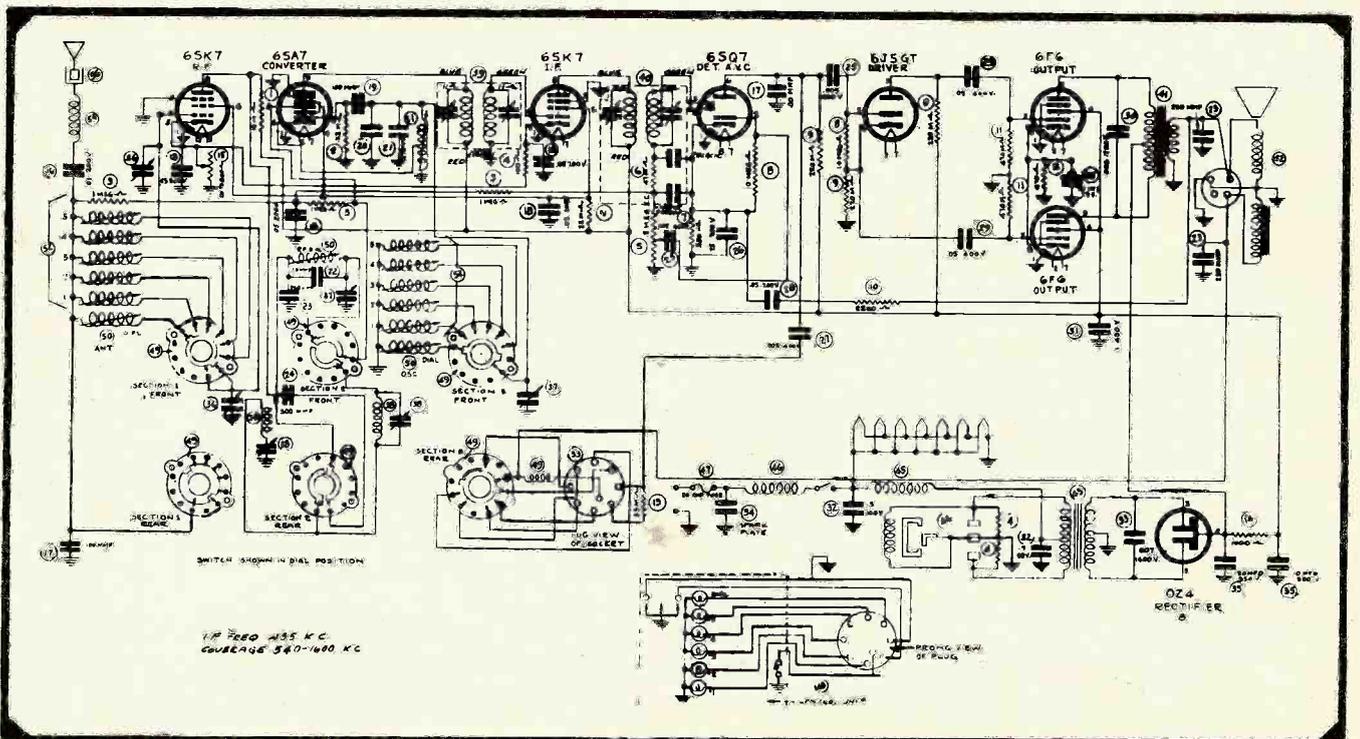
A similar circuit is used in the converter stage except that the broadcast coil is resistance-coupled to the signal grid. In the oscillator circuit, the same procedure is used, except for the feedback arrangements; cathode tickler for

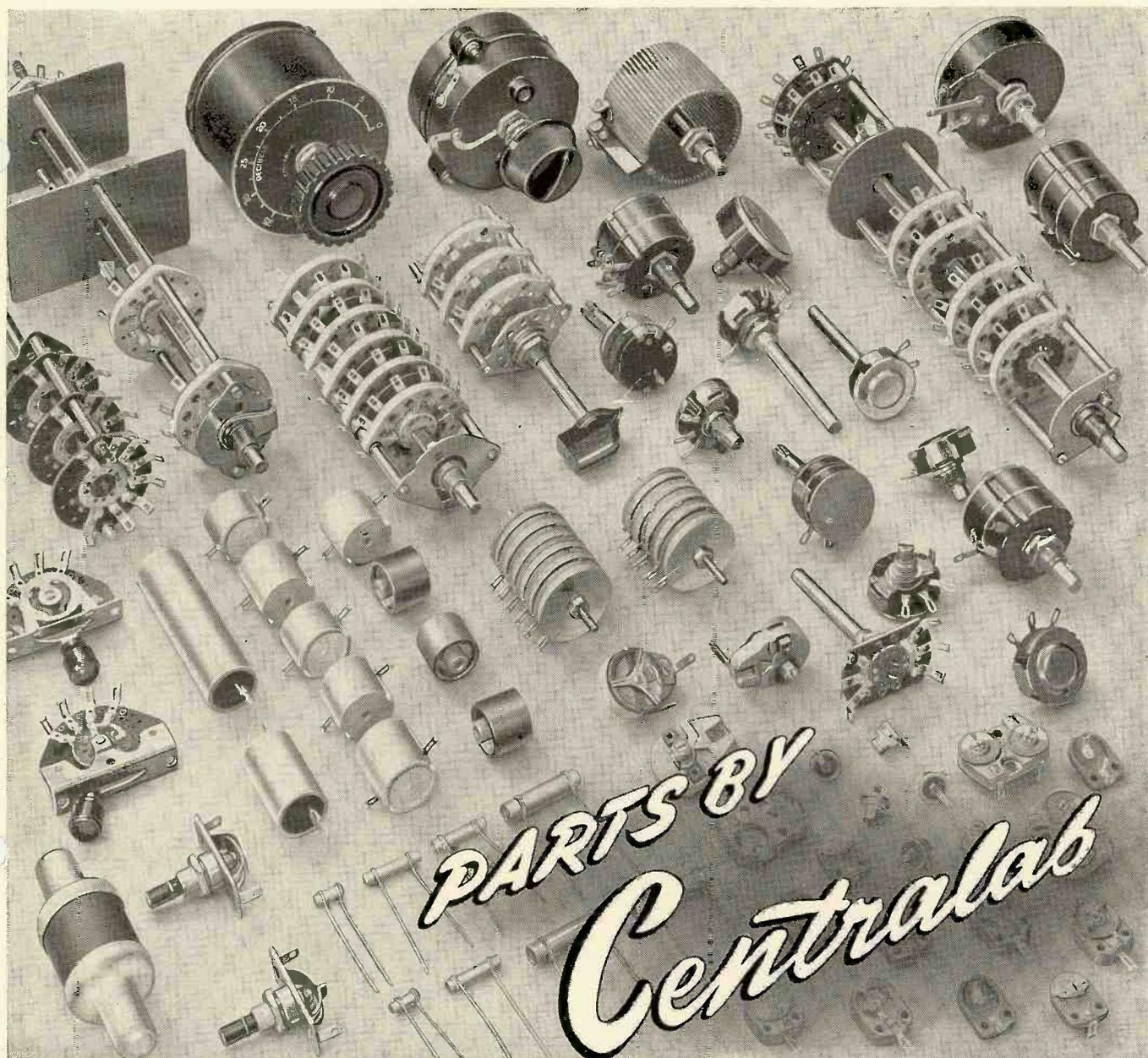
b-c and cathode taps on T_{1a} for all other bands.

The i-f channel is switched to wide-band reception for b-c and sharp tuning for s-w to aid in the reduction of noise. A triple-tuned interstage transformer is used and, on the third i-f transformer, the detector is tapped down on the secondary to lighten the loading and boost the selectivity. Both 6SK7 i-f cathodes are left unbypassed. Automatic volume control is connected to the first three stages, but not to the 2nd i-f.

Three audio stages are used in combination with a high degree of degeneration, whereby signal voltage is sent from the voice coil circuit back to the second a-f cathode. This encompasses a

Fig. 4. Firestone S-7350-1, with novel r-f and i-f sensitivity control.





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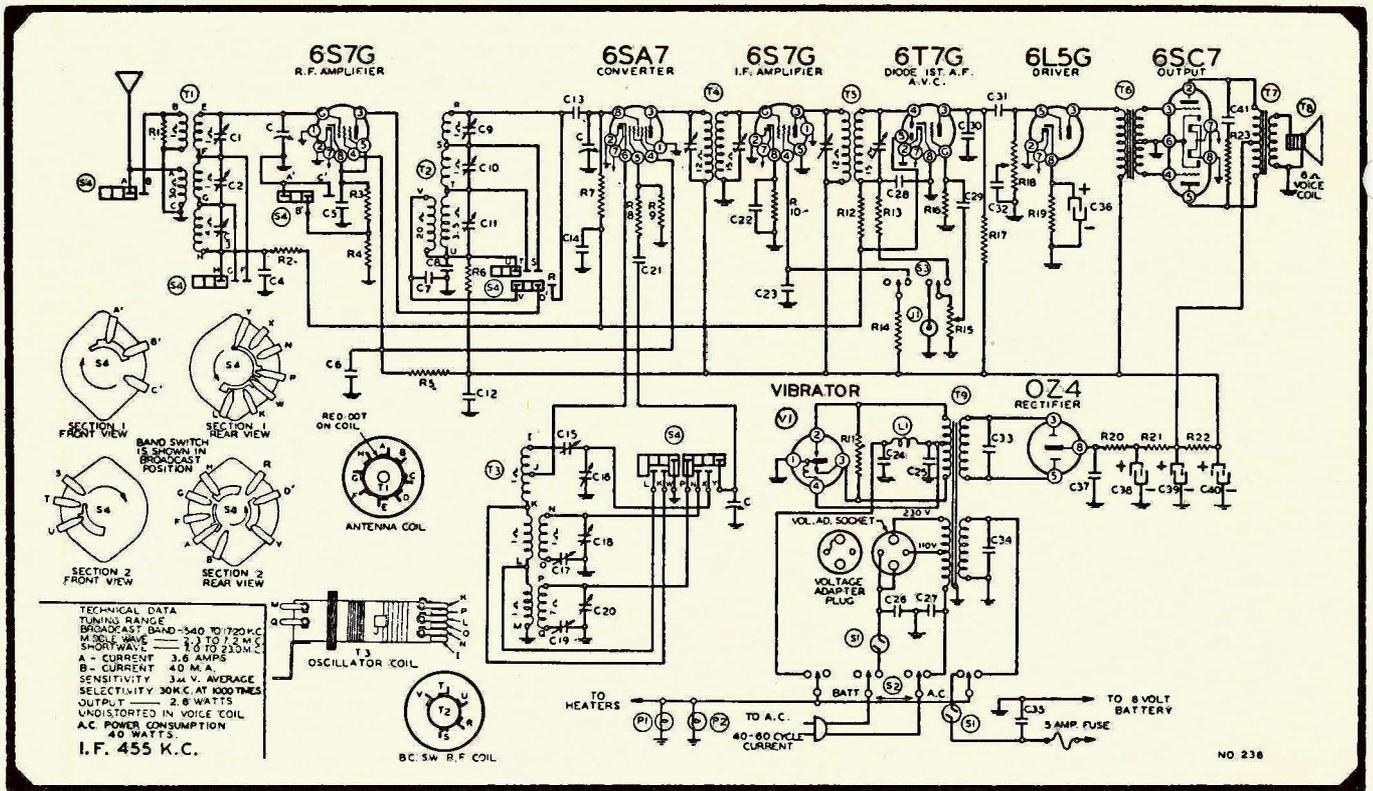
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cathode type inverter and should be quite effective. With all this r-f and audio gain, the ripple filtering must be effective and this is assured by the three filter sections.

Separate bass and treble tone controls are obtained by introducing two series resistors between the first and second a-f stages. Shunting small condensers across the resistors serves to boost the highs while various combinations of R

Fig. 5. Belmont 7H31, that may be operated on either of three power supplies.

and C shunt the highs to ground, giving the familiar bass boost.

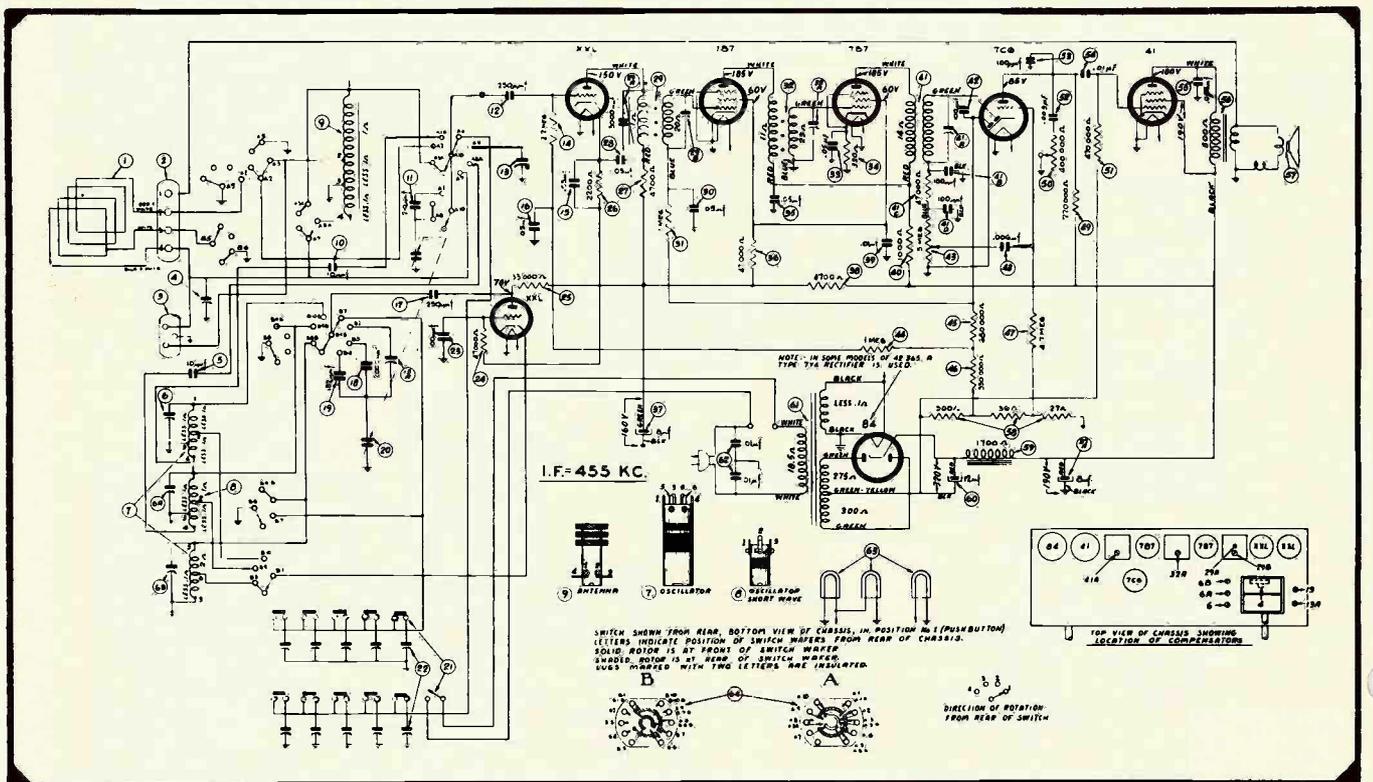
The second audio stage feeds a cathode type inverter which drives the push-pull 6V6's. A speaker socket is provided with all the output leads for

Fig. 6. Philco 42-365, with rotatable low-impedance untuned loop.

plugging in a cutter for recording. A microphone socket is also provided in the grid of the inverter.

Air Chief S-7350-1

The Firestone Air Chief auto model S-7350-1, shown in Fig. 4, has several novel features. A bank of pilot lights is used, for instance, one for each push button. A sensitivity control varies the bias on the r-f and i-f stages. The



inverter stage is a 6J5GT cathode followed with a free 220,000 ohm cathode bias resistor and the same value plate load resistor. This arrangement gives an amplification factor of unity and a well regulated output (voltage regulation).

Belmont 7H31

Fig. 5 shows Belmont's model 7H31, a 7-tube unit, with a t-r-f stage. The receiver is capable of operating on three power supplies: a 6-volt storage battery, 105-125 volt a-c line or 200-250 volt a-c line. The set covers b-c, medium wave and s-w bands. A bandspread indicator is provided to spread the two short-wave bands completely around an auxiliary dial. A separate knob is provided to operate the indicator which borrows a bit of art from the communications receiver field. The main tuning pointer is set at the high-end of the band with the bandspread indicator at zero. The bandspread knob may then be used for the entire band without moving the main pointer.

An 0Z4 rectifier is used in conjunction with a 3-stage resistance/capacity filter with the following components: 0.1 mfd.—50 ohms; 40 mfd.—200 ohms; 20 mfd.—1500 ohms—20 mfd. The bandswitching system is very simple. Three coils in series are used for the lowest frequency band; one coil is cut out for intermediate frequency and two for the highest frequency. A push-pull input audio transformer feeds the 6SC7 dual triode.

Philco 42-365

A 3-band, 7-tube receiver, Philco 42-365, with a low impedance untuned loop, which is completely rotatable, is shown in Fig. 6. The loop is fed to a portion (primary) of the antenna autotransformer, which is so tapped that a single unit is used for all three bands. On short-waves, the loop is opened, serving as a capacity aerial. The first two i-f transformers are iron-cored; the third is an air core unit. Both the second and third have untuned primaries. A type 41 pentode is used in the power stage. We note that Philco frequently uses this economical old timer. A "C" voltage divider supplies bias to the power stage, 1st audio and avc bus for the converter and first i-f stage.

Westinghouse M-102 and M-111

Westinghouse models M-102 and M-111, shown in Fig. 7, have a simple bandswitching system. The antenna feeds the primaries of the two aerial transformers in series, the b-c primary being shunted by a 250 mmfd. bypass condenser. This bypass condenser prevents the large primary acting as a choke for s-w signals. No switching is

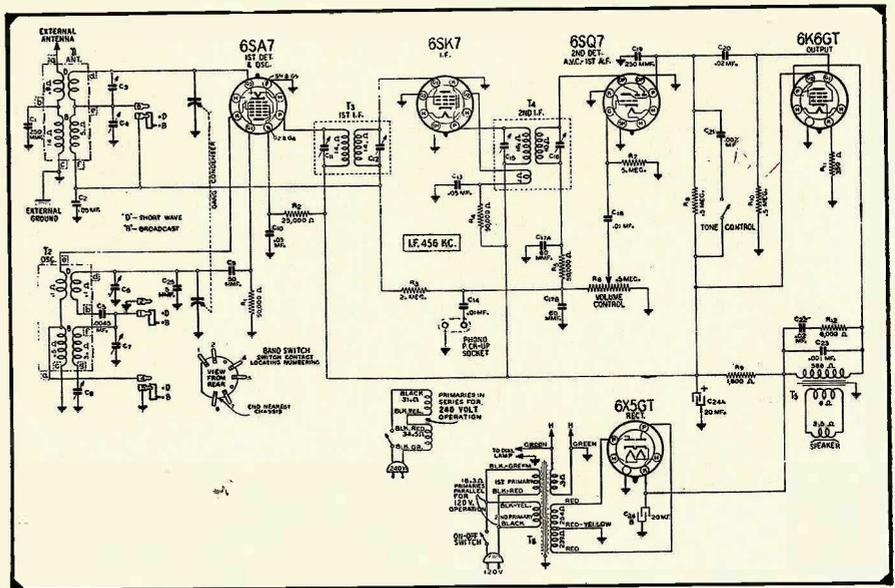


Fig. 7. Westinghouse M-102-111, in which bandswitching provides many services.

required. The two secondaries in series make up the required inductance for b-c, switching to short-waves being accomplished by simply shorting out the larger secondary.

In the oscillator circuit, two cathode feedback coils are used, the larger one being shorted for s-w. The secondary circuit (oscillator grid) is interesting. Again, a series circuit is employed consisting of the two coils plus a .0045 mfd. fixed condenser and a b-c padder. Besides the shunt trimmers for each band, a temperature compensating ceramic condenser is included. Switching to short-waves is accomplished by shorting out the larger coil and padder.

This receiver also features a dual primary transformer for 120 or 240 volts and screen grid regeneration in the i-f stage.

De Wald 814

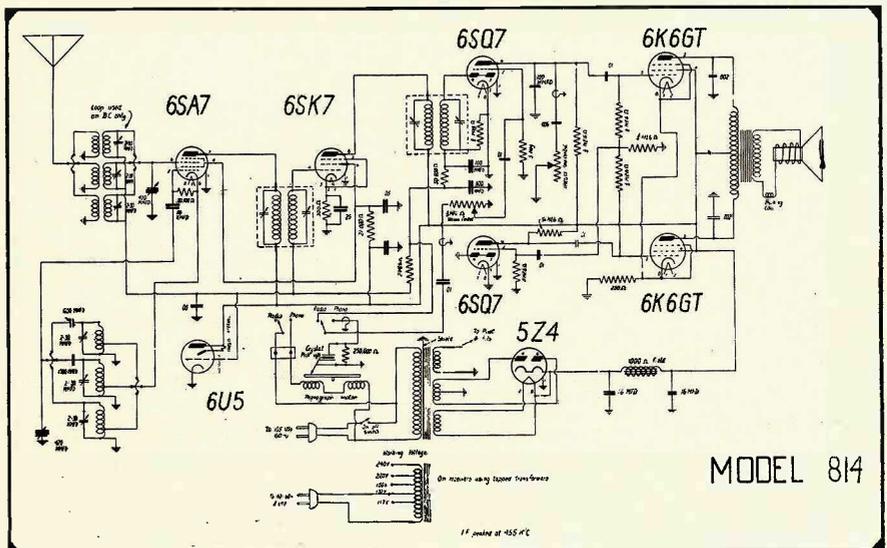
Some of the production models of

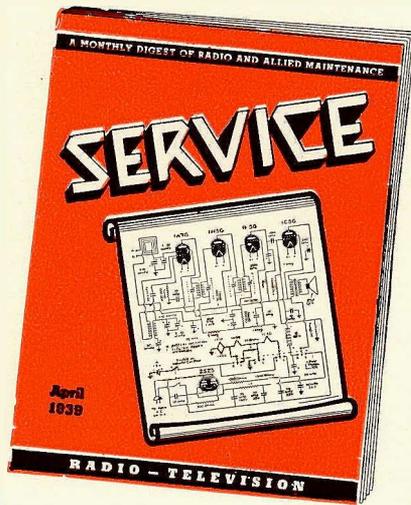
Fig. 8. DeWald 814, with multi-tap power transformer.

DeWald's model 814 are equipped with a multi-tap power transformer operating on 117, 135, 150, 220 or 240 volts at 40-60 cycles. This 8 tube, 3-band push-pull job makes use of a degenerative push-pull stage. In the receiver, shown in Fig. 8, we note that the voltage pick-off for the inverter grid is used at the junction of the two 1/2 megohm grid leaks and the 1/4 megohm degenerative coupling resistor.

Westinghouse WR-62K1 and 62K2

Most battery sets which are adapted for line power are probably running on the latter type supply. Nevertheless, they still serve a purpose and shouldn't be neglected. Hence, we show the Westinghouse models WR-62K1 and WR-62K2 (Fig. 9). These are 6-tube sets with an r-f stage and untuned first detector. Among the features are screen grid i-f regeneration and an indicator window in the dial showing the position of the battery-line switch. This switch has three positions: *off*, *battery* and





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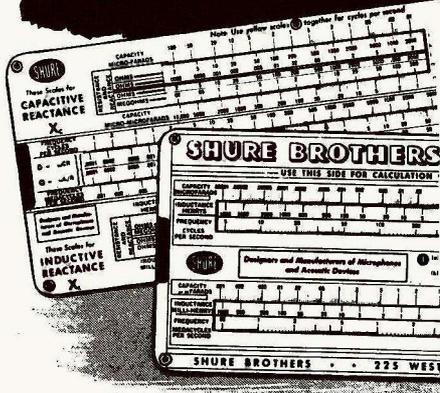
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BACK	$f = \frac{1}{2\pi\sqrt{LC}}$ $C = \frac{1}{4\pi^2 f^2 L}$ $L = \frac{1}{4\pi^2 f^2 C}$ $Q = \frac{X_L}{R}$ $D = \frac{1}{Q^2 + 1} \times 100$	Any single unknown variable plus direct relationships between the equations for Resonant Frequency, Capacitive Reactance, Coil "Q" or Dissipation Factor	Frequency 50 cycles to 50 megacycles Capacitance 1 p.f. to 1000 p.f. Inductance 1000 microhenries to 100 henries

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REPLACING SCREEN-GRID TUBES

(Continued from page 8)

consider the simple so-called *antenna-C-bias* circuit. Essentially it comprises a variable cathode resistor for the controlled tubes and an antenna shunting resistor. The cathode bias is derived solely from the plate current. There are two distinct types. In one, shown in Fig. 5, separate potentiometers are used for the antenna and the cathode circuit. These are connected together by being on the same shaft, or are made as double controls for simultaneous actuation.

The second type is common in later model sets and utilizes only one control, the two functions of antenna and cathode control being combined by grounding the rider and connecting one terminal of the potentiometer to the antenna and the other to the cathodes of the controlled tubes as shown in Fig. 6.

The controls encountered in these sets may have various values generally from a few thousand ohms up to 50-thousand. These values depend on the number of tubes controlled and the plate current which flows when the cathode control is at the minimum volume position. It will be found that at the off position of the volume control, the cathode bias is generally in the neighborhood of 10 to 12 volts, e.g., at a voltage which will not place the tube too near to cut-off in order to avoid operation at the curvature of the characteristics resulting in the undesirable effect called cross-modulation. We need not go into this since our purpose is to eliminate the evils by changing to super-control tubes. Our problem again is more cathode bias, that is, at least 40 volts. We can also eliminate the antenna control which so often introduces noise and fading. In changing over, we must increase the voltage drop across the cathode potentiometer. Since we need a considerable increase, we cannot depend on plate current alone, particularly since it is at the lowest value when we want the highest cathode voltage. In practically all cases, we can obtain the increased voltage without changing the original control of the set—provided that the control is in good condition—by connecting an auxiliary bleeder circuit, as shown in Fig. 7, from the cathode end to a point of positive potential such as the screen grid tap or the plate return point. The bleeder circuit should not carry more than 5 or 10 mils in order not to offset the voltage distribution circuit. When the control is of sufficiently high value, at least 10,000 ohms, the bleeder circuit current of 4 milliamperes will give a 40 volt drop. The additional 4 milliamperes drain will have no appreciable effect on the volt-

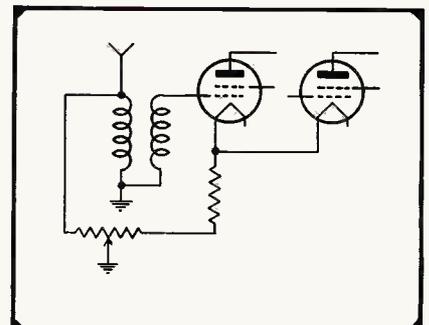
ages. For this reason, it is better to have a volume control of sufficiently high resistance. Otherwise, if the control is, let us say, only 1000 ohms, ten times the current will be needed to produce the 40 volt drop, that is, 40 milliamperes. A current drain of this order is likely to lower the voltage considerably at the point from which it is taken; not to mention that an increased wattage must be dissipated by the control and the bleeder resistor. In the former example, the watts dissipation of the 10,000 ohm control is only .16 watt, whereas in the 1000 ohm control, it will be 1.6 watts.

The bleeder resistor can be calculated very easily when the voltage is known at the point to which it is connected. For example, with reference to Fig. 7, let us assume that R_1 is to be connected to the 180 volt terminal and it is desired to obtain 40 volts across the 10,000 volume control. The current to produce this voltage is $\frac{40}{10,000} = .004$. The resistor R_1 must drop $180 - 40 = 140$ volts. $R_1 = \frac{140}{.004} = 35,000$ ohms. The watt capacity of $R_1 = .004^2 \times 35,000 = .56$. Therefore, a one-watt resistor will be satisfactory.

The plate current of the tubes is not taken into consideration inasmuch as at the minimum volume position, the current is very small and as the volume control is progressively shunted to ground when volume is increased, the bleeder current also changes. This is of no practical consequence since this change simply alters the ratio of control position with respect to bias voltage obtained. Linearity is not desired and controls with antenna tapers are preferable. The antenna connection can be disconnected or in some cases, left in the circuit in localities where unusually strong signals are encountered.

In a practical way, the following

Fig. 5. A typical antenna-C-bias circuit, wherein separate potentiometers are used for antenna and cathode.



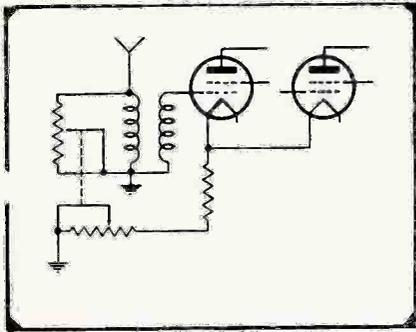


Fig. 6. Single control with dual function antenna and cathode control.

procedure is recommended. Place the type 35's in place of the 24A's in the controlled stages. Disconnect the antenna connection from the volume control if this is used. Take a variable resistor of about 100,000 ohms and connect one terminal to the cathode-end of the control and the rider to a positive voltage tap, say, the plate B + terminal. Adjust the rider of this trial rheostat so that it is of maximum value. Tune in the strongest local station. Place the set volume control to minimum volume position. With type 35's, the station will be still very strong. Then adjust the trial rheostat to a point where the station is just inaudible. Re-tune the set while this is done since bias controls have a tendency to slightly detune r-f stages. The variable resistor is then removed and the value used measured with an ohmmeter. The resistance value indicated by the meter is then the correct one for the bleeder resistor. If it is desired to use the antenna side of the control also for smoother control action, since often the taper of the control on hand or in the set is not quite suitable for bias control alone, proceed as before with the following exception: adjust the trial rheostat until the station is at a fairly low volume and then connect the antenna back temporarily to the control. This connection should silence the set. A happy medium can be found by trying various degrees of volume with the antenna removed until there is smooth action with strong and weak stations. In all cases, it is recommended that the minimum bias resistor originally used be retained and left out of the bleeder circuit as shown in Fig. 7.

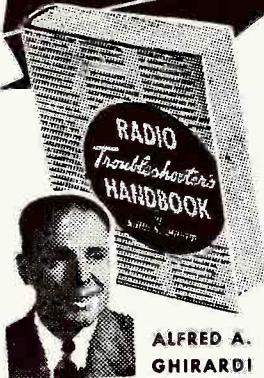
Receivers with Screen-Grid Volume Control

In sets where the volume control is effected by varying the screen-grid potential of r-f stages, distortion is particularly strong at high signal levels with the control turned to low volume. Changing these sets to accommodate 35's generally calls for replacement of the volume control, inasmuch as the value used for varying the screen volt-

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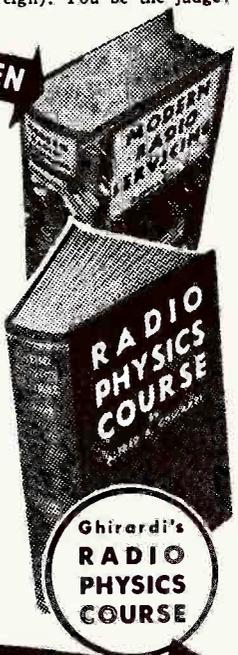
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Associate Director of Research,
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ELECTRONICS, electronic engineering! These are words which fire the popular imagination today. Radio and television, the talking movie, the door opening electric eye, the dentist's X-ray tube, the new fluorescent lamps, all these, evident in our daily lives, are said to be products of the science of electronics. The press, and our electrical manufacturers hint of marvels accomplished in the war, and the revolutionary devices to come after the war, all out of this science of electronics.

What is this science of electronics? Perhaps no very exact answer can be given at this time. In technical or scientific literature a new word is given a sharp, precise meaning by definition by those who first use it, but a popular word may have initially only a vague meaning, which becomes more definite only after considerable usage. Gradually, and partly through discussions such as I am offering in this essay, a meaning emerges upon which most people will agree.

Consider a moderately well educated young man, say one who has just come out of high school, and let us follow him in his explorations in trying to arrive at a good definition of the "science of electronics," or "electronics engineering." He has already met the electron. He knows that its existence was established by J. J. Thomson in the 1890's. He knows that it carries a negative charge of 4.77×10^{-10} electrostatic units, and has a mass only $1/1830$ of the mass of the hydrogen atom. He knows, also, that its dynamics is quite different from that of bodies in everyday life, that it must be regarded as a wave, as well as a particle, and that a newly developed "wave-mechanics" can describe its motions where the older Newtonian mechanics fails.

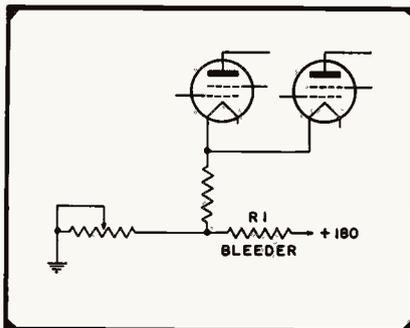
His first impulse is perhaps to say that the "science of electronics" deals with those phenomena in which the electron enters, and that "electronics engineering" deals with apparatus or machines in which electrons play a necessary part. But he then immediately realizes that such a meaning is too comprehensive. He has learned that the electron is omnipresent, that it is a part of every electrical manifestation of matter, and even of those manifestations which are not ordinarily thought of as electrical. He has come to believe that so commonplace a matter as the conducting of a current by a metal wire,

SCREEN-GRID REPLACEMENT

(Continued from page 27)

age is generally only a few thousand ohms and the control is part of the voltage divider. We may proceed as described above, using a standard 10,000-ohm control for cathode bias with a suitable bleeder resistor. Making this change, the resistance value of the old control should be replaced by an equivalent resistor and the screen grid return connected to the terminal which gives the rated or maximum screen voltage. The cathode connection of the controlled tubes generally has a fixed minimum bias resistance, which can be retained, and is placed in series with the new volume control resulting in the circuit shown in Fig. 7.

Fig. 7. Method of connecting an auxiliary bleeder circuit to obtain increased voltage without changing original control of set.



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is accomplished by the motion of tremendous numbers of these tiny electrons along the wire. With his first definition he would then be making the "science of electronics" and "electronics engineering" synonymous with the "science of electricity" and "electrical engineering." He would be making an electric motor or an electric toaster, "electronic apparatus."

He then feels the need of a drastic restriction in his definition, and perhaps proceeds next to examine a tube of his radio, which he is very sure is an "electronic apparatus." Such a tube has in it a hot filament from which electrons emerge, a highly evacuated space, in which these electrons can move about under the influence of electric fields without encountering grosser matter, and various electrodes, grids and plate for creating the electric fields to cause the motion of these free electrons.

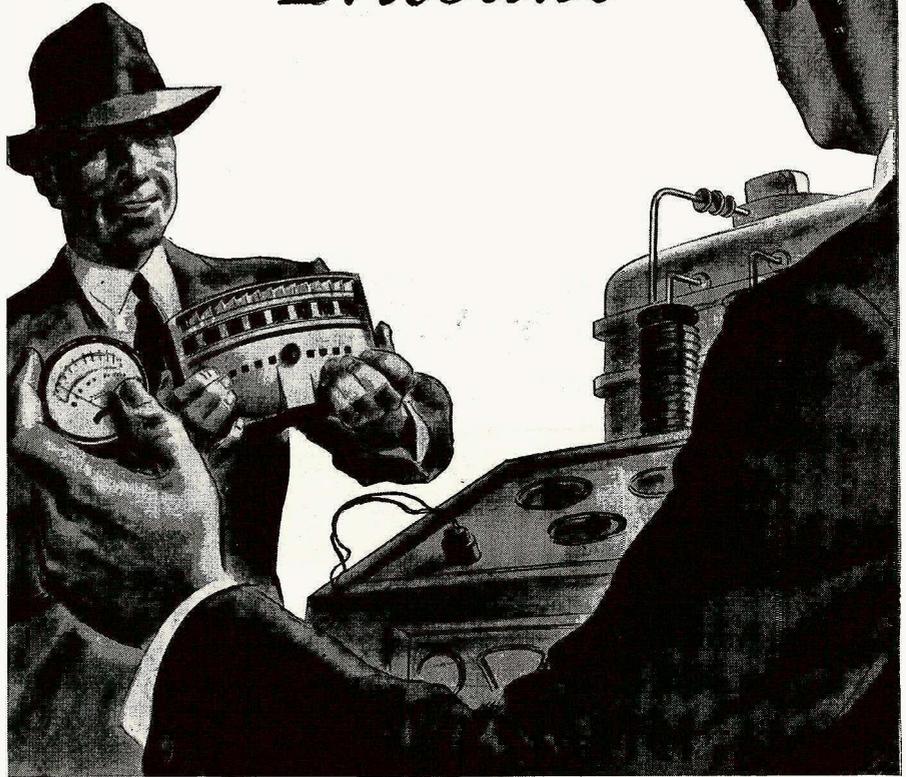
He is now ready to consider this definition. An "electronic apparatus" is one which accomplishes the purpose for which it was constructed, through the intermediary of electrons, relatively free from the grosser matter to which they are ordinarily bound. The "science of electronics" then, deals with free electrons, the means for setting them free, their motions when free, and the effects they can produce by being acted upon while free.

This definition seems quite good. For example, the free electrons in the radio tube, through the charges they carry, and the control the grids exert upon them, can change direct current into high frequency alternating and vice-versa. Thus a radio tube is an "electronic apparatus." The free electrons in the X-ray tube are accelerated to high kinetic energy, while free, and strike their target, producing Roentgen rays. The X-ray tube is an "electronic apparatus." Quanta of light arriving at the cathode of the phototube set free electrons to carry their charge to the anode. The "electric eye" or phototube is an "electronic apparatus." Free electrons in the fluorescent lamp strike mercury atoms so violently that they are excited, and emit ultra-violet light, which in turn excites the material on the glass to fluorescence. The fluorescent lamp is an "electronic apparatus."

But the young man looks again at the metal wire, and pauses. Do not the electrons in the wire move readily when acted upon by an electric field? Are they not, then, free? Again the electric motor and electric toaster intrude. Are they also "electronic apparatuses?" He is back to his original dilemma.

Somehow, the young man feels, the electrons in the "electronic apparatus" are free in a different way than the electrons in the metal wire. And by examining the modern theory of the

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Brisbane"



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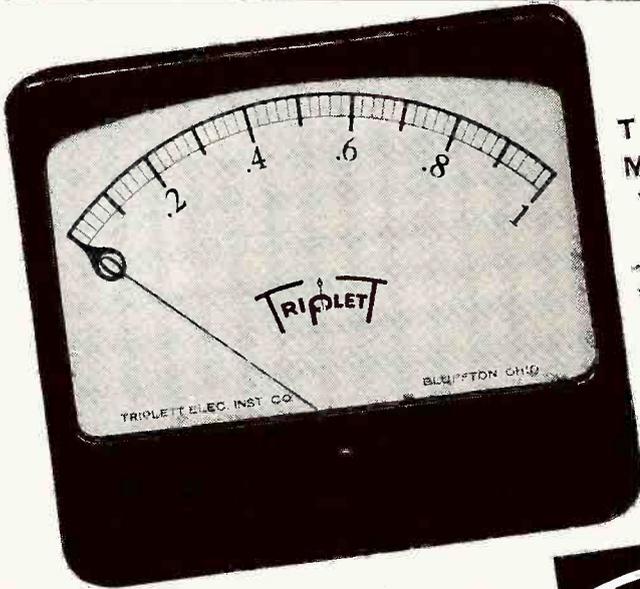
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W. R. BURTT
(Ph. 45412)
308 Orpheum Bldg., Wichita, Kans.

atom, and the modern theory of the electronic states of a metal, he begins to see how he may distinguish between the two kinds of freedom.

An isolated atom of an element in its normal state, he knows, according to Rutherford, Bohr, and their followers, has a positively charged nucleus surrounded by a swarm of electrons, and these electrons are in a kind of regular motion about the nucleus. Bohr regarded these electrons as moving in special radiationless orbits. But while moving in these orbits, and thus in a sense free, the electrons remain always close to the nucleus. Thus, they still remain bound. Impressed electric and magnetic fields will alter the motion of electrons about the nucleus, as is shown by the Stark and Zeeman effects. But the orbits are only shifted slightly or perturbed by the field. They continue to surround the nucleus closely. The change in energy of the electrons with the largest attainable impressed fields is only a fraction of a volt, while their normal energies are many volts.

Now let two nuclei with their accompanying swarms of electrons, approach each other. When about 10^{-8} cm apart, the orbits of the outermost electrons begin to overlap. A new set of orbits form, in which the outermost electrons now circulate around the two nuclei. Thus the outermost electrons have become free. Such an outer electron is no longer bound to a single nucleus, but can and does move from the neighborhood of one nucleus to the neighborhood of the other.

Now, by building up a chain of these nuclei, with their overlapping electron swarms, the young man in search of a definition of "electronic apparatus," begins to see what happens in a metal, and why a metal wire may not be an "electronic apparatus." In the metal wire the electrons become free only by being able to follow orbits which go from nucleus to nucleus. They are thus still bound in their freedom. They remain always within about 10^{-8} cm from some nucleus.

The young man now triumphantly proposes his more refined definition of the "science of electronics." The "science of electronics" deals with electrons which are free in the sense of being substantially at much greater distances from the nuclei of atoms than the radii of the outermost stable orbits of the normal atom. That is, free electrons in the sense developed here, are farther away from nuclei than many times 10^{-8} cm. In the usual radio tube, for example, the electrons in the vacuum space are generally more than 10^{-4} cm away from any atom. They are free. In the metal wire, however, the conduction electrons are never more than a few times 10^{-8} cm away from a nucleus.

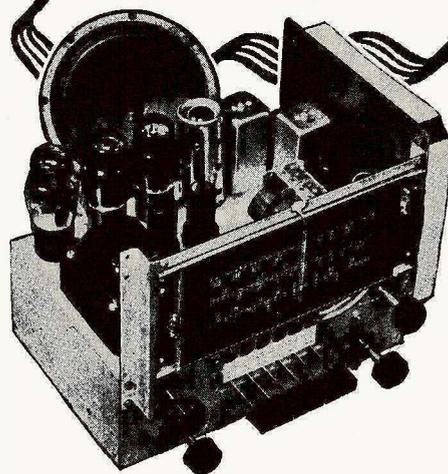
In spite of their mobility, they are not free in the sense used here.

The "science of electronics" is the science of these now sufficiently well defined free electrons. It deals with the means for setting electrons free; thermionic emission, photoelectric effect, secondary emission, etc. It deals with the properties of free electrons, their motion in electric and magnetic fields, as in the electron microscope; their space charge effects, etc. It deals with effects produced by free electrons acting on other matter, excitation, and ionization of atoms by collision, generation of X-rays, excitation of fluorescence, activation of a photographic film. It deals with the ways free electrons lose their freedom, recombination with positive ions, attachment to neutral molecules to form negative ions, etc. "Electronics engineering" is the applied "science of electronics." It deals with the development, design, and application to useful purpose of electronic apparatus, that is apparatus employing electrons free in the sense which has just been described.

The "free electrons" of an electronic apparatus, must of course have space in which to exercise their freedom, so every electronic apparatus has in it a vacuum or gaseous space in which electric current is carried by free electrons. This is clear because in any liquid or solid element of a circuit the atoms or nuclei are so close together electrons cannot be free there in the sense defined above. This suggests a fully equivalent alternative definition of an "electronic apparatus." An "electronic apparatus" is a device in which electric conduction current is carried through a vacuum or gaseous space. This form of definition has the advantage of avoiding theory in its formulation, and referring only to objects which can be directly and immediately observed.

According to the two equivalent definitions, "electronic apparatus" obviously include the various vacuum tube detectors, amplifiers, oscillators of radio, X-ray tubes, phototubes, ultra-violet germ-killing lamps, fluorescent lamps, neon signs, thyratrons, and ignitrons. But they also include devices which in the past we have not thought of as electronic devices. Electric switchers which use the electric arc for safely interrupting power circuits, spark gaps in lightning arresters and similar devices for protecting electric circuits, spark plugs for igniting in proper sequence the explosive mixtures in internal combustion engines, electric arc welders, electric arc furnaces, the precipitron for electrically cleaning air of dust; these are all electronic devices according to the definitions developed above. Shall we try to modify the definition so as to exclude these devices? No, that is not possible. Rather we must accept these

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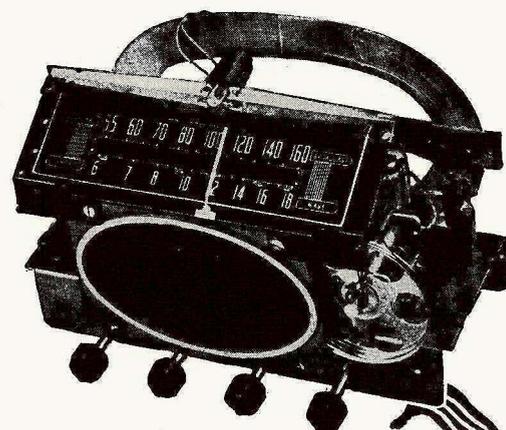


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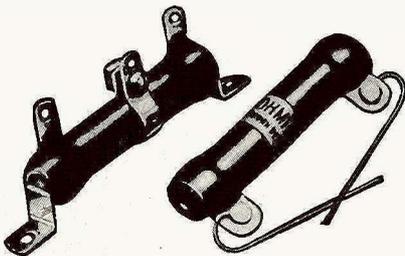
familiar things as truly electronic apparatus, and even more we must expect confidently that the "science of electronics" now and in the future will make clearer the manner of operation of the devices, and will teach us how to make better these devices. In fact, some of the "next" things in electrical engineering will be great developments and improvements in these devices through "electronic science."

When we examine these electronic devices, we find that they fall into two rather definite classes. All employ free electrons, but some make important use also of positively charged atoms or mole-

cules of the gas through which the electrons pass. These positively charged atoms or molecules are called ions, so perhaps the devices using them might be called ionic devices, or perhaps still better electro-ionic, indicating that they use both free electrons and ions.

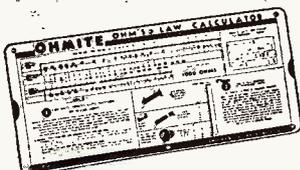
The ions in an ionic or electro-ionic device are generally produced by the free electrons themselves. If the circumstances are such that free electrons acquire ten to twenty volts of kinetic energy and then strike neutral molecules, the neutral molecules are broken up into positively charged ions, and other free electrons. Conversely, as we

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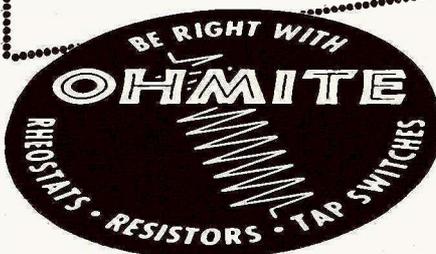


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shall point out presently, the ions may produce free electrons, so that a new possibility arises, namely, the self-maintaining gas discharge, as in the glow in the neon sign, the quick acting spark in the lightning arrester, the energetic arc in the electric circuit breaker, and the silent cleansing discharge in the precipitron.

The ions in an electro-ionic device generally exercise a very useful function in neutralizing the space charge of the free electrons. When large numbers of free electrons are introduced into space, the electrical effects of their charges are additive, and large electrical fields are produced. These fields react on the motion of the electrons, and the net effect is that large currents can be carried by free electrons above, only by using excessively large impressed voltages. If, however, a corresponding number of positive ions are interspersed among the electrons, the additive effect of the charge on the electrons is neutralized, and large currents may be carried by quite low impressed voltages. For example, in the ignitron tubes supplying the direct current for making aluminum and magnesium, thousands of amperes are carried with a voltage of less than twenty volts. Without the space charge neutralizing effect of the positive ions, the use of free electrons for rectifying large alternating currents would be practically impossible.

Another useful function of ions in electro-ionic devices, is their action in setting free electrons at the cathode, so that a hot filament is not a necessary element in an electro-ionic tube. The cathode ray tubes which J. J. Thomson used in discovering the electron, and the tube which blackened Roetgen's photographic plate, had in them no thermionic filament. But ions in the gas striking the cathode set free the electrons which started the electronic age.

When the current density at the cathode is sufficiently large, a new phenomenon appears, the so-called cathode spot,



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which sets free enormous numbers of electrons from the otherwise unheated cathode. Thousands of amperes of free electrons per square inch emerge from the cathode spot with a voltage drop of less than twenty volts. The detailed mechanism of the cathode spot is still not known, but there is little doubt that the positive ions are an absolutely necessary part of this mechanism.

It is extremely easy to produce such a cathode spot. Davy in 1808 separated a pair of carbons in a circuit carrying a few amperes, and produced the dazzling electric arc, with its free electrons, ions, and cathode spot. Thus an electro-ionic device appeared for scientific experiment nearly a century before the discovery of the electron. Also, antedating the electron discovery, the electrical industry started street lighting with electric arcs, and before the knowledge of the free electron was widespread, was using mercury arcs in glass tubes for supplying the direct current for the series arc street-lighting systems. Thus the electrical engineers of that time were practicing "electronic engineering" without knowing it, like the famous gentleman who was surprised to find that he had been speaking prose all his life without knowing it.

But while these electro-ionic devices are very simple in their physical structure, enough has been said to indicate that their theory is complex, and that they present problems upon which "electronic science" has shed light, but still has not solved. We may confidently expect, however, that these problems will be more and more resolved by the electronic scientists and engineers of the future. And with the resolution of these problems, far-reaching improvements of the older electro-ionic devices will result, as well as the invention and development of entirely new devices.

Under the guidance of electronic science, the mercury arc rectifier in the 1920's was developed up to large sizes, and particularly in Europe displaced dynamo-electric converters for railway electrification and in the electro-chemical industry.

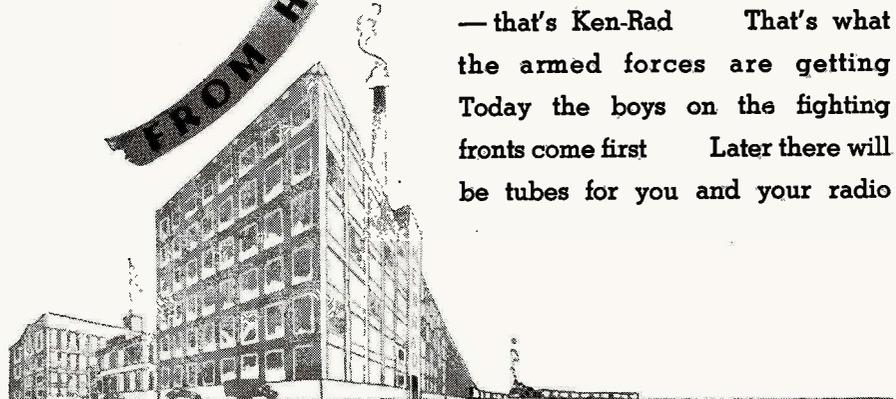
The mercury arc rectifier was invented by Peter Cooper-Hewitt in 1903, shortly after the discovery of the electron.

These examples are only a few of the instances where electronic science is modifying and improving the apparatus of the electric-power industry. We may be quite sure that the next steps in electrical engineering will include further improvements in electro-ionic apparatus, and wider applications.

*Address before the Science Talent Institute being attended by 40 winners of the Second Annual Science Talent Search competing for the Westinghouse Science Scholarships.



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(Continued from page 9)

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0.001	600	-20, + 50
0.002	600	-20, + 50
0.005	600	-20, + 30
0.01	600	-20, + 30
0.02	600	-20, + 30
0.05	600	-20, + 30
0.1	600	-20, + 30
0.25	600	-20, + 30

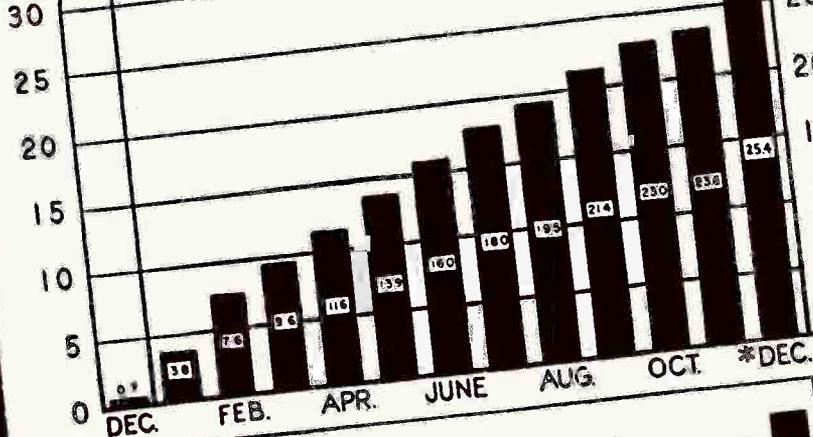
Dry Electrolytic Capacitors

Capacitance, Microfarads	Rated D-C Working Voltage	Capacitance Tolerance, Per Cent	Maximum Allowable Power Factor, Per Cent
100	25	-15, + 200	25
10	50	-15, + 200	25
20	150	-15, + 100	20
20-20*	150	-15, + 100	20
50	150	-15, + 100	20
20	250	-15, + 100	20
10	450	-15, + 100	15
10-10*	450	-15, + 100	15
40	450	-15, + 100	15

*Dual units are common cathode, concentrically wound.

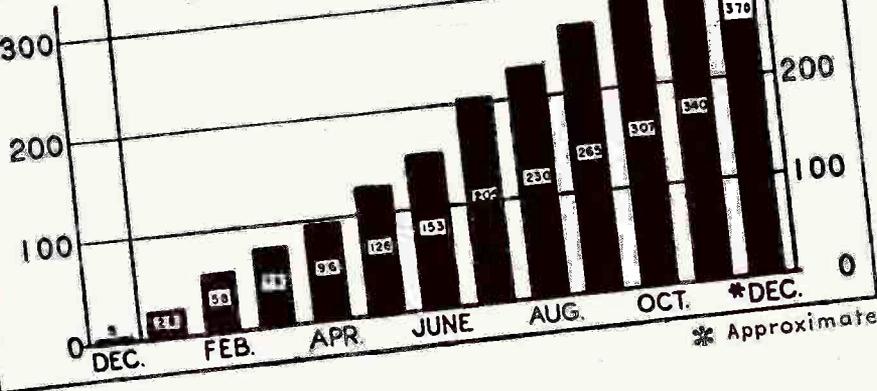
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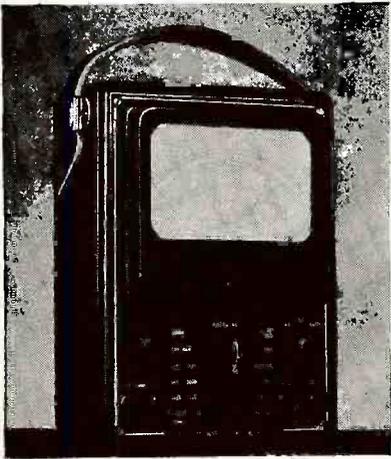
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The meter movement on this instrument



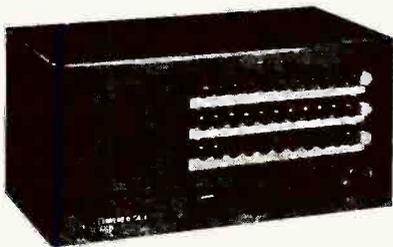
is adjusted to 50 microamperes. A suppressor type copper oxide rectifier is used.

The ranges of this instrument are . . . d-c voltmeter: 0-2-2.5-10-50-250-1,000-5,000; a-c voltmeter: 0-2.5-10-50-250-1,000-5,000; output voltmeter: 0-2.5-10-50-250-1,000-5,000; d-c microammeter: 0-100; d-c milliammeter: 0-10-100-500; ohmmeter: 0-1,000-100,000-10,000,000, and decibel meter: minus 10 to plus 50. Overall dimensions of the unit are 7" x 5½" x 3".

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SPEED REPAIRS — AND VICTORY ★ ★ ★

fluorescence under "black light" from the usual sources within aircraft. A radium-active fluorescent paint used on the indicator shows signals in total darkness. The device uses only 1½ watts, as against the customary 4½ watts of the usual lamps. A transparent plastic cap protects the lamp.

The body of the indicator houses a solenoid, the armature of which is connected with "butterfly" indication vanes, by a simple lever hookup. The fluorescent "butterfly" opens instantly to show signals reflecting the proper indicator light. These "butterflies" are furnished in red, amber and green. When not indicating, the signalette is black. Its overall length is 2 5/32 inches. It can be mounted in panels up to 3/8 inch in thickness.

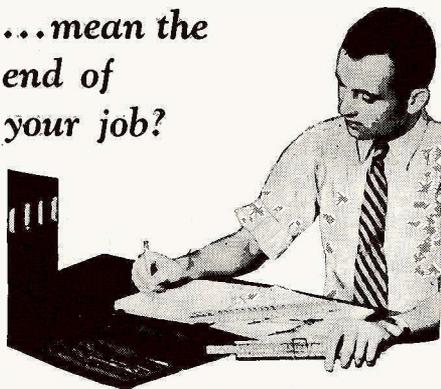
VOLTAGE REGULATOR FOR VIBRATORS

A new type regulator, that automatically controls the voltage delivered to vibrators used in aircraft service, has been developed by Amperite Company, 561 Broadway, New York City. With a battery variation of from 20 to 30 volts (50% variation), the voltage on the vibrator with this new device is said to be kept between 6.0 and 6.3 volts (a 5% variation).

Included in this Amperite is an automatic thermal switch which automatically turns on an auxiliary circuit 10 seconds after the vibrator is started.

A catalog describing this and other Amperite products is available, gratis.

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end of
your job?**



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JOBBER URGED TO USE PD-IX MORE CONSISTENTLY

Because many jobbers are not taking the time to check their inventory, and fill out the PD-IX form to replenish their stock of civilian repair parts, they're easing themselves out of business, warned Charley Golenpaul of Aerovox Corporation, recently.

"No one denies the fact that there are many business details to cope with today," said Mr. Golenpaul. "Nevertheless," he continued, "it is imperative that the task of maintaining an adequate stock of parts be considered an essential one."

"Many of us at the manufacturing end have done everything possible to keep the jobber in business in spite of the tremendous production strain placed on us by war requirements. The jobber should be appreciative of such cooperation and take advantage of the medium by which he can secure replacement parts for his customers," said Mr. Golenpaul.

* * *

IT'S NOW ELECTRONICS DEPARTMENT AT G. E.

The General Electric Radio, Television and Electronics Department will hereafter be known as the Electronics Department, according to an announcement by Dr. W. R. G. Baker, vice president in charge of the department.

* * *

CO-EDS RECEIVE TECHNICIAN TRAINING AT RCA

A program designed to provide women radio technicians will be undertaken by the RCA Victor Division of RCA, according to F. H. Kirkpatrick.

The first courses, which will begin around May 1, will be given at Purdue University in Lafayette, Indiana. A group of from eighty to one hundred girls, between the ages of eighteen and twenty-two, will be selected from the RCA plant and from colleges and universities. To obtain admittance, two years of college study with satisfactory grades, some knowledge of mathematics, good health, and an interest in technical radio work, are necessary. A salary will be paid to the "employees in training." The courses will consist of two terms of twenty-two weeks each.

* * *

WAR EDITION OF BELDEN CATALOGUE

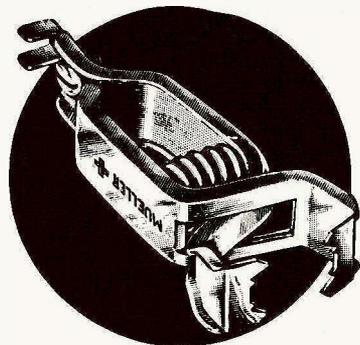
A four-page war edition issue of the Belden radio wiring line has just been released by Belden Manufacturing Company, Chicago, Illinois.

The catalogue, known as "843," contains data on those products that use a minimum amount of critical materials, reduce idle inventory, and yet make possible the servicing of a maximum range of equipment. According to the manufacturer, the 171 units described in this catalogue will service all essential needs, as compared with the 467 units listed in the previous catalogue.

* * *

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BLIND SERVICE MAN TEACHING IN ARMY

Von Peterson, blind Service Man of Preston, Idaho, recently accepted a position with the Electronic Radio and Television Institute to teach soldiers to repair radios during blackouts and at night.

Peterson learned radio servicing at the Idaho School for the Deaf and Blind, Gooding, Idaho.

* * *

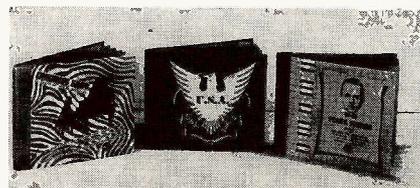
KEN-RAD WOMAN WORKER SETS RECORD

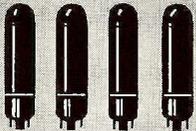
Sarah Thomson, tube analyzer at Ken-Rad Tube & Lamp Corporation, Owensboro, Kentucky, has lost only one-half day in the last ten years. Her total employment with Ken-Rad runs over eighteen years.

* * *

HIT ALBUMS RELEASED BY CLASSIC RECORDS

Three new HIT albums had been released by the Classic Record Company, 2 West 46th Street, New York City. In one of the albums are swing piano selections by Frank Froeba, in another are piano solos by Chauncey Gray, and in the third album appear eight patriotic selections.





4 STANDARD TYPES
of Amperite Regulators replace over 400 types of AC-DC Ballast Tubes now in use. Amperites are real REGULATORS . . . have patented Automatic Starting Resistor which prevents initial surge and saves pilot light . . . Ask Your Jobber.

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RCA TUBE PICTURE BOOK

A sixteen-page, chart-size book, showing structural details of representative receiving, transmitting, cathode-ray, and special type tubes, has just been prepared by the Commercial Engineering Section, RCA Victor Division, Radio Corporation of America, Harrison, New Jersey.

The book, designed especially for use in war training centers, contains eight charts printed on one side to facilitate their use for display mounting.

Copies are available to those in the United States and Canada at 10c a copy.

* * *

REPAIR CAMPAIGN LAUNCHED BY PHILCO

To provide maximum receiver maintenance, Philco has developed a streamlined plan employing the facilities of test shops in strategic cities throughout the country. These shops cooperating with local distributors, will provide an effective means of receiver maintenance. These new units will also cooperate with other service facilities in local communities, in an effort to supplement the efforts of dealers and Service Men, whose present facilities are inadequate today.

* * *

CLANCEY IN NEW N. U. POST

J. A. Clancey is now plant manager of the National Union factory at 57 State Street, Newark, New Jersey.

Mr. Clancey entered the radio tube manufacturing business with Westinghouse Lamp Works at Bloomfield, New Jersey, in 1926. He joined National Union in 1930.

G. E. PROMOTES FRITSCHSEL

E. H. Fritschel has been placed in charge of sales of industrial electronic tubes of General Electric at Schenectady, New York. Mr. Fritschel succeeds Dr. H. A. Jones, now with the U. S. Army Signal Corps, as a Lieutenant-Colonel.

* * *

RUSSELL JOINS HALLICRAFTERS

Robert L. Russell, formerly with the legal section of the Chicago Signal Corps depot, has joined the Hallicrafters Company, Chicago, Illinois, as administrative assistant, according to Raymond W. Durst. Mr. Durst also announced the appointment of Cletus Wiot as manager of the Government contract section.

* * *

SIGNAL CORPS ASKS FOR AMATEUR EQUIPMENT

Radio amateurs are again being asked to sell their short-wave equipment to the Signal Corps, Army Services of Supply, for training purposes and operational use.

The radio communication equipment needed consists of transmitters (Hallicrafter and Collins), ranging in power from 25 watts to 450 watts and covering various bands in the short-wave range. Also needed are receivers (Hallicrafter, National, RME, Hammarlund and Howard) and such radio components as capacitors, resistors, etc. Especially desired are audio-frequency and radio-frequency signal generators and oscilloscopes, Weston a-c and d-c voltmeters, ammeters and milliammeters, and other equipment for testing.

Used equipment will be purchased, if it is in perfect operating condition or if it can readily be restored to such condition. The price paid for each item will be set by a Signal Corps inspector.

Persons in possession of the desired equipment, who wish to sell it for the use of the Army are invited to send a brief description, including name of manufacturer and model type, to Captain James C. Short, Philadelphia Signal Corps Procurement District, 5000 Wissahickon Avenue, Philadelphia, Pa.

* * *

SIMPLIFIED OHM'S LAW TABLES

The last two issues of *Ohmite News* have contained interesting tables covering simplified explanations of Ohm's Law as applied to d-c and a-c.

Copies of these issues dated January and February are available free of charge from the Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago, Illinois.

* * *

MALLORY LECTURES ON ELECTRONICS BY DR. HEYL

A series of four lectures on the future of electronics in the industrial field was started recently by Dr. Paul R. Heyl, through the courtesy of P. R. Mallory & Company, Inc.

The lectures, the first of which was given on March 1, will develop the history, theory and practical applications of electrons, and indicate the progress which the science of electronics has made. Although the lectures are planned primarily for the Mallory engineering, sales and production personnel, a number of individuals from manufacturing plants, colleges, high schools, broadcasting stations, and training schools of the armed forces, have been invited.

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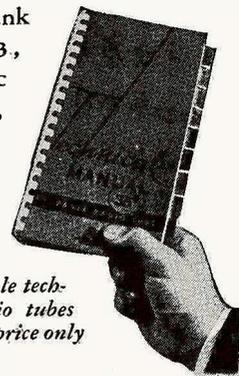
by
FRANK FAX

AT the risk of repeating myself, I'm plugging again the new revised Sylvania Technical Manual on Radio Tubes, because it should be a "must" on the bench or in the pocket of everyone interested in radio sales and service. Particularly now, because it has the basic data behind the Correlation for Substitution Chart and the Characteristics Sheet.

One section of this 275-page handbook lists new types of tubes released since issue of the last Manual. There is also a new section on panel lamps. Thus, it is as complete as possible at this time.

A plastic-ring binder allows the book to lie flat and remain open at whatever page is being consulted. Data arrangement remains the same, as do the easy-to-use index tabs.

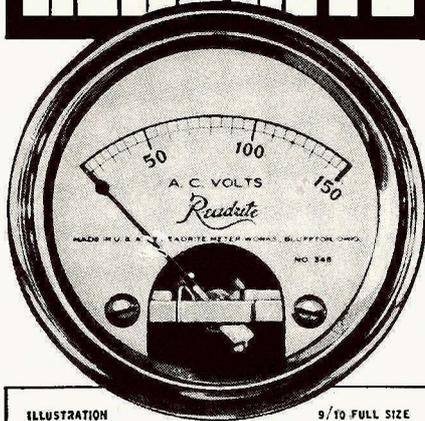
The new revised Technical Manual still sells for the prewar price of 35 cents. If your jobber is unable to supply you, write to Frank Fax, Dept. S-3, Sylvania Electric Products Inc., Emporium, Pa.



Complete and reliable technical data on radio tubes—recently revised—price only 35 cents.

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FILAMENT SWITCHING

(Continued from page 16)

the filament string; 3Q5GT, second i-f, first i-f, converter and 2nd detector—the same line-up as the previous set. The line-battery switch is similar to the Sea Pal but it has an additional switch for i-f bias. With the switch in battery position, two bias cells are connected in the first i-f grid return, while a third cell serves the second i-f in series with the other two. These cells, incidentally, are connected "backwards" with the positive terminal to grid, combatting the negative bias derived from the "B—" drop resistor. High resistance grid leaks are also included in the circuit. The idea is to prevent sharp cut-off of the i-f stages when the "B" battery voltage gets low. In the line position, only the single cell in the second i-f is in use.

A three-pole double throw switch is featured in Belmont's 6PII (Fig. 4). The first pole connects the negative bus

to line or battery common; the second connects the "B+" to rectifier or 90 volt battery, while the third section opens the "A" battery on line operation. An "A" economizer is also used.

A different form of switch is shown in Fig. 5. This is a three position rotary functioning as an on-off switch as well as a battery-line switch. It is very simple in operation—connecting ground to line or battery common and "B+" bus to rectifier or "B+."

Parallel Filaments

Parallel filament connection has an advantage in personal or camera type receivers not mentioned before. Only a flashlight cell (or two) is required for the "A" battery. A series connection would require five cells. Fig. 6 shows the Westinghouse WR-62K3 personal receiver with the rotary switching system required. In battery operation, all No. 7 pins and No. 1 pin of the 3S4 are connected to "A+". All other filament pins will be grounded. In line

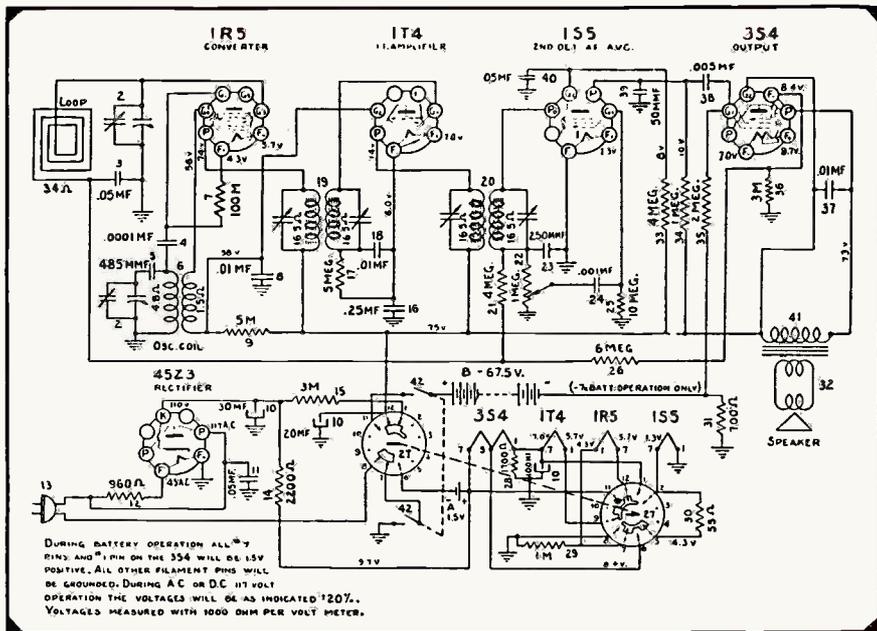
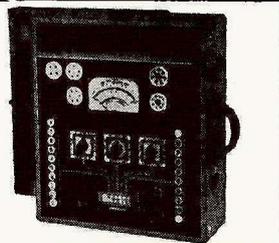


Fig. 6. Series filament connection wherein entire filament string is used for bias.

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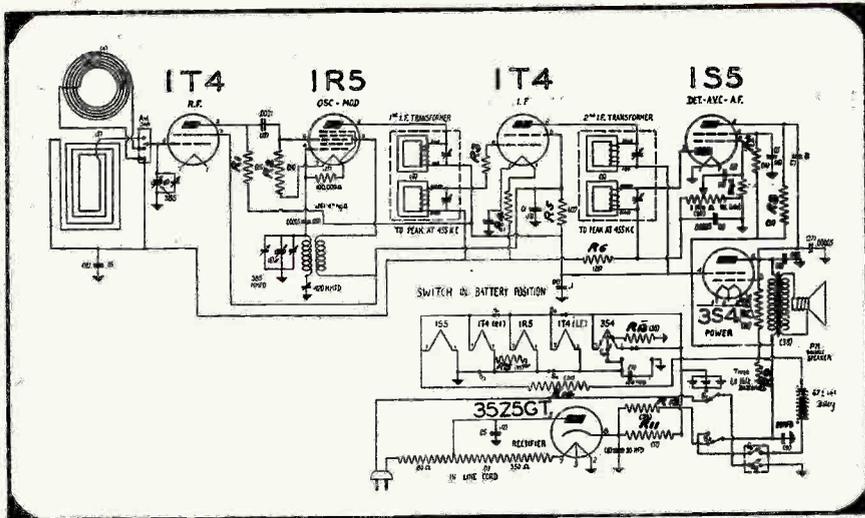
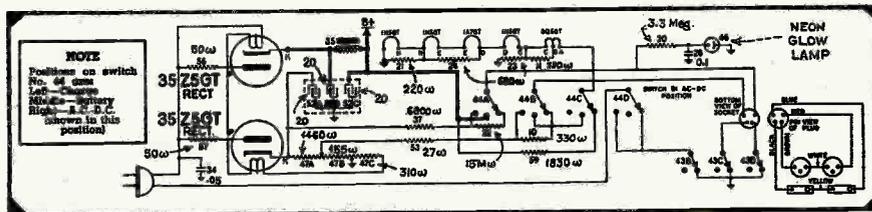


Fig. 7, top, economic A battery operation with flashlight cells. Fig. 8, below, filament system with emphasis on battery charging.



operation, three equalizing resistors and a 10 mfd. audio bypass condenser function, as in the previous series circuits. The condenser, while seemingly small for the job, is adequate because of the reduced low frequency response.

The output tube grid bias is obtained by a 700-ohm resistor in the "B—" battery leg, which sacrifices 7 volts of the "B" supply. When switched to line, the entire filament string is used for bias.

Fig. 7 shows a receiver with an r-f stage, requiring three flashlight cells in parallel for reasonably economic "A" battery operation. The switching is similar to the previous set.

Dry Battery Charging

There has been a wide difference of opinion in the matter of charging dry

"A" and "B" batteries. Some sets use no true battery-line switch, allowing the batteries to float on the power supplied by the rectifier tube. Fig. 8 shows a 7-tube Stewart Warner which places unusual emphasis on battery charging, devoting a separate rectifier to this use. A three position switch is used for charging, battery or line operation. Separate load resistor permits charging both "A" and "B" batteries at a proper rate. A series filament system is used.

STEWART WARNER 208C

Open field coil: Speaker 501245 may have to be replaced. Before replacing, open field coil casing and check for broken leadin wire.

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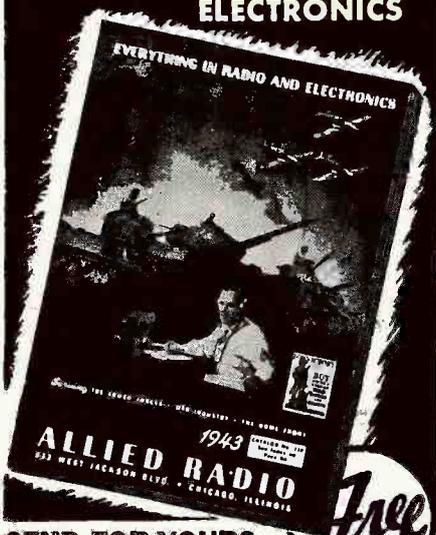
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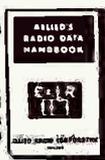
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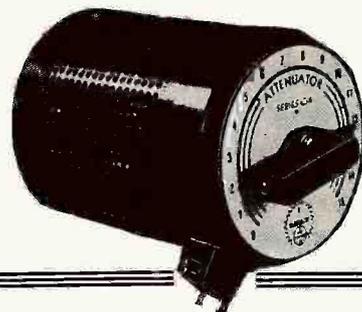
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JOTS & FLASHES

TERRY P. CUNNINGHAM appointed radio advertising manager of Sylvania . . . has had 20 years' experience, primarily on radio accounts . . . congratulations . . . Wedemeyer Radio Company, Ann Arbor, Mich., changes name to Wedemeyer Electronic Supply Co. . . . Regal Amplifier Mfg. Co. now located in larger quarters at 20 W. 20th St., New York City . . . glad to have Jackson and Hickok represented in SERVICE advertising section once again . . . Sprague's *Trading Post* plan going over with a bang . . . advise Harry Kalker if you have any equipment to trade or sell and what your own requirements are . . . hope all you progressive Service Men have sent your entries to International Resistance for their *Volume Control Contest* . . . winners get War Bonds . . . DeMambro Radio Supply Co. moved to 1111 Commonwealth Ave., Boston . . . larger quarters for better service . . . this month's Army-Navy "E" award winners include Solar Mfg. Corp., Sprague Specialties Co., Wincharger Corp., Truscon Steel Co., Fred M. Link . . . congratulations . . . Mallory received a second white star for its Army-Navy "E" pennant . . . renewed for another six months . . . sorry to report death of Henry Kasner, for over 30 years associated with the Radio Corp. of America and its predecessor, the American Marconi Co. . . now that you fellows have paid your income tax, be certain to swing back on the War Bond bandwagon . . . Uncle Sam urgently needs every dollar you can scrape together . . . new line of electrical insulation known as *Multiform Insulators* announced by Corning Glass Works . . . "Muggs" Pugh and Jerry Kahn of Stancor were recent visitors to New York . . . Congratulations to Lieut. Commander Henry and Mrs. Hutchins on recent addition to family . . . Henry was sales manager of National Union prior to entering the service . . . all three major works of Western Electric win six months' extension of Army-Navy "E" . . . we like *The Hallicrafters Tuner*, a house organ that is certainly a morale booster . . . Frank H. McIntosh appointed assistant director of radio division of WPB . . . if you are not getting *Sylvania News* better notify headquarters . . . it's full of valuable data essential to all Service Men . . . send us your new or novel ideas applicable to wartime servicing . . . we'll publish those deemed acceptable and pay you for them . . . you will be helping other Service Men and, in turn, be helped by their suggestions . . . buy bonds . . . save scrap . . . let's all work together to get this war won in a hurry.



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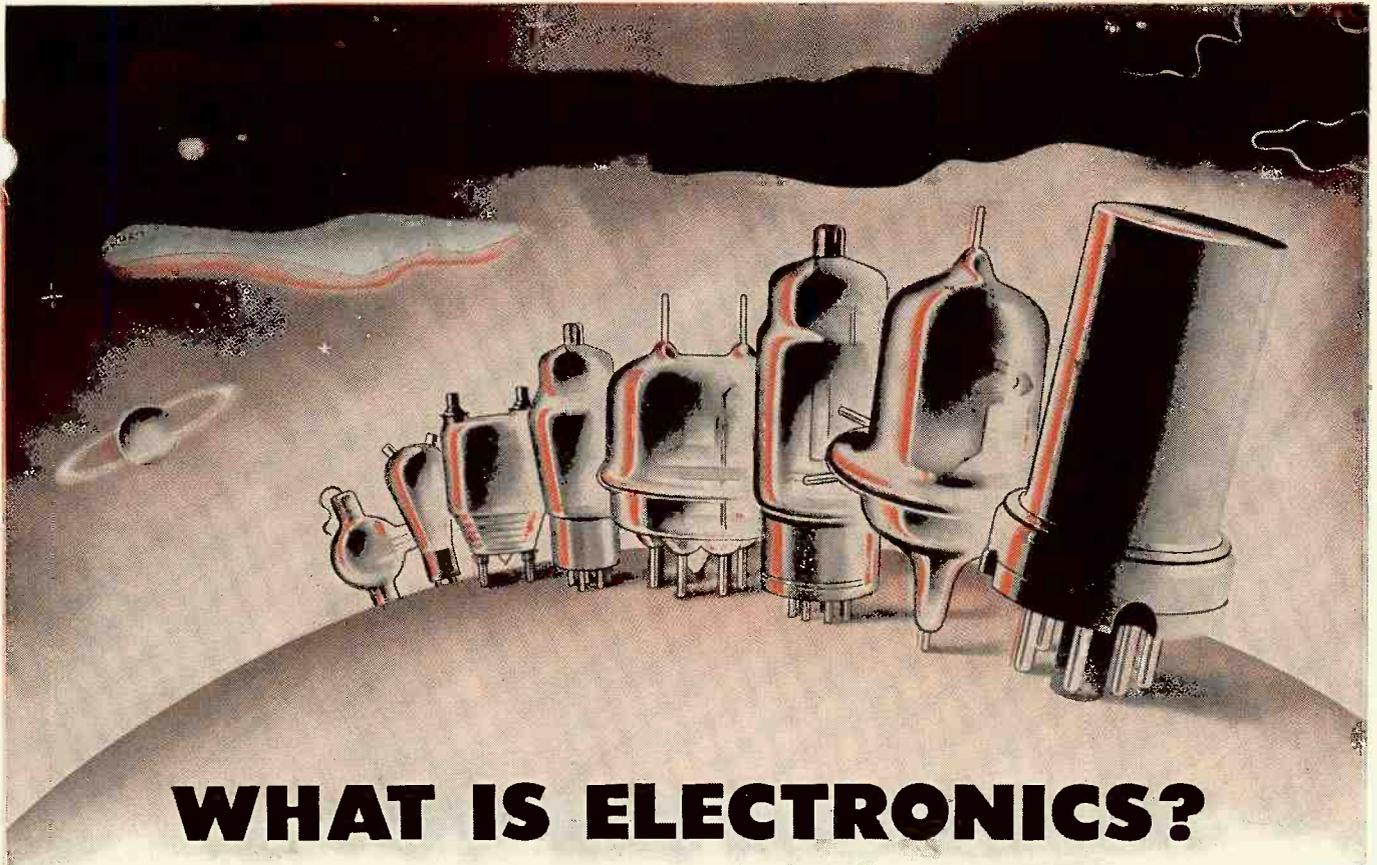
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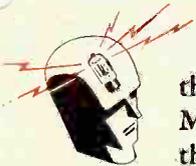
Index to Advertisers

Aerovox Corp.	39
Aircraft Radio Lab.	32
Allied Radio Corp.	40
Amperite Co.	37
Astatic Corp., The	28
Capital Radio Engineering Inst.	36
Centralab	21
Clarostat Mfg. Co., Inc.	40
Electro-Voice Mfg. Co.	15
Fada of New York	39
General Electric	1
Hickok Electrical Instru. Co., Second Cover	
International Resistance Co.	3
Jackson Electrical Instrument Co.	29
Ken-Rad Tube & Lamp Corp.	33
Meissner Mfg. Co.	31
Mueller Electric Co.	38
National Union Radio Corp.	Back Cover
Ohmite Mfg. Co.	32
Polymet Condenser Co.	30
Radio & Technical Publishing Co.	27
RCA-Victor Division—Inside Back Cover	
Readrite Meter Works	39
Rider Publisher, Inc., John F.	35
Shure Bros.	26
Solar Mfg. Corp.	28
Sprague Products Co.	13
Standard Transformer Corp.	39
Supreme Instruments Corp.	38
Sylvania Electric Products, Inc.	37
Triplett Electrical Instr. Co.	30
United Transformer Co.	17
Weston Electrical Instru. Co.	3



WHAT IS ELECTRONICS?

... and what does it mean to the radio serviceman and tube equipment distributor?



You've been hearing a lot about the "Electronics Industry" lately. Maybe you've been puzzled about the aura of mystery surrounding it.

Perhaps you've even done a little wondering as to where such a development leaves you, and why.

Actually, "Electronics" is neither altogether new nor mysterious. Just as "wireless" grew into Radio with all of its ramifications in the fields of communications, and entertainment, so is Radio now expanding into "Electronics."

"Electronics," then, is simply a term for the newer applications of the basic radio-electronic circuit utilizing the well-known Radio Tube and its derivations.

Thus, in considering the latter, it is well to remember that the "Magic Brain" of any Electronic device is a tube—and

that the fountain-head of modern tube development is RCA. Remember, too, that development of a new tube, or a new application for an old one, stands as a new opportunity for the men to whom *no* tube or the circuit designed for its operation is altogether new. *This means you.*

The whole history of Radio has been one of rapid growth. New developments have constantly created new business and markets—and the best of these have fallen naturally to those who have specialized in the basic principles behind them all. Certainly they should continue to do so now.

Thus, to the RCA Tube and Equipment Distributor and Serviceman, "Electronics" means that Radio again stands on the threshold of another of its beginnings—one which may prove to them to hold the greatest possibilities of all!

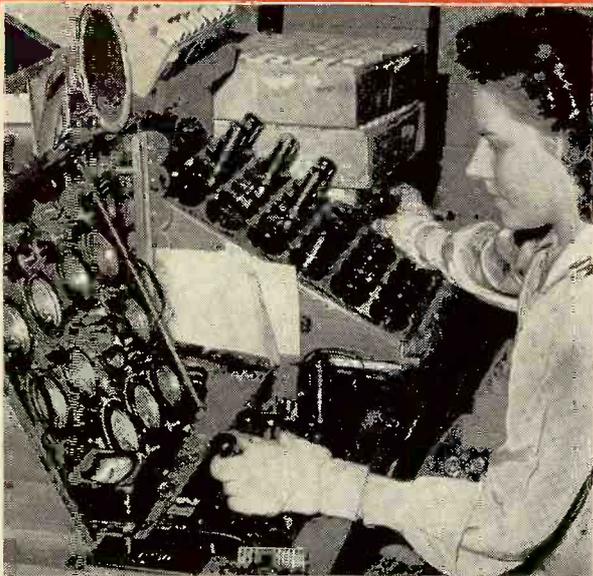


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Every National Union Electronic Tube is carefully tested at every stage in its manufacture. And when it is ready for shipment, it receives a final test that insures its meeting not only Army and Navy specifications but the rigid standards of National Union engineers.

It has a reputation to preserve!



The war work that National Union is doing today in its research laboratories and production lines is helping to build the peacetime future of Electronics. More important still, it is helping to build *your* future as a service man. For as our scientists create new wonders for the electronic tube to perform, they are creating new opportunities for you who are trained in electronics. Just as the pre-war history of National Union was devoted to the welfare of the radio service man, so the post-war plans of National Union are being built to help you take full advantage of the rich promise in the coming "Age of Electronics".

NATIONAL UNION RADIO CORPORATION
NEWARK, N. J. LANSDALE, PA.

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