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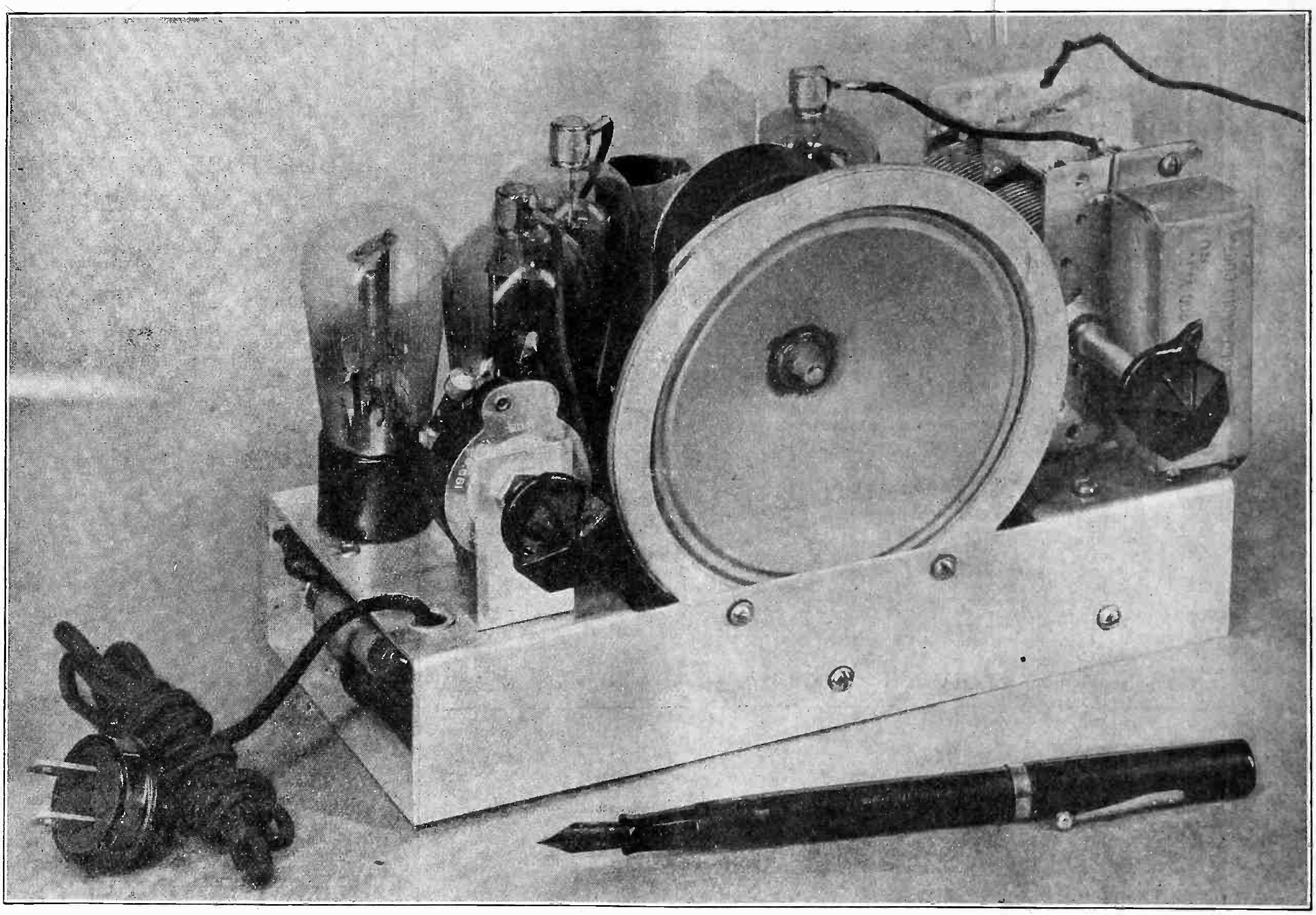

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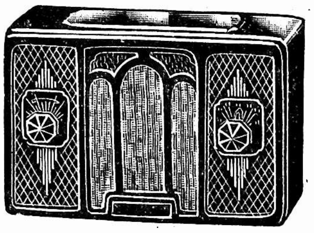

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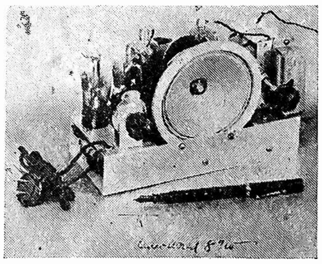

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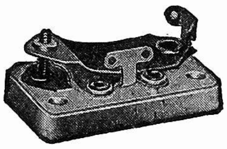

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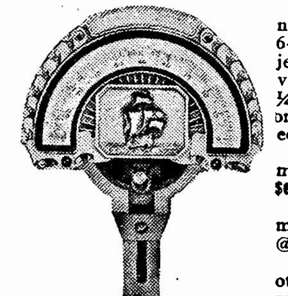

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Complete Official Data on THE FOUR NEW TUBES

[*The following technical bulletins on four new tubes are printed as supplied by RCA Radiotron Co., Inc., and E. T. Cunningham, Inc.*—EDITOR.]

25Z5

The 25Z5 is a full-wave, high vacuum rectifier of the heater-cathode type for use in suitable circuits designed to supply d-c power from an a-c power line. This tube is of particular interest because of its adaptability to the design of "transformerless" receivers of either the "universal" type or the "a-c operated" type.

In "universal" receivers, the 25Z5 may be used as a half-wave rectifier, while in the "a-c operated" type, it may be used as a voltage doubler to provide about twice the d-c output voltage obtainable from the half-wave arrangement. This two-fold application is made possible by the use of a separate base pin for each cathode.

The heater of this tube has been designed to facilitate its economical operation in series with the heaters of other tubes in the radio set. The employment of a 25-volt heater permits the construction of a receiver having reduced heat dissipation in the fixed series resistor. Furthermore, the heater-cathode design permits of close electrode spacing and provides high rectifying efficiency.

The 25Z5 is constructed compactly in a small dome-top bulb and requires a minimum of space for its installation.

Voltage-Doubling Rectifier Considerations

In rectifying circuits using tubes, current flows between cathode and plate only during the time when the voltage on the plate is positive. Such circuits in their simplest form employ a single diode which rectifies the a-c supply on alternate half-cycles. The output of a single diode consists of unidirectional pulses of current and voltage. These pulses may be smoothed by means of a suitable filter.

If two diodes are employed, each half-cycle of the a-c supply may be rectified. The conventional circuit using two diodes is known as a full-wave rectifier. The features of such a rectifier in comparison with a half-wave rectifier are: approximately twice

(*Continued on next page*)

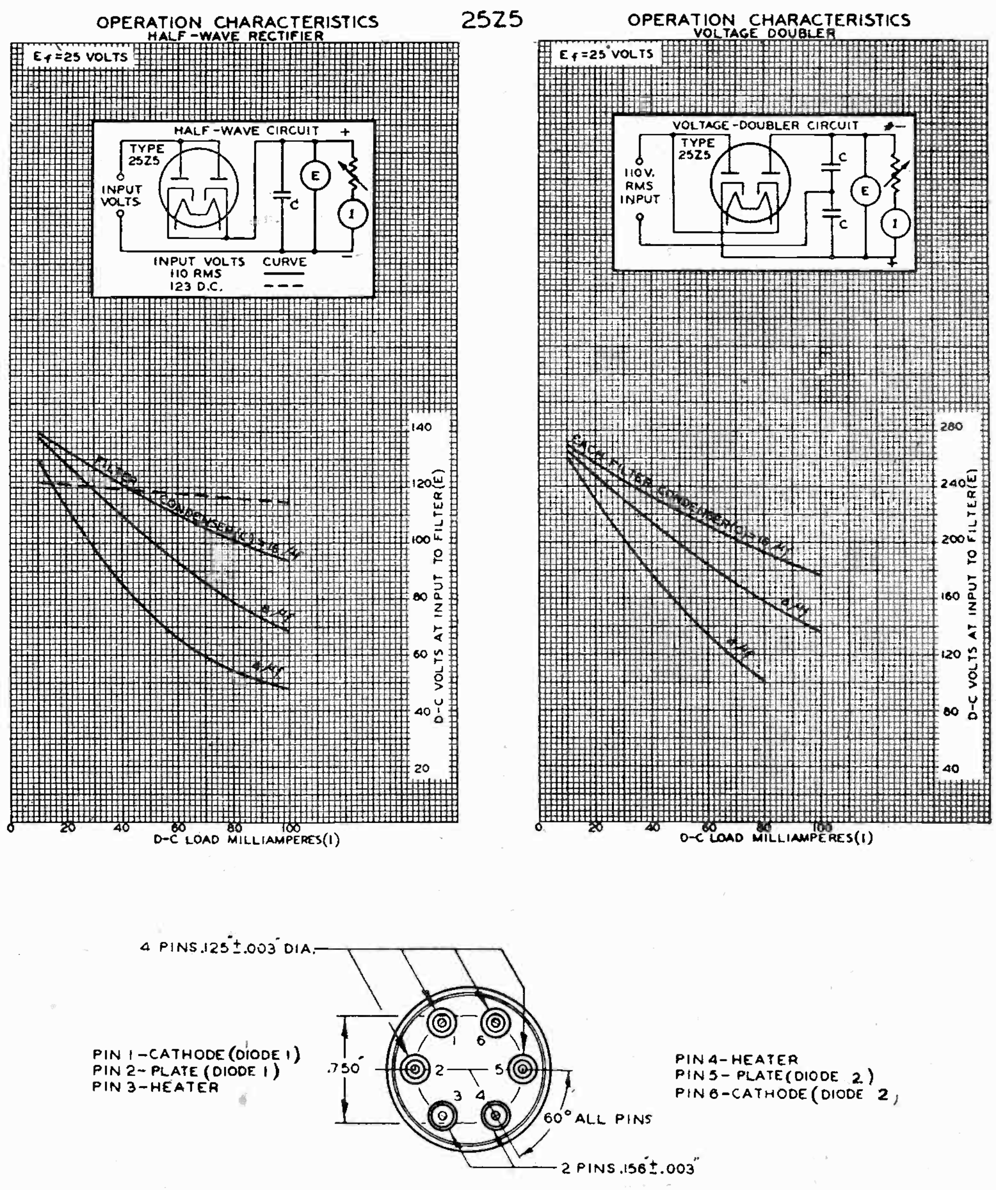


FIG. 1

Half-wave and full-wave circuits and curves of the 25Z5, with view of base connections, looking at the bottom of the base pins or of the socket.

(*Continued from preceding page*)
the output current with essentially the same d-c voltage output; and more economical filtering due to the doubled frequency of the output pulsations.

In comparison with the full-wave connection, another arrangement of two diodes is of interest. In this case, two diodes one of which is reversed with respect to the other, are connected to two condensers as shown in Fig. 1. This arrangement provides rectification of each half-cycle of the a-c supply. Furthermore, during the period that a diode is rectifying, the condenser across the other diode is discharging through the load and the conducting diode. As a result the voltage across the load is the sum of the d-c output voltage of the conducting tube and the discharge voltage of the condenser. The total d-c voltage across the load therefore, is approximately twice the d-c voltage obtainable from a half-wave rectifier. For this reason, this circuit is known as a voltage-doubler. Like the full-wave circuit, the doubler circuit gives an output having a ripple frequency twice that of the supply line.

In the design of a voltage doubler using this circuit, large capacitances are necessary to give good regulation of the d-c output voltages at higher values of load current. A point of interest to the set designer, however, is that the voltage rating of these condensers is determined not by the d-c output voltage, but by the peak value of the a-c supply.

Tentative Rating and Characteristics of the 25Z5

Heater Voltage	25 Volts
Heater Current	0.3 Ampere
A-C Plate Voltage per Plate (RMS)	125 max. Volts
D-C Load Current	100 max. milliamperes
Maximum Overall Length	4¼"
Maximum Diameter	1 9/16"
Bulb	ST-12
Base (Refer to Figs. 1 and 7)	Small 6-Pin

Installation

The base pins of the 25Z5 fit the standard 6-contact socket which may be mounted either in a vertical or in a horizontal position. Base connections are given in Fig. 1 and external dimensions of the 25Z5 in Fig. 7.

The bulb of this tube will become quite hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided to circulate air freely around the tube to prevent overheating.

The heater is designed to operate under the normal conditions of line voltage variation without materially affecting performance and/or serviceability of this tube. The current in the heater circuit should be adjusted to 0.3 ampere for the normal supply voltage.

A filter of the condenser-input type is recommended for use with this tube in order to obtain a d-c output voltage as high as possible. A large input capacitance i.e., 16 mfd., is desirable for half-wave rectifier service; while a higher value is advantageous for voltage-doubler circuits. Since the peak voltage applied to the input condenser(s) is relatively low, it is possible to use condensers having a moderate voltage rating (sufficient only for the line voltage).

Application

As a half-wave rectifier the 25Z5 is designed for service in "transformerless" receivers of the "universal" type. In such service, the two plates are connected together at the socket so as to act as a single plate; likewise, the cathodes are connected as a unit. Conditions for this method of operation are given under RATING AND CHARACTERISTICS. Typical output curves for several values of input condensers are shown in Fig. 1. As a supplement to the curves with a-c input voltage, a curve is included for a d-c input voltage.

As a voltage doubler, the 25Z5 is adaptable to service in "transformerless" receivers of the "a-c operated" type and is capable of supplying approximately twice the d-c output voltage of the half-wave circuit. In voltage-doubling service, the two diode units of the 25Z5 are arranged in series as described under voltage-doubling rectifier considerations. Operating conditions for this type of service are the same as for half-wave service. Typical output curves with a schematic diagram of connections are shown in Fig. 1.

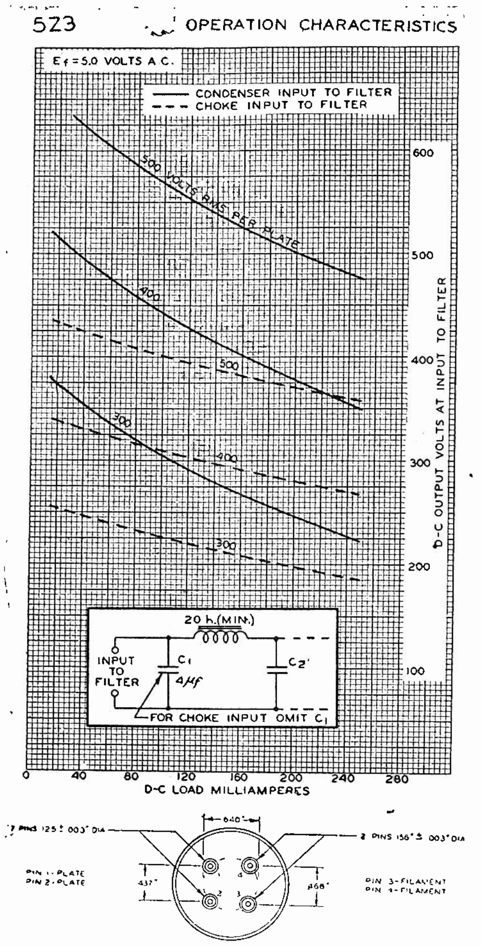


FIG. 2

Regulation curves of the 5Z3 with condenser input and choke input, with bottom view of socket or base pin connections.

5Z3

The 5Z3 is a high-vacuum rectifier of the full-wave type intended for supplying rectified power to radio equipment having very large direct-current requirements.

In comparison with the '80, the 5Z3 will furnish approximately twice the d-c load current at higher d-c output voltages.

The coated filaments employed in the 5Z3 provide an efficient source of electron emission, and reach their dull-red operating temperature quickly.

Tentative Rating and Characteristics of the 5Z3

Filament Voltage (A.C.)	5.0 Volts
Filament Current	3.0 Amperes
A-C Voltage per Plate (RMS)	500 max. Volts
D-C Output Current	250 max. Milliamperes
Maximum Overall Length	5⅝"
Maximum Diameter	2 1/16"
Bulb	ST-16
Base (Refer to Figs. 2 and 7)	Medium 4-Pin

Installation

The base pins of the 5Z3 fit the standard four-contact socket which should be installed to hold the tube preferably in a vertical position with the base down. If it is necessary to place the tube in a horizontal position, the socket should be mounted with the filament pin openings either at the top or at the bottom so that the plane of each filament is vertical. Only a socket making very good filament contact and capable of carrying three amperes continuously should be used with the 5Z3. Base connections of the 5Z3 are given in Fig. 2.

The bulb becomes hot during continuous operation. Provision should be made, therefore, for adequate natural ventilation to prevent overheating.

The filament is intended for a-c operation from one of the secondary windings of a power transformer. This winding provided with a center-tap or center-tap resistor, should supply at the filament terminals the rated operating voltage of 5.0 volts when average rated voltage is applied to the primary.

The high current taken by the filament makes it imperative that all connections in the filament circuit be of low resistance, of adequate current-carrying capacity, and well soldered.

The plate supply is obtained from a center-tapped high voltage winding on the power transformer. This winding should be designed so that the maximum a-c input voltage per plate will not exceed 500 volts r.m.s. under varying conditions of supply line voltage. The return lead from the plates, i.e., the positive bus of the filter and load circuit, should be connected to the center-point of the filament transformer.

The secondary windings of the power transformer should be adequately insulated from each other to withstand the full peak voltage of the high voltage winding. Under recommended maximum operating conditions, the full peak voltage will be about 1,400 volts. The resistance of the transformer windings should, of course, be sufficiently low so as not to impair the regulation between no load and full load.

A fuse having a rating approximately 50% in excess of normal load requirements should be inserted in the primary of the power transformer. This fuse is necessary to prevent damage to the power transformer in case of excessive current under abnormal conditions.

Application

The 5Z3 is well suited for supplying rectified power to radio equipment having very large direct-current requirements. In such equipment, the performance of this tube is similar to that of any other high-vacuum rectifier.

Filter circuits of the condenser-input or the choke-input type may be employed provided the recommended maximum plate voltage and output current given under rating and characteristics are not exceeded.

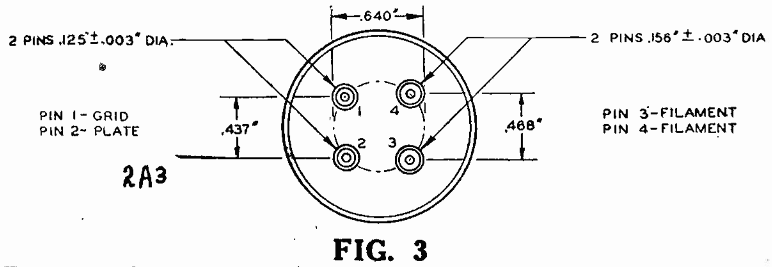
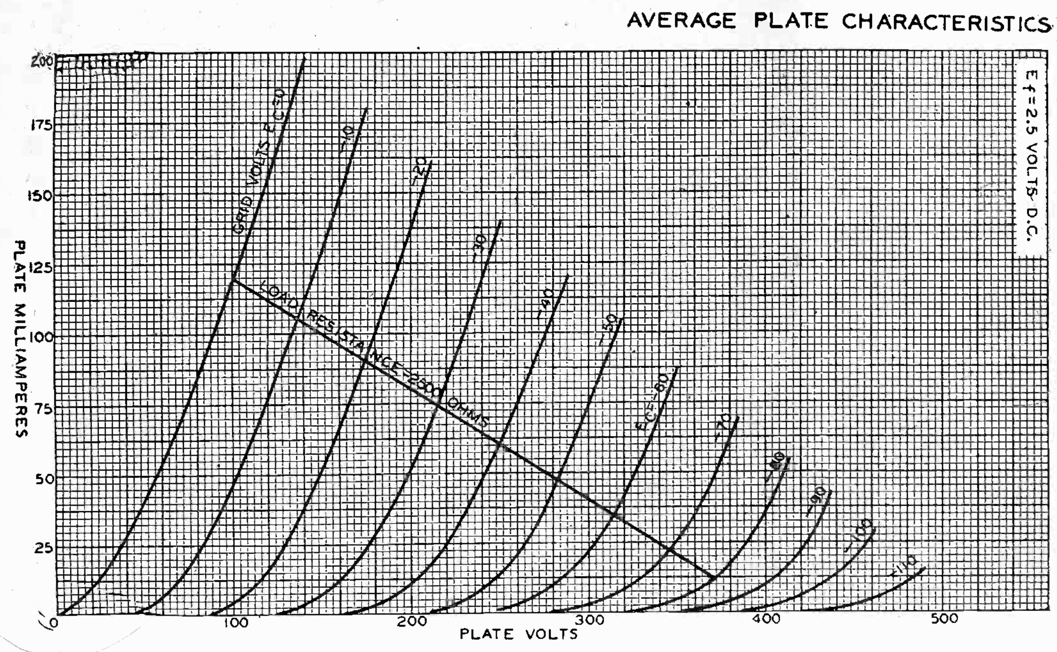
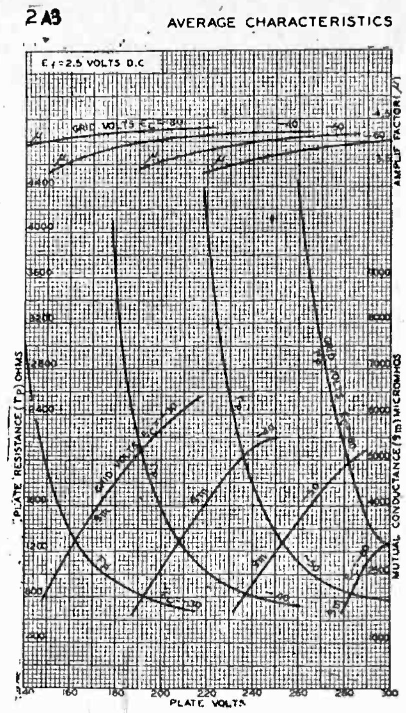


FIG. 3

Bottom view of base or socket connections for the 2A3.





If the condenser-input type of filter is used, consideration must be given to the instantaneous peak value of the a-c input voltage which is about 1.4 times the r.m.s. value measured from plate to filament with an a-c voltmeter. It is important, therefore, that the filter condensers (especially the input one) have a sufficiently high breakdown rating to withstand this instanteous peak value. It should be noted that with condenser input to the filter, the peak plate current of the tube is considerably higher than the load current. With a large condenser in the filter circuit next to the rectifier tube, the peak current is often as much as four times the load current.

When, however, choke input to the filter is used, the peak plate current is considerably reduced. This type of circuit, therefore, is to be preferred from the standpoint of imposing less severe operating conditions on the tube. Choke input will give a somewhat lower d-c output voltage than condenser input for a given a-c plate voltage, but improved regulation will be obtained.

2A3

The 2A3 is a three-electrode, high-vacuum type of power amplifier tube for use in the power output stage of a-c operated receivers. It possesses new capabilities for delivering exceptionally large, undistorted power output.

A pair of these tubes in a Class A push-pull stage operating at 300 volts on the plates can supply 15 watts of undistorted power.

The exceptionally large power-handling ability of the 2A3 is the result of its design features. Among these are its extremely high mutual conductance and its highly efficient cathode of unconventional form.

The cathode is composed of a large number of coated filaments arranged in series-parallel combination to provide a very large effective cathode area, and as a result, the desirable characteristics of the 2A3.

Tentative Rating and Characteristics of the 2A3

Filament Voltage (A.C. or D.C.)	2.5	Volts
Filament Current	2.5	Amperes
Direct Interelectrode Capacitances (approx.):		
Grid to Plate	13	uuf.
Grid to Filament	9	uuf.
Plate to Filament	4	uuf.
Maximum Overall Length	5⅝"	
Maximum Diameter	2 1/16"	
Bulb	ST-16	
Base	Medium 4-Pin	

SINGLE-STAGE AMPLIFIER (Class A)

Operating Conditions and Characteristics:		
Filament Voltage (A.C.)	2.5	Volts
Plate Voltage	250 max.	Volts
Grid Voltage	—42*	Volts
Plate Current	60	Milliamperes
Plate Resistance	765	Ohms
Amplification Factor	4.2	
Mutual Conductance	5500	Micromhos
Load Resistance	2500	Ohms
Power Output (5% second harmonic)	3.5	Watts

PUSH-PULL AMPLIFIER (Class A)

Operating Conditions:	Fixed-Bias	Self-Bias°	
Filament Voltage (A.C.)	2.5	2.5	Volts
Plate Voltage	300 max.	300 max.	Volts
Grid Voltage	—62*	—62*	Volts
Plate Current (per tube)	40	40	Milliamperes
Load Resistance (plate to plate)	3000	5000	Ohms
Total Harmonic Distortion	2.5	5	%
Power Output	15	15	Watts

°For this condition, the values given are on the basis of momentary average power output as distinguished from the continuous average power output of the fixed-bias condition. The power output and percentage distortion are functions of the duration and magnitude of the signal which through variation in plate current causes fluctuating grid bias. Obviously, a filter associated with the biasing resistor will tend to stabilize the grid bias. The duration of stabilization increases with the time constant of the filter; the longer the period, the longer the power peaks can be maintained.

*Grid volts measured from mid-point of a-c operated filament.

FIG. 4

Curves of the 2A3. At left the plate current is plotted against plate voltage and grid bias voltage, the load being 2,500 ohms. At right is a family of plate resistance, amplification factor, mutual conductance and plate voltage curves.

Installation

The base pins of the 2A3 fit the standard four-contact socket which may be installed to operate the tube either in a vertical or in a horizontal position. For horizontal operation, the socket should be positioned with the filament pin openings one vertically above the other. Base connections are given in Fig. 3, and external dimensions of the 2A3 are given in Fig. 8.

The bulb of this tube may become very hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided for free circulation of air around the tube to prevent overheating.

The filament is designed to operate at 2.5 volts. The transformer winding supplying the filament circuit should be designed to operate the filament at this recommended value (as measured at the filament terminals) when rated voltage is applied to the primary of the power transformer operating under average load. The filament circuit wiring and the filament contacts of the socket should have adequate current capacity to accommodate the high current drain (2.5 amperes) of this tube. All connections should be well soldered.

The filament winding should be provided either with a mid-tap or with a mid-tapped resistor of approximately 20 ohms shunted across it. To this mid-tap, the grid and the plate return lead should be connected. A variable center-tapped resistor across the filament supply for the output stage may be desirable in some circuits for minimum hum adjustment.

Application

The 2A3 because of its exceptional power-delivering ability offers the designer of a-c receivers a new means for obtaining high undistorted power output.

As a power amplifier (Class A), the 2A3 is adaptable either singly or in push-pull combination to the power output stage of a-c receivers. Recommended operating conditions are given under Rating and Characteristics.

It will be noted that the values recommended for push-pull operation are different than the conventional ones usually given on the basis of characteristics for a single tube. The values shown for Push-Pull Class A operation cover operation with fixed-bias and with self-bias, and have been determined on the basis of no grid current flow during the most positive excursions of the signal swing and of cancellation of second harmonic distortion by virtue of the push-pull circuit.

A theoretical consideration of the method

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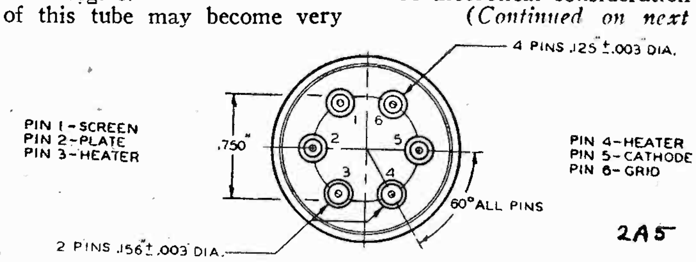


FIG. 5
Bottom view of 2A5 connections.

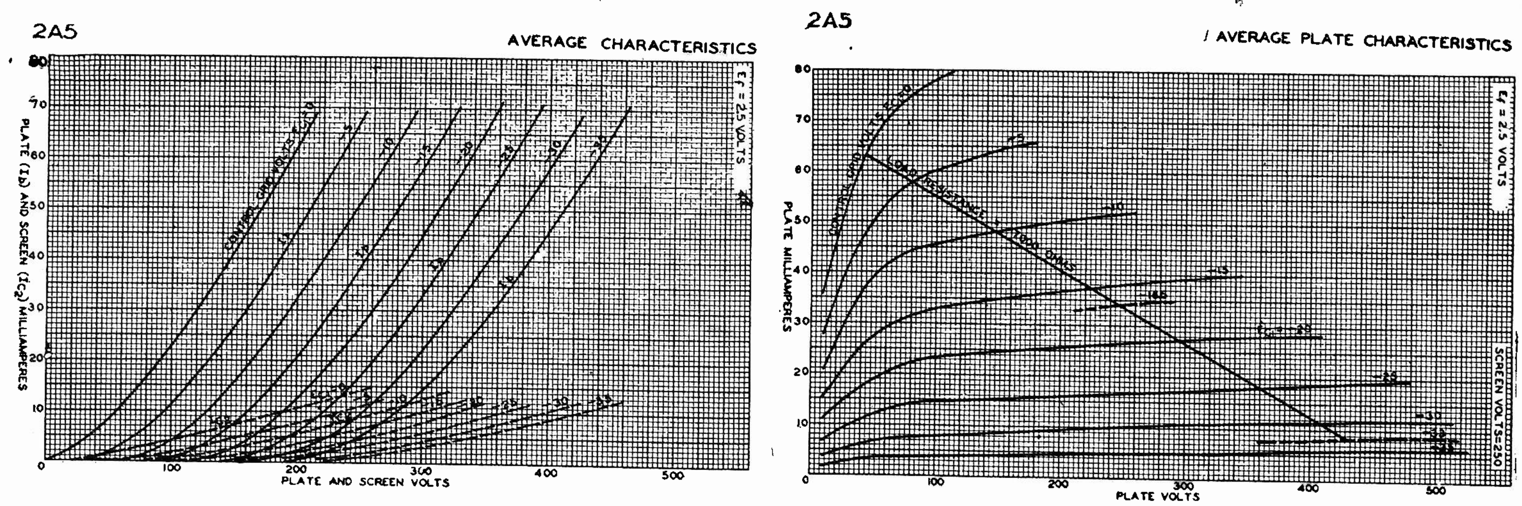


FIG. 6
Curves of the performance of the 2A5.

(Continued from preceding page)

for determining the performance of push-pull audio amplifiers by graphical means is given in a paper entitled "Graphical Determination of Performance of Push-Pull Audio Amplifiers" by B. J. Thompson of our Research and Development Laboratory. This paper is scheduled to appear in the April, 1933, issue of "Proceedings of the Institute of Radio Engineers."

If a single 2A3 is operated self-biased, the self-biasing resistor should be approximately 700 ohms. This same value is also recommended for use with two 2A3's in push-pull. In either case the resistor should preferably be shunted by a suitable filter network to minimize grid bias variations produced by current surges in the biasing resistor.

Any conventional type of input coupling may be used provided the resistance added to the grid circuit by this device is not too high. Transformers or impedances are recommended. When self-bias is used, the d-c resistance in the grid circuit should not exceed 0.5 megohm. With fixed-bias, however, the d-c resistance should not exceed 10,000 ohms. The use of resistances higher than these may cause the tube(s) to lose bias due to grid current with the result that the plate current will rise to a value sufficiently high to damage the tube(s).

An output transformer should be connected in the plate circuit of the 2A3 in order to transfer power efficiently to the loudspeaker. Recommended values of load resistance for single-tube and push-pull operation are given under Rating and Characteristics.

2A5

The 2A5 is a power amplifier pentode of the heater-cathode type for use in the audio output stage of a-c receivers. It is capable of giving large power output with a relatively small input-signal voltage. Because of the heater-cathode construction, a uniformly low hum-level is attainable in high quality power amplifier design.

A single 2A5 in the output stage is capable of supplying about 3.0 watts, while two 2A5's in a push-pull stage can deliver in excess of 6.0 watts.

The power-handling ability of the 2A5 is essentially the same as that of the 59 with pentode connection, but the 59 has a greater flexibility of application to power amplifier design. The two types, however, are not directly interchangeable because of the difference in base connections.

Like the 59, the 2A5 is characterized physically by the dome-top bulb, and the rigidity of electrode assembly. In size, the 2A5 is somewhat smaller than the 59.

Tentative Rating and Characteristics of the 2A5

Heater Voltage (A.C. or D.C.)	2.5 Volts
Heater Current	1.75 Amperes
Plate Voltage	250 max. Volts
Screen Voltage	250 max. Volts
Grid Voltage	—16.5 Volts
Plate Current	34 Milliamperes
Screen Current	6.5 Milliamperes
Plate Resistance	100000 approx. Ohms
Amplification Factor	220 approx.
Mutual Conductance	2200 Micromhos
Load Resistance	7000* Ohms
Power Output (7% total harmonic distortion)	3.0 Watts
Maximum Overall Length	4 11/16"
Maximum Diameter	1 13/16"
Bulb	ST-14
Base (Refer to Fig. 6)	Medium 6-Pin

*A load resistance of 9000 ohms will give approximately the same power output and same total harmonic distortion as 7000 ohms.

Installation

The base pins of the 2A5 fit the standard six-contact socket which may be installed to operate the tube either in a vertical or in a horizontal position. Base connections of the 2A5 are given in Fig. 6 and external dimensions in Fig. 7.

The bulb of this tube will become very hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided to circulate air freely around the tube to prevent overheating.

The heater is designed to operate at 2.5 volts. The transformer winding supplying the heater circuit should be designed to operate the heater at this recommended value for full-load operating conditions at average line voltage.

The cathode should preferably be connected directly to a mid-tap on the heater winding.

Application

The 2A5, because of its heater-cathode construction, consequent low hum-level, and large power output, is recommended to de-

(Continued on next page)

COMPARATIVE SIZES OF THE FOUR NEW TUBES, WITH ALL ESSENTIAL DIMENSIONS GIVEN

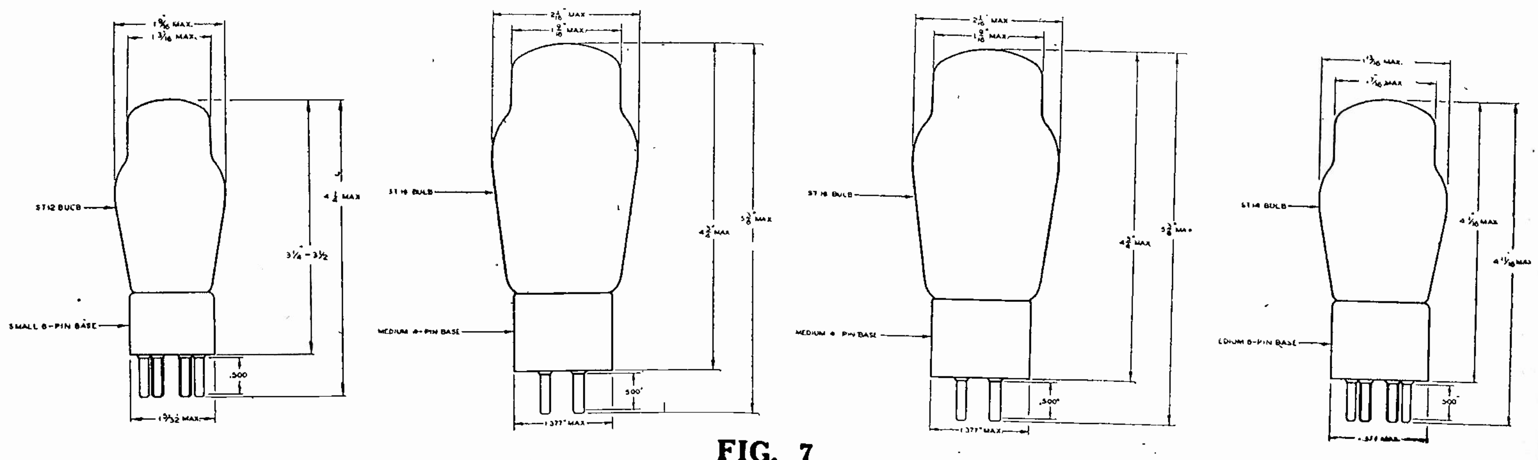


FIG. 7

25Z5 **5Z3** **2A3** **2A5**

ADJUSTMENTS for N.S.C.

Voltages Must Be Just Right, Otherwise Failure

By Einar Andrews

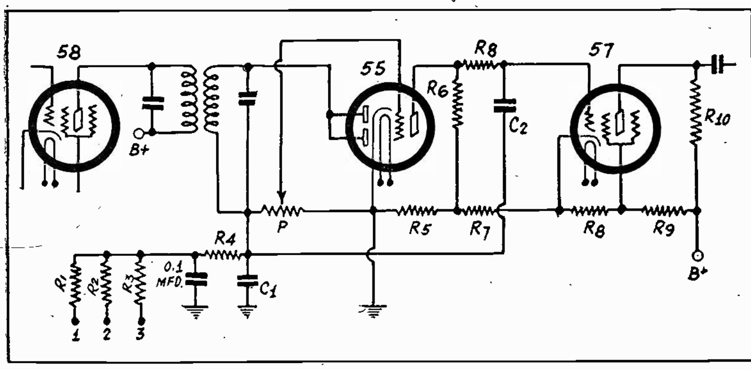


FIG. 1
This shows the arrangement of resistors in a circuit comprising a.v.c., n.s.c., diode detection, and audio amplification.

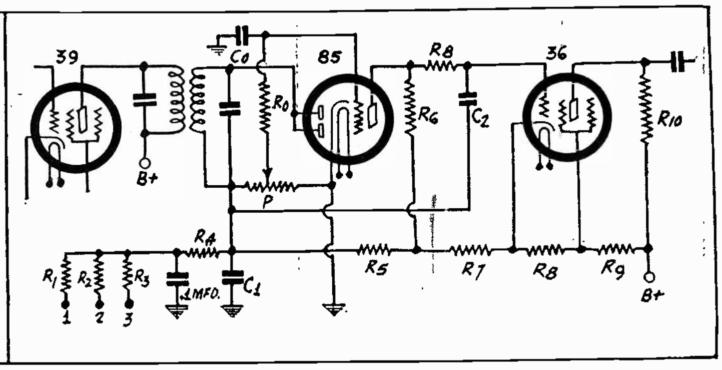


FIG. 2
This is the same circuit as that in Fig. 1 except that a filter has been inserted in the d-c amplifier grid.

THE adjustment of a noise suppression control (n. s. c.) offers some difficulties, but if the functioning of all the components is clearly understood it should be a comparatively simple matter. It is largely a matter of proportioning the various voltages correctly. One of the possible difficulties is that when the amplifier is biased so that it will cut off the noise on no signal, it will be overbiased when there is a signal, so that the amplification will not be distortionless.

Refer to Fig. 1. This is a typical circuit in which a.v.c., detection, n.v.c., and audio amplification have been provided for. The 55 tube serves the triple purpose of a.v.c., detection, and d-c amplifier. The 57 serves as an audio amplifier, and in conjunction with the d-c amplifier of the 55 serves also as the n.s.c.

Let us assume that the grid bias, the screen voltage and the applied plate voltage on the 57 have been adjusted so that the tube will amplify without distortion. This means that the drop in R7, which gives the grid a fixed bias, should be about 3 volts, that the applied plate voltage, that is, the drop in R8 and R9, should be about 250 volts, and that the screen voltage, or drop in R8 should be something less than 100 volts. Just how much less will depend on the value of R10, the load resistance on the 57. If this is low, say 50,000 ohms, the drop in R8 should be near 100 volts.

Plate Voltage on 55

Next we must make certain that the plate voltage on the triode of the 55 is sufficiently high. If this voltage is lower than the voltage by which the bias on the 57 must be increased to cut off the plate current, we cannot hope to effect the proper adjustment. Suppose the voltage in the plate circuit, which is the drop in R5, is 10 volts. This is the maximum possible voltage drop in R6. Hence the maximum grid bias possible on the 57 is 13 volts. If that is high enough completely to cut off the plate current in the 57, all is well. But it is not likely that the drop in R6 will ever be equal to applied voltage, that is the drop in R6. It depends on the value of R6 and on the bias that may be encountered in the load resistance P. The drop in R5 must have a certain minimum value.

Therefore the voltage in R5 cannot be too low. Neither can it be too high. Suppose it is so high that the bias afforded by the drop in P never can cut off the current in R6. Then the 57 tube will be shut off even when we want it to operate justment such that when there is a signal to amplify, the plate current in the 55 triode is cut off and such that when there is no signal to amplify the plate current in the 57 will be cut off.

Suppose that we select a voltage of 25 volts for the plate of the triode. That will be the drop in R5. This is certainly high enough to cut off the plate current in the 57, say if we can get 50 per cent. of this voltage to drop across R6, and the remaining 50 per cent. in the internal resistance of the 55. That would be the case if R6 is equal to the internal resistance of the 55 triode at zero bias, or on no signal. Apparently there is no difficulty in getting the plate current in the 57 to cut off.

No Cut-Off

When a signal is coming through the current in R6 should be virtually zero, for only when it is zero will the bias on the 57 be 3 volts. Of course, some current may be allowed to flow, for the 57 will amplify even though the bias is a little higher.

What can be done to cut off the plate current in the 55, or in resistance R6? Suppose we connect the grid of the triode to the left end of the potentiometer P. On a strong signal the drop in the resistor may be as high as 75 volts. That certainly is enough to cut off the current. Indeed, we need much less, considering the low applied voltage on the plate. If the whole voltage is too much we can use only a portion of it, by connecting the grid to the slider as shown in the figure. But if we move the slider too close to the cathode the 57 will be cut off all the time.

If only a portion of the d-c voltage in P is needed we do not necessarily have to apply a corresponding portion of the a-c to the audio amplifier. We can apply the full a-c signal by making the connection as indicated in the figure.

The principle of the noise suppressor can be applied to a circuit utilizing other

(*Continued on next page*)

NEW TUBES

(*Continued from preceding page*)

signers for output use in a-c receivers employing a pentode-power stage.

As a power amplifier (Class A), the 2A5 may be used either singly or in push-pull combination. Recommended operating conditions are given under Rating and Characteristics.

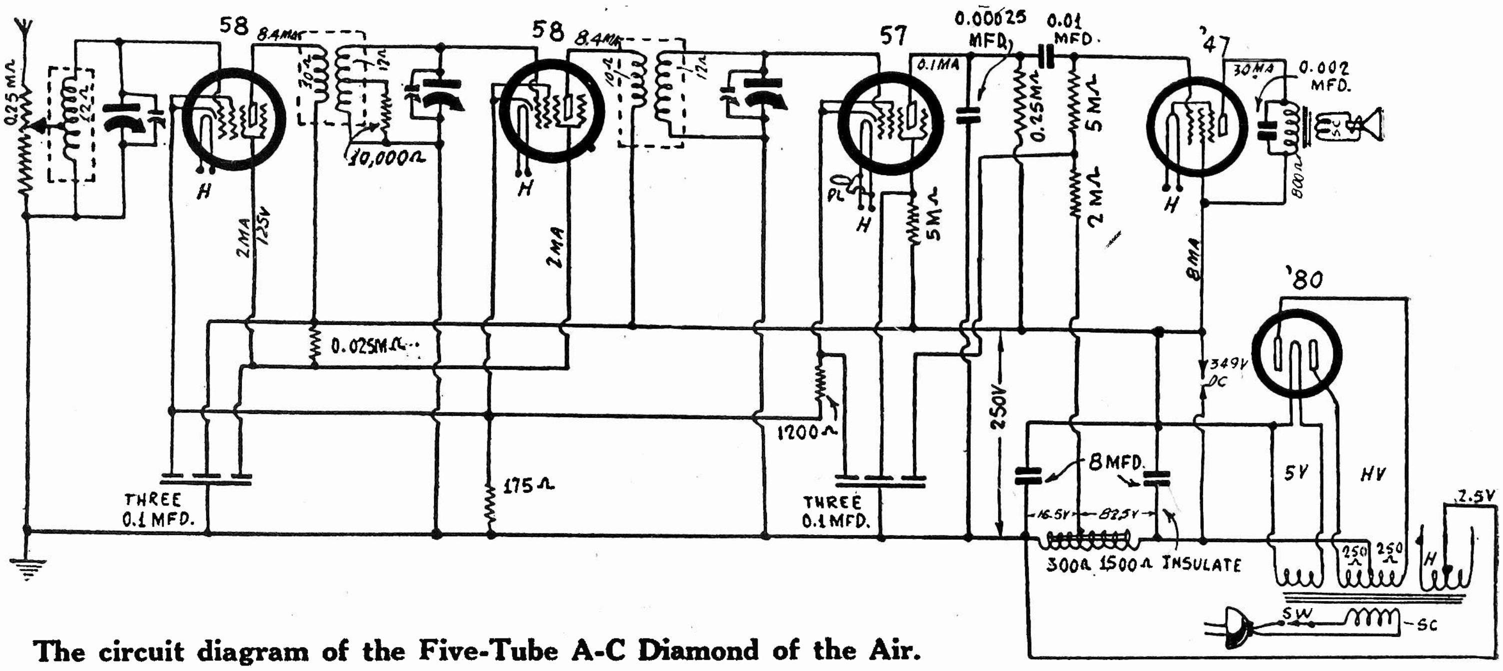
If a single 2A5 is operated self-biased, the self-biasing resistor (408 ohms) should be shunted by a suitable filter network to avoid degenerative effects at low audio frequencies. The use of two 2A5's in push-pull eliminates the necessity for shunting the resistor (204 ohms).

Any conventional type of input coupling may be used provided the resistance added to the grid circuit by this device is not too high. Transformer or impedance coupling devices are recommended. If, however, resistance coupling is employed, the grid resistor should not exceed 250,000 ohms with self-bias; without self-bias, the value should be limited to 100,000 ohms.

An output transformer should be used in order to transfer power efficiently to the speaker. The optimum value of load resistance for a single tube is given under Rating and Characteristics. For push-pull operation, the plate to plate load resistance should be twice that for a single tube. For best results, the impedance in the plate circuit of the 2A5 should be as uniform as possible over the entire audio-frequency range.

The Three Outstanding T-R-F and Super DIAMOND CIRCUITS

By Herman Bernard



The circuit diagram of the Five-Tube A-C Diamond of the Air.

THE most recent Diamond of the Air circuits are the five-tube tuned radio frequency design, and the two superheterodynes of which there are a six-tube and a seven-tube model.

The circuits were so designed that most excellent tone quality would prevail in all of them, and no concession to circuit difficulties surrounding the audio response was made even in the superheterodynes. In the seven-tube super, for instance, although one of the primary intentions was to afford a degree of selectivity commonly referred to as "10 kc selectivity," the sidebands were fully protected, by using resistor-capacity filters in the plate circuits, so that the drop in response at 10 kc from carrier was not at all serious. While it is generally true that the tone obtained from supers does not come up to that afforded by t-r-f systems, such is not true of the two Super Diamonds.

Field Day for Diamonds

The first presentation of the seven-tube model was made last week, and the discussion is brought to a close this week with the printing of the circuit diagram, with slight changes, and the full-scale picture diagram of the wiring to carry out those changes, too. They are not essential alterations, but they have to do in general with best assurance of obtaining full oscillation from the autodyne oscillator. The detailed reasons will be presented.

In view of the considerable requests for the three circuits, and as a means of providing a ready reference for those who want to have authenticated circuits handy, the circuit and picture diagrams of all three models are printed this week. So the diagrams represent a sort of Diamond symposium, and the present series will have added to it, for broadcast coverage, only one more super, using eight tubes. This will be a push-pull output, otherwise much the same as the seven-tube circuit, but will not be published until the new tubes intended to be used in them (the 2A3 heavy-duty triode power tube and the heavy-duty 5Z3 rectifier) are ready for distribution to the public. These tubes were prophesied in last week's issue and are described in full detail in this week's issue. The maximum undistorted power output from the push-pull pair will be 15 watts, which is the highest power rating for any of the moderately-voltaged tubes to date.

The T-R-F Set

The five-tube t-r-f circuit uses a '47 output tube, as this tube has the required sensitivity, while the six and seven-tube t-r-f sets use the 59 output tube. There is not much difference between the two output tubes, and therefore it was not deemed worth while to alter the five-tube model to accomodate the newer tube, although any who desire to do so may simply follow the method as described and illustrated in the text and diagrams of the six and seven-tube models. No change in speaker field ohmage or bias tap is necessary. Indeed, a speaker intended for the '47 may be used for the 59, as there is small difference here, but if one has a choice anew, the speaker for the 59 should have a 6,000 ohms input impedance, while that for the '47 should have 7,000 ohms impedance.

Some who have built the five-tube model have requested that the volume control be made more effective. Since the circuit is quite sensitive, the wire running between volume control and antenna post will act as a pickup or aerial, hence to reduce or almost eliminate the pickup from this source shielded wire may be used, its shield grounded at extremes. However, to avoid loss to ground wire should have thick insulation, about ½ inch diameter, and the wire recommended has a cotton insulation of that approximate thickness, over the usual rubber insulation, with the shield braid completely covering the outside of the cotton covering. While the picture diagram notes that shielded wire should be used for one of the leads, some may desire to use shielded wire for both of the leads. These are the connections between antenna post and one extreme of the potentiometer, and from antenna tap on coil and moving arm of the potentiometer.

The Volume Control Difference

With the location of the potentiometer as now shown there will be complete cutoff of the signal, if desired, and sharper con-

(Continued on next page)

Voltage Division in N. S. C.

(Continued from preceding page)

tubes as well. In Fig. 2 it is applied to a set utilizing 39s, an 85 and a 36. One condition in any case is that the first audio tube should have a high amplification factor so that the current may be cut off with moderate grid bias voltages.

Coupling

C2 is the ordinary coupling condenser between the amplifier and the source of the signal. Its value may be 0.02 mfd. R8, which should be of the order of one megohm, is used to prevent the signal from being shorted, in part at least, through the resistance R6.

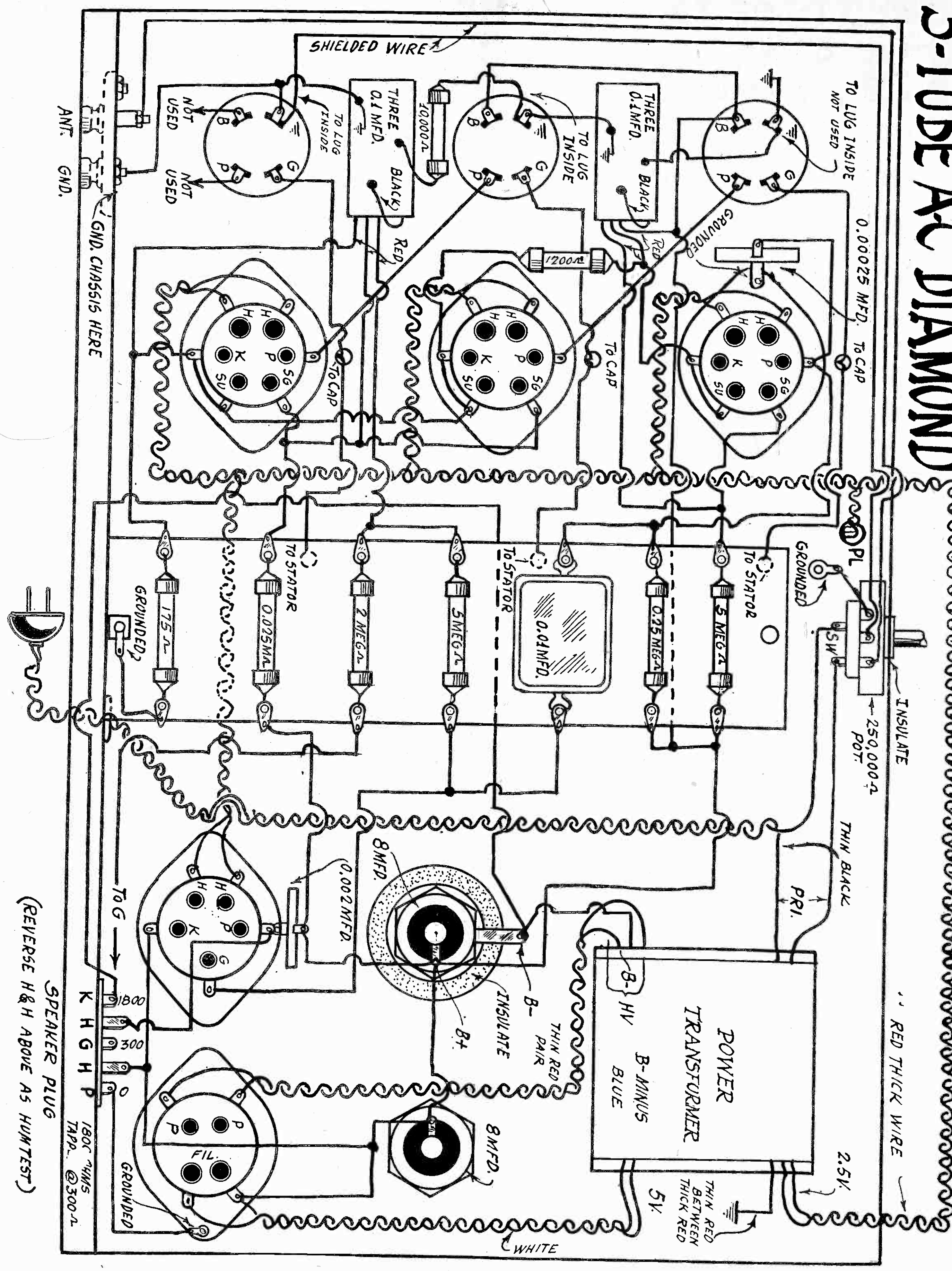
As a means of limiting the amplification in the 57, or 36, resistance R10 has a comparatively low value, say from 20,000 to 50,000 ohms. With such a low resistance on a screen grid tube the screen voltage may be considerably higher than if a very high load resistance were used.

In both circuits provision has been made for a.v.c. C1 is the ripple filter across the load resistance P. R4 is a high resistance of about 0.5 megohm, which prevents the audio signal from shorting to ground through by-pass condensers associated with the a.v.c. Resistors R1, R2 and R3 are filter resistors in the grid returns of the controlled tubes. From each grid return is usually a condenser of 0.1 mfd., but is not shown in the figure.

Insuring D-c Amplification

In the grid circuit of the 85 in Fig. 2 is a filter consisting of a resistor Ro and a condenser Co. The object of these is to insure that the triode grid only gets d-c voltage. The condenser Co may be as large as 1 mfd. and the resistance may be one megohm. It is the condenser that maintains the voltage on the grid free of signal voltages and the resistor Ro is used only to prevent the audio voltages across the load resistance P from being shorted through the condenser.

5-TUBE A-C DIAMOND



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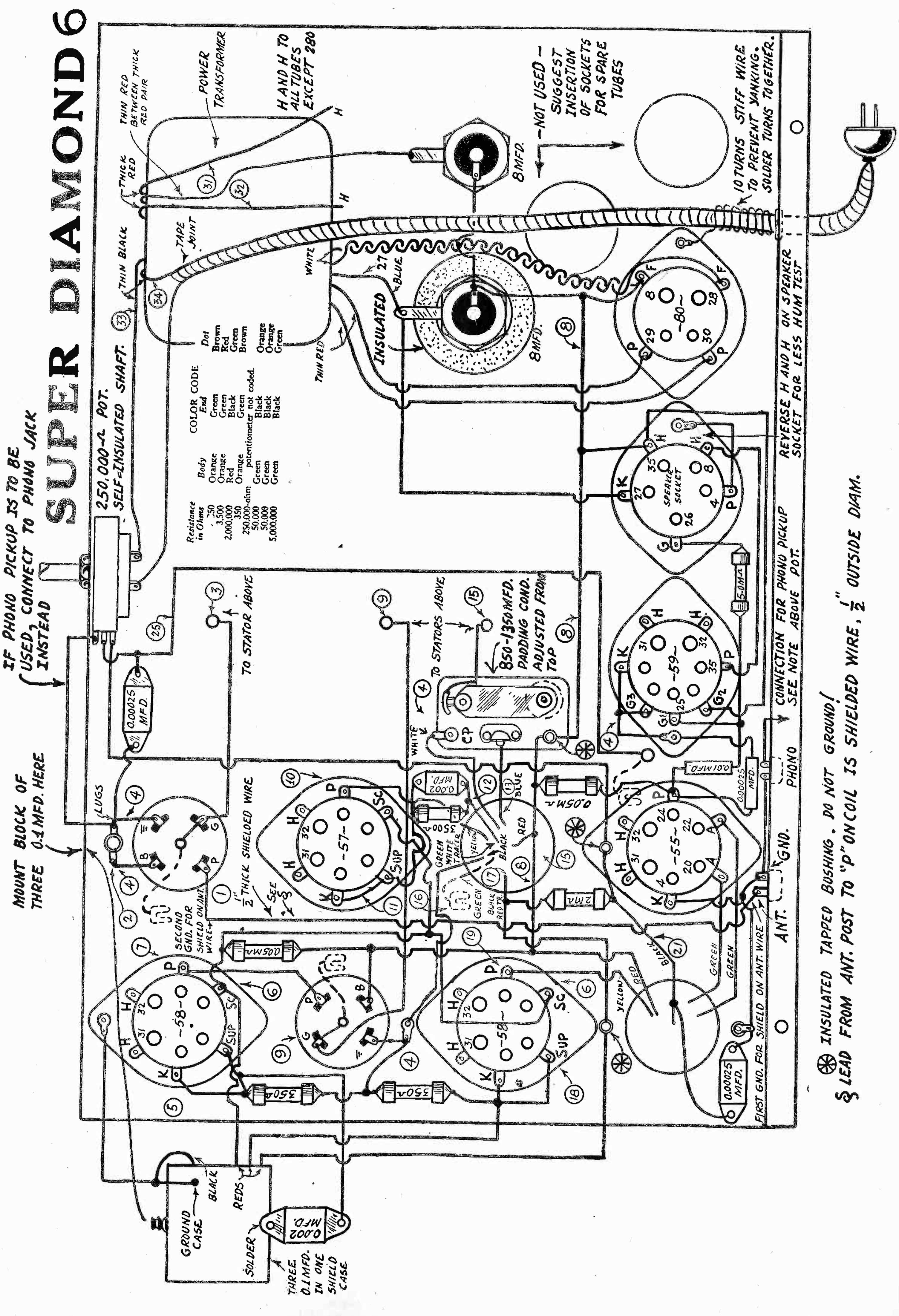
trol, although the method shown formerly is adequate, also, if the shielded wire is used as directed. The previous method had the potentiometer between tap and ground. Now, as stated, the potentiometer is between aerial and ground, and so much of the antenna voltage as is desired is picked off by adjusting the volume control.

For the five-tube model, the a-c switch is separate from the potentiometer, as the chassis construction is such that a combination unit would not fit under the dial because of dial bracket interference.

It is possible that the set as shown will oscillate, but the cure for oscillation would be to use a lower value of resistance than 10,000 ohms between tap of the second coil and ground. In previous models this resistor was shown as 1,200 ohms, but many builders reported there was no oscillation, even with the resistor omitted, and others stated that 10,000 ohms cured the trouble, so now 10,000 ohms are shown, with the suggestion that the resistor be omitted entirely, and if no oscillation is present that it be left out. Then if any oscillation arises, put in a resistance value as high as practical, consistent with the stoppage of oscil-

(Continued on page 11)

SUPER DIAMOND 6

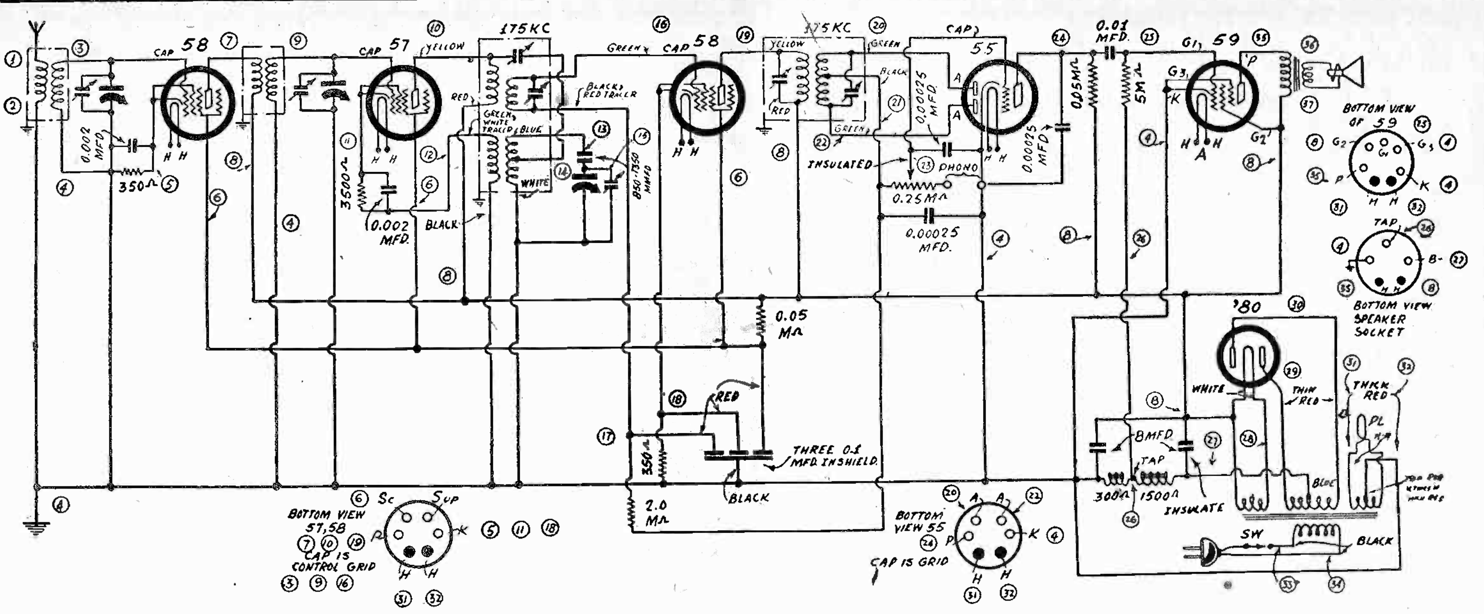


COLOR CODE

Resistance in Ohms	Body	End	Dot
350	Orange	Green	Brown
3,500	Orange	Green	Red
2,000,000	Red	Black	Green
350	Orange	Green	Brown
250,000-ohm potentiometer not coded			
50,000	Green	Black	Orange
50,000	Green	Black	Orange
5,000,000	Green	Black	Green

✱ INSULATED TAPPED BUSHING. DO NOT GROUND!

§ LEAD FROM ANT. POST TO "P" ON COIL IS SHIELDED WIRE, 1/2" OUTSIDE DIAM.



The Super Diamond 6.

(*Continued from page* 9)
lation. This is exactly the same advice given originally, so the change in the resistance value is really immaterial, since no definite value is recommended. One is stated simply to avoid confusion.

Meets Requirements of T-R-F

The five-tube set has most excellent tone, a fact that nearly every builder must realize, for certainly enough have written in commending its tone to allow the presumption that this tone excellence has struck the consciousness of all builders. And there has been very little trouble in the circuit, far less than in the average circuit, which no doubt is partly accounted for by the fact it is a t-r-f set, and also by the fact that the design was fully tried and tested, and subjected to many hours of patient work, before it was offered to readers. Any who prefer a t-r-f set, and one that can be built most inexpensively, will find that the five-tube Diamond, using the new 50 series tubes, with 57 power detector, '47 output tube and '80 rectifier, will more than meet the requirements.

Sidelights on Supers

When it comes to building a super there is bound to be more trouble. It is a circuit that has not been "licked" completely even by the best engineers. However, for the benefit of those who do not know as much about supers as they'd like to, the fundamental circuit was reduced to an easily reproductible form, using an autodyne oscillator, so that the performance equal to that of an extra tube would be enjoyed. Of course the 55 detector is two tubes in one also—really three in one, for there are two diodes—but it is only fair to count it as one tube, because diode detection is less sensitive than the 57 that might otherwise be used, approximately by the amount of the amplification of the triode unit of the 55.

The six- and seven-tube supers use the diode as a full-wave second detector, and this gives the detector a great power handling capacity without distortion, in fact, makes it safe to claim that the detector itself can not be overloaded by the input delivered to it from the receiver. There would be no sign of overload until the rectified voltage in the second detector exceeded 60 volts, an extremely unlikely voltage in the six-tube model anyway. Another contribution to tone is the use of direct coupling between the diode and its triode for transfer of the audio frequencies. This is accomplished by tying the grid of the tube to the arm of the volume control potentiometer.

Signal Is Cut Off

In the six-tube model the voltage at the detector will not rise so high that if the volume control is full-on the negative bias on the triode unit will be great enough to cut off the plate current. The expression "plate current cutoff" or equivalent is a relative one, and should be taken to mean signal cutoff due to failure of the tube to act as a repeater on account of high negative bias paralysis. Actually the plate current never cuts off, for so long as there is a voltage across a resistance there is current through that resistance, though one may not have instruments sensitive enough to measure that current.

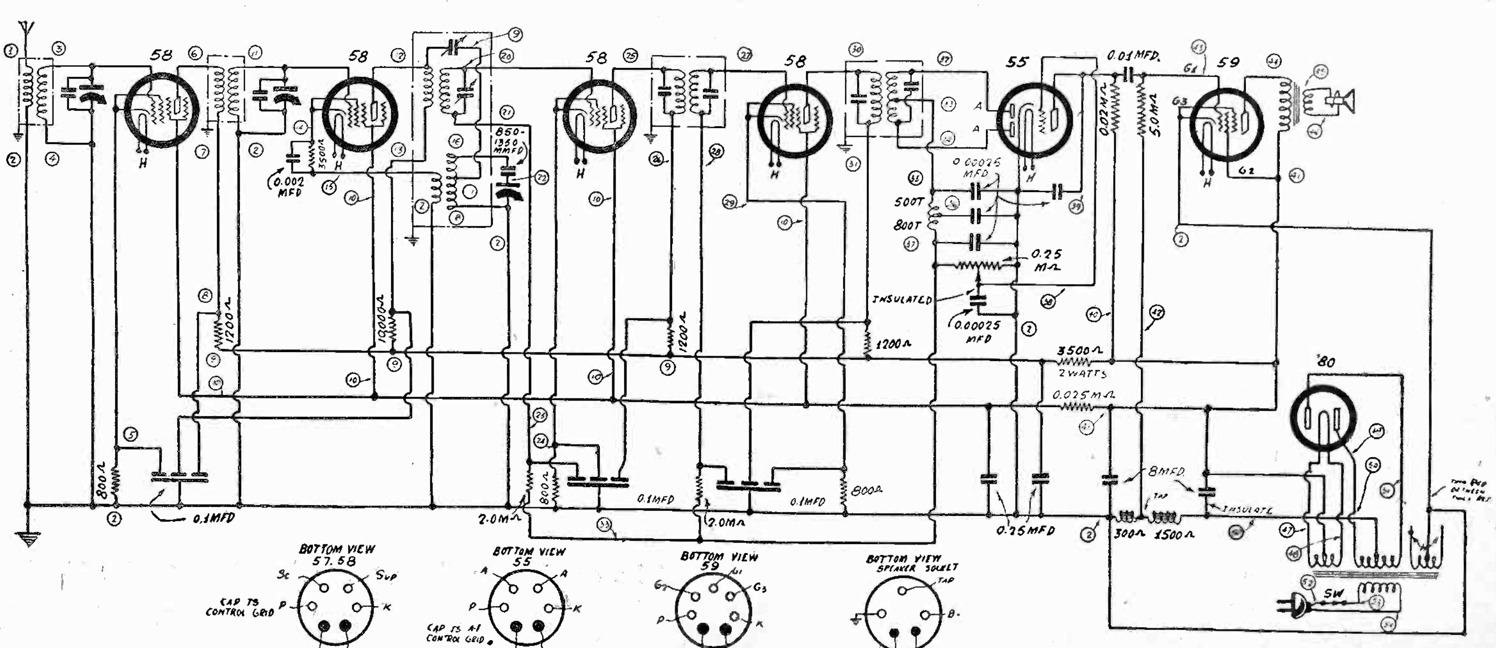
In the seven-tube model, if the aerial is long enough, the plate current (to recur to the popular loose expression) will cut off, and the signal will not come through. There is nothing dangerous about this, and no possible damage thereby can occur to the tube. Those who do not want to include this feature may shorten the aerial until at full-on volume control position the strongest local does not stop the signal. Many will desire to retain the condition, because of the automatic shutoff of the signal when under conditions which would anyway overload the power tube badly if the signal did come through. That is, automatic "punishment" is inflicted by the set on the user when he would strive to overload the power tube, by cutting off his signal. Thus the volume control has to be retarded until the stoppage of signal itself stops.

Bias on Triode

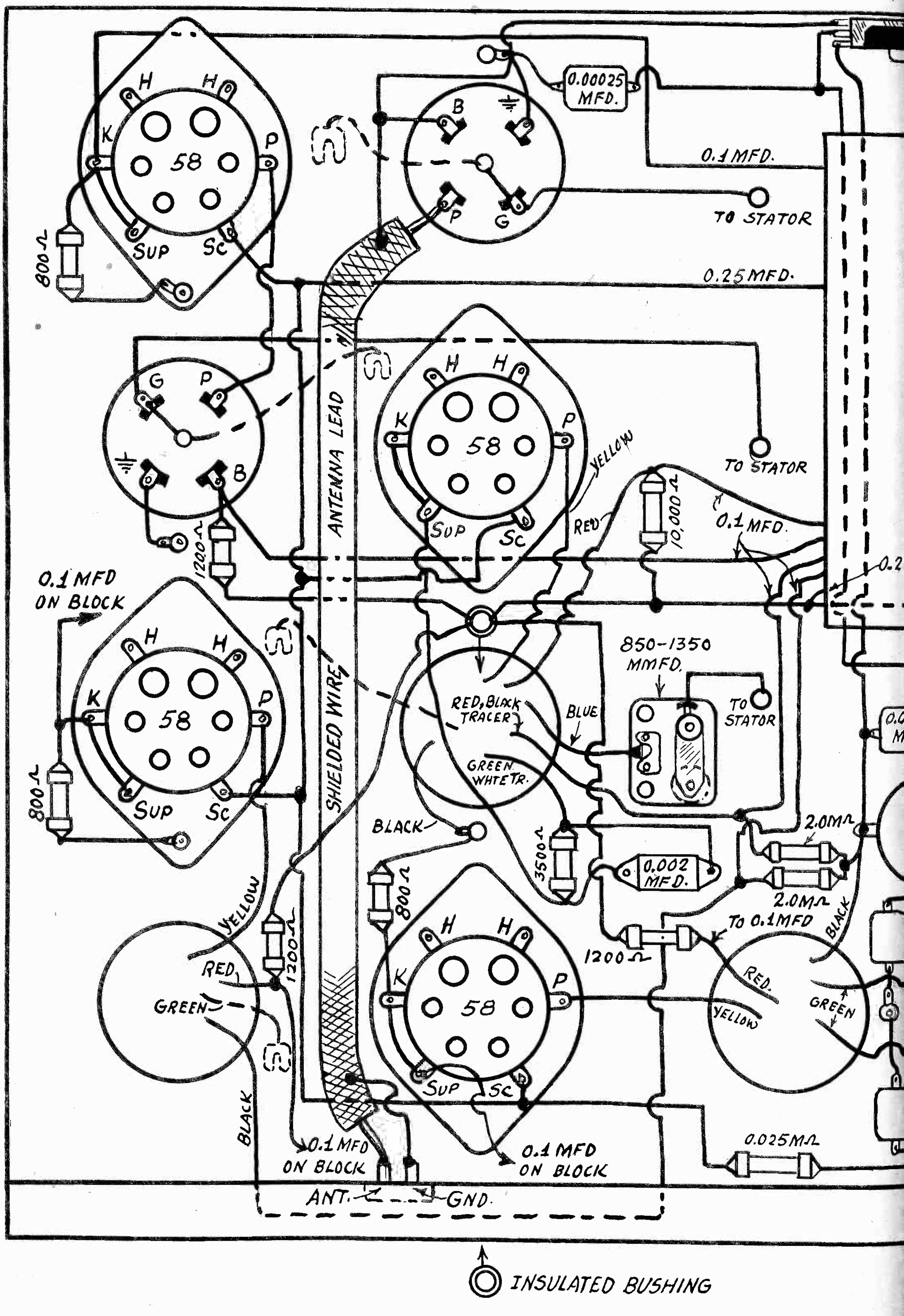
Many have asked about this feature, which was discussed also last week, prior to the receipt of questions, although the only possible way they ran into it was by putting in more r-f or intermediate stages than the six-tube model called for, in other words, they anticipated an approximation of the seven-tube model.

Others ask about the negative bias on the triode.

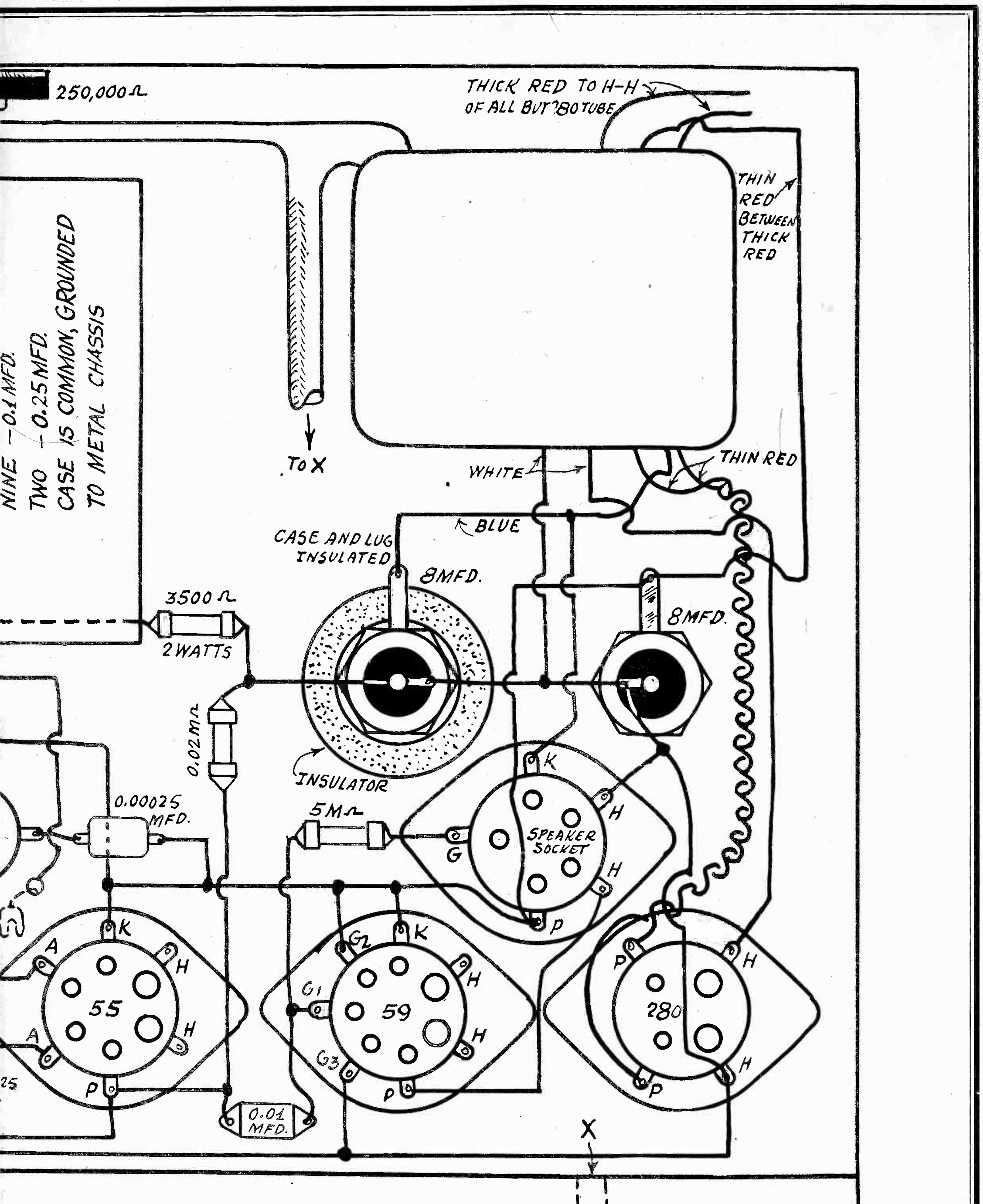
These subjects have been taken up before.
(*Continued on page* 14)



The Super Diamond 7.



The condenser block has colored outleads: black, commo
0.25 mfd.; seven si



SUPER DIAMOND 7

r to case and ground case to chassis; two similar blues are
blues are 0.1 mfd.

(*Continued from page 11*)

but will be re-discussed briefly. First, the negative bias on the triode unit of the 55 arises from the fact that the rectified current outside the tube flows from grounded cathode to anode in the load resistor voltages (total of 250,000-ohm potentiometer) and coil, hence to the left in the circuit diagram of the six- and a seven-tube models are negative. How can they be more negative than ground? For the same reason the tap on the field coil is more negative than ground, and affords bias for the power tube. The direction of current flow constitutes ground the positive end in both instances.

Therefore, since the grid of the triode is tied to the arm of the potentiometer, as much or as little of the total voltage developed across this rectifier load resistor is put into the triode, and the grid is always negative.

The word "always" is a bit strong. The grid may not be negative. Although the potentiometer will have a minimum resistance of 175 ohms, it is conceivable that no current will be flowing, due to no carrier, and then the tube works at zero bias, and the grid may run even a bit positive due to the shot effect, or stray pelting of the tube elements by truant electrons, and the grid current will make a strong hissing noise. This is the "noise" of the same sort referred to in connection with automatic volume control circuits where no remedy has been applied to the lowest bias condition.

Bias Depends on Signal

In the present supers the remedy is to use an aerial. It makes no difference how long the aerial is, so long as it exceeds six inches. There will then be enough input to make current flow through the rectifier even if you can not hear a station, and the grid will never go positive, for so soon as carrier intensity increases, the grid bias increases along with it, and the relationship is linear, so there is no possibility of overload. Indeed, even on a strong signal, if the volume control is greatly retarded, still there will be enough bias, for a strong signal may mean a total of 20 rectified volts, and if you used only one-third the resistance there would be around 7 volts negative bias, and besides the signal input would be cut down automatically to meet that condition, for the bias is exactly equal to the amount of the signal put into the triode grid.

When it came to putting out a seven-tube model it was found that considerable filtration had to be included, and as resistor-capacity circuits are the handiest and serve the purpose here as well as choke-coil capacity circuits, the numerous resistors and by-pass condensers are the result. They are orthodox, except perhaps for the fact that the resistor in series with the plate of the autodyne tube, in the 7-tube model, is 10,000 ohms, and results in 100 volts effective on the plate, whereas the screen voltage may run from 110 to 120 volts, hence will be higher. This condition resulted accidentally, but it provided a method of making oscillation almost certain in the autodyne tube, despite an unusual type of coil.

Code for Coil

The cathode biasing resistor is shown between cathode and pickup coil (while the padding condenser is not grounded, in both the super models, because these methods also better insured oscillation). Those who prefer grounded padding condenser may use the grounded method, but if oscillation fails should reduce the value of the biasing resistor until oscillation is present.

No suspicion need attach to the special combination coil if oscillation fails, for though the tap cannot be located by any external test (the reading should be an open circuit for tests with a d-c instrument because of an intervening condenser) you may be certain the tap is there. The coil combination normally will have seven leads for this circuit, coded as follows: green with white tracer to one side of cathode resistor, other side of which resistor goes to cathode; blue, to one side of padding condenser, other side of which condenser goes to stator of the tuning condenser; black, common return of green with white tracer and of blue, goes to ground; yellow, to plate of the autodyne tube; red to 10,000-ohm resistor that eventually leads to B plus; green, to grid cap of the first (and in the six-tube model, only) intermediate tube; black with red tracer, to automatic volume control filter resistor.

A. V. C. in Both

The six-tube model has its intermediate tube subject to a.v.c., and while this gives some effect to the attempt, it is not much a.v.c. and no more is included, because it is desired to keep the sensitivity as high as practical. Hence the circuit may be adjusted to a sensitivity of a few microvolts per meter, with good selectivity as well. It is much more sensitive and selective than the five-tube t-r-f model.

But you really must have an oscillator or you cannot hope to get the circuit working properly. The oscillator is needed particularly for lining up the intermediate frequency. I know that many try their best to get along in building a super without an oscillator, and that's one reason I get so many letters. The set doesn't work properly, etc., and small wonder. One I looked over was 90 kc off the intended resonance point of 175 kc. Poor sensitivity, many, many squeals, loss of signals over part of the dial, fluttering reception, etc., were some of the ills, all cured when the circuit was properly lined up.

Both circuits now use the same coils for r-f and oscillator, intended for 0.00041 mfd. capacity, and permitting the use of a dial calibrated solely in frequencies. The adjustment to excellent coincidence is achieved by setting the tuning condenser at maximum capacity, and having the dial read 51 instead of 50, then lining up at 600 kc for both padding condenser and trimmers, and relining trimmers only at 1,450 kc. The trimmers on r-f and autodyne input have to be down all the way, and the oscillator trimmer nearly or completely so. The circuit then will not tune higher than 1,510 kc unless the intermediate frequency is lower than 175 kc.

Sensitivity Compared

Of course this is a great clue for the fellows who haven't an oscillator and yet want to try their hand at a super. If what the gentleman says is true, why do I need an oscillator? They may ask. All I need do is use the prescribed coils and condensers, tightened down the compensators or trimmers all the way, and make 1,450 kc come in just a trifle to the right of the dial end, or line up at the extreme for 1,500 kc, which is permissible, mechanically of course, and then adjust the intermediates until the signal of the desired frequency comes through where it should. This is a pretty good theory, but it is much better to have an oscillator and a certainty back of you than merely a pretty good theory. The stunt can be worked, but I do not advise that it be tried, except as a lark.

The seven-tube model has brought in 96 channels out of 96, under circumstances when the six-tube model brought in 42 and the five-tube model 28 channels. Perhaps this is as good a way as any to compare the sensitivity in words. As for the tone, one cannot tell the difference between any of the three sets. The supers are louder, but the seven-tube is no louder than the six, due to full a.v.c. governing two tubes, and moreover the locals do not blast in the seven-tube super, or even in the six-tube, but may on the t-r-f set.

Noise Suppression

On the subject of blasting, and what may be termed a concomitant, noise suppression control, it is my belief that there is adequate noise suppression control in the circuit, although without any extra tube. This refers both to the six and seven-tube models.

Reference has been made to the plate current cutoff, and a statement made it is really signal current cutoff due to paralysis. Now, this is gradual. It is proportionate to the voltage put in. Therefore as the voltage increases the amplification decreases, because the bias has gone up. Point number 1 therefore is that the 55 as used here helps the blast prevention.

Now, noise suppression control. It is well known, is it not, that a tube with high grid load loses amplification as the bias approaches zero? In fact, paralysis from another cause results. Therefore at no carrier, or extremely small carrier, the condition that causes noise in other circuits, there is not enough bias on the tube to give it amplification properties, so the noise is cut off. This asset is actually present, and the fact that some small carrier voltage is bound to be present in the antenna, enough to stop grid current in the 55 triode, does not introduce enough bias or amplification to defeat the noise suppression, but does provide enough bias to stop the grid current hiss. Thus the tube cuts off its amplification in two directions—if too much voltage is put in, or too little. The first is an anti-blast auxiliary, as well as an output tube overload check, the second is a noise suppressor. These facts have never before been presented to the public.

Hence the 55 grid cannot be connected to the 57 or 58 first detector grid clip and any signal come through. In either circuit the 57 or 58 may be used as autodyne tube. The 57 is more sensitive, the 58 stands more oscillation voltage.

Oscillation Safeguards

If a grounded padding condenser hookup is used in either of the Super Diamonds, then the combination oscillator and first intermediate coil should have a total of eight leads. If the ungrounded type of padding condenser hookup is used there is need for only seven leads, provided that the biasing resistor for the autodyne tube is "lifted" to the position between cathode and the one terminal of the pickup winding, as diagramed.

The code for the ungrounded padding condenser and for the "lifted" biasing resistor is given in the accompanying discussion of the Super Diamonds. As stated, for following the diagrams as shown, a seven-lead coil fits the needs.

With the eight-lead coil both the padding condenser and the biasing resistor may be grounded directly. The performance differences are as follows:

With cathode resistor "lifted," there is no doubt about the presence of oscillation of the right intensity, and also of the correctness of 3,500 ohms as the biasing resistor.

Since the adjustment of the padding condenser, at its "hot" potential, is not very convenient, because of body capacity, when one adjusts this condenser for 600 kc, using a regular screwdriver, the adjustment is incorrect the moment the hand is taken away. The body capacity has been removed. But the intensity of the output sound, or meter reading, at correct adjustment may be duplicated by easy trial. Turn down the padding condenser a little at a time until the intensity is as strong with hand removed as it was at first when hand was present. The operation is much easier if an insulated driver is used, of the neutralizing tool type, but even this introduces a little capacity.

A TINY UNIVERSAL

4-Tube Receiver Works on A-C or D-C

By J. E. Anderson

THE new tiny universal receiver turned out to be a big thing, judging by its popularity and performance. At first, sets of this type could only be obtained ready-made, but now they have been made available in kit form, completely assembled, and any radio fan can wire his own with every assurance of success. This kit, it must be remembered, is not merely a collection of parts from which a radio receiver may be built, but it is a group of carefully coordinated receiver essentials from which a really engineered receiver can be made.

The small universal sets usually contain four tubes, a radio frequency amplifier, a detector, a power amplifier, and a rectifier. Since these tubes are required to give as much gain and volume as possible, all the tubes, except the rectifier, are of the screen grid type. Thus in the universal we are about to describe, the radio frequency amplifier is a 239, the detector is a 236, and the power tube is a 238. The rectifier is a 237 used as a diode.

Since the set must be usable on either a-c or d-c lines without alteration, all the tubes must be of the heater type, and the tubes ennumerated above are of this type.

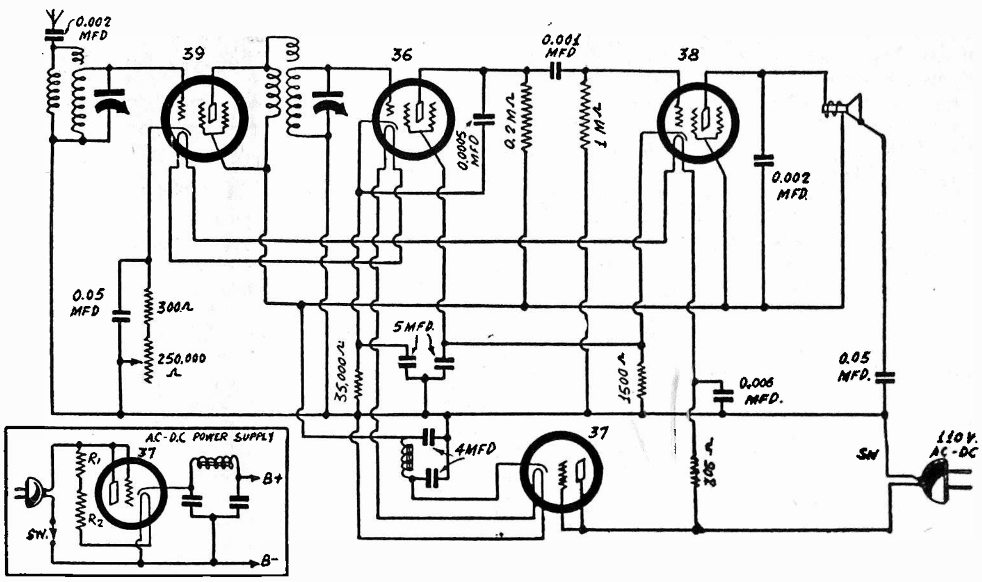


FIG. 1

This diagram reveals the electrical design of the Postal Universal receiver, a set that can be operated equally well on a-c and d-c.

Connection of Heaters

All the heaters are connected in series and a ballast resistor is used to drop the excess voltage. The heater circuit can be traced easily on the circuit diagram of the set as given in Fig. 1. A simplified drawing of the power supply, which includes the heater circuit, is given in a box in the lower left corner of the figure. At the extreme left in the insert drawing is the line plug, with the line switch in the negative lead. To the positive side is connected a resistor R1, then another resistor R2, and finally the heater winding of the rectifier.

Resistor R1 is the ballast, which in this case has a value of 305 ohms. It may be seen so marked in the full diagram. Resistor R2 represents the resistance of the heaters of the three tubes in the receiver proper. This resistance is nominally 3 x 21, or 63 ohms, for the effective resistance of each heater is 21 ohms. The value of the ballast resistance R1 is given on the supposition that the line voltage is 117 volts, which is a mean value both on a-c and d-c lines.

The Rectifier

The rectifier is also shown in the box in the lower left corner of the figure. The plate and the grid are tied together to form the anode, which is connected to the positive side of a d-c line. The cathode of the tube becomes the positive side of the line after the rectifier, and the filter choke is connected in this lead.

The rectifier is left in the circuit whether the supply voltage is alternating or unidirectional. When the supply is a-c, no polarity need be observed in respect to the plug, for no matter how it is inserted, one side of the voltage wave will be rectified. When the supply is d-c, however, polarity must be observed for the circuit will only function when the positive is connected to the grid-plate anode. No damage will occur if the plug should be inserted in the wrong way. The filaments will light but there will be no plate voltage. If no life is indicated in the set after the power has been on a couple of minutes, it should work instantly the plug is reversed, assuming that the receiver is in a working condition otherwise.

The Main Circuit

Now let us examine the main circuit. First we note that there are two high gain coils, which are essential for high sensitivity. And there are two tuned circuits, both tuned by a single knob controlling a pair of 350 mmfd. condenser.

The radio frequency amplifier is a 239 operated with an exceptionally high screen voltage. Indeed, it is the same as the voltage applied to the plate, and in this respect the 239 works in the same manner as a power pentode.

The volume is controlled in this stage by means of a variable resistor in the cathode lead. This has a maximum value of 250,000 ohms so that complete control is assured. A limiting resistor of 300 ohms is also used for bias on maximum sensitivity.

The detector is a 236, connected so as to give greatest possible detecting efficiency consistent with unimpaired tone. Grid bias detection is used, and the tube is self biased by means of a 35,000-ohm resistor in the cathode lead. The plate is fed with the highest available voltage through a coupling resistor of 0.2 megohm.

Special attention is called to the manner in which the screen voltage for this tube is obtained. As is well known, a screen grid tube operating into a high resistance should have a low screen voltage in order to give undistorted output, as well as good sensitivity. In the present circuit the screen voltage is about 13.5 volts, or the same as the grid bias on the 238 power tube. The screen is simply connected to the cathode of the power tube. Thus the one 1,500-ohm bias resistor serves two purposes, and it serves them well. Not only does it give the proper bias to the 238 but it gives the proper screen voltage to the detector tube.

By-passing

There might be some interaction between the two tubes due to the coupling effected by this bias resistor. There would be if a large by-pass condenser were not used across the resistor. In this case the condenser has the unusually large value of 5 mfd., which is high enough to eliminate interaction.

Another condenser of 5 mfd. is connected across the bias resistor for the detector. This also is much larger than condensers ordinarily used, but the large value is decidedly worth while.

There is also considerable by-passing in respect to signal currents. There is a 0.05

(*Continued on next page*)

LIST OF PARTS

Coils

One high gain antenna r-f tuning coil.
One high gain interstage r-f tuning coil.
One 30-henry choke coil.

Condensers

One gang of two 350 mmfd. tuning condensers.
One 0.001 mfd. Cosmic stopping condenser.
Two 0.002 mfd. Cosmic condensers.
One 0.0005 mfd. condenser.
One 0.0006 mfd. condenser.
Two 0.05 mfd. Cosmic condensers.
Two 4 mfd. electrolytic condensers, 200-volt rating.
Two 5 mfd. electrolytic condensers, 35-volt rating.

Resistors

One 300-ohm bias resistor.
One 35,000-ohm bias resistor.
One 200,000-ohm plate coupling resistor.
One megohm grid leak.
One 1,500-ohm bias resistor.
One 305-ohm ballast resistor, wire wound.
One 250,000-ohm volume control, with switch.

Other Requirements

One power cone speaker.
Four five-contact sockets (UY).
Three screen grid clips.
One drilled and stamped chassis, 6½ inches high, 9½ inches wide, and 4½ inches deep.
One cabinet.
One carrying case.
Weight of complete set, 6½ pounds.
One line cord and plug.
An assortment of necessary hardware.
Tubes.
One 239 super control pentode.
One 236 screen grid tube.
One 238 power pentode.
One 237.

(*Continued from preceding page*)

mfd. condenser across the bias resistance on the 239 amplifier, which is large enough to be quite effective.

In the plate circuit of the detector is a 0.0005 mfd. by-pass condenser to prevent the transmission of the carrier. The condenser is connected directly to the cathode, which is theoretically as well as practically the best connection.

High frequency noise that may reach the speaker is reduced by means of a 0.002 mfd. condenser across the speaker input terminals. This condenser also serves to cut down somewhat the high audio notes which often are too strong in a circuit employing a pentode power tube.

Signal frequencies as well as audio noise may stray into the heater circuit at one point and back into the signal circuit at another. To prevent this a 0.006 mfd. condenser is connected between ground and one terminal of the heater of the 238 pentode. Thus both ends of the heater circuit, exclusive of the ballast resistor, are at ground potential to signal frequencies. Elimination of tunable hum and other noises carried from circuit to circuit by carriers is the main object of this condenser.

There is also a 0.05 mfd. condenser between the frame of the speaker and ground, the object of which is similar to that of the condenser just mentioned.

The Filter

The filter in the B supply consists of one 30-henry choke coil and two 4 mfd. by-pass condensers. This combination assures adequate filtering both when the supply voltage is a.c. and when it is d.c. The choke is especially effective because the current drain is small and there is little saturation effect. The total plate current is less than 20 milliamperes.

The speaker employed is a small magnetic designed to work efficiently with the 238 pentode. The maximum undistorted power is close to half a watt.

A stopping condenser of 0.001 mfd. is used between the plate of the detector and the grid of the power pentode, and a grid leak of one megohm between the grid and ground.

A condenser of 0.002 mfd. is connected in the antenna lead as a precaution against possible short circuit of the line, which would occur in certain instances if the antenna wire should become grounded.

No ground is needed on the set for it is always grounded through the power line. If the d-c line used should happen to be grounded on the negative side the ground thus afforded is better than any ground that can be contrived around the house. If the line is grounded on the positive side, which is usually the case, the circuit is still grounded to signal frequencies through the capacity between the leads feeding the set and through other stray capacities. About the same situation obtains when the supply is a-c.

Electrolytic Condensers

The larger filter and by-pass condensers in the circuit are of the electrolytic type. The two 4 mfd. units are rated at 200 volts while the two 5 mfd. units are rated at only 35 volts. In each case the rating is adequate, for the voltage across either of the 5 mfd. units will not exceed 20 volts and the highest voltage across either of the 4 mfd. units will not exceed about 170 volts.

The use of low voltage rating condensers is a matter of space. A 5 mfd. unit rated at 35 volts occupies a much smaller space than a condenser of the same value rated at 200 volts. Likewise a condenser rated at 200 volts is much smaller than a similar condenser rated at 500 volts. It is only because the 5 mfd. condensers are rated at such a low voltage that it is practical to use such large values. Large values are more important than needless ability to withstand high voltages.

The circuit can also be changed to operate on a 32-volt supply. In this case the filaments should be left in series. Indeed, the only change necessary is to connect an external booster voltage to make the total

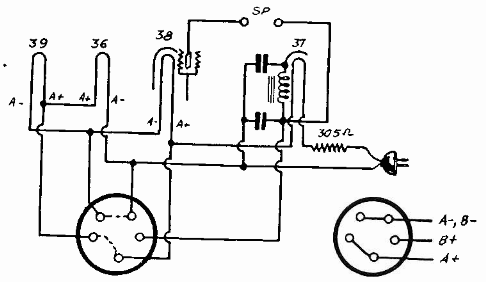


FIG. 2

This skeleton diagram of the heater circuit shows how the various heaters are connected to the battery plug for converting the circuit from series to parallel.

117 volts, approximately. This arrangement would be rather expensive, and another modification is preferable. Change the 305-ohm ballast resistor to 30 ohms, and instead of connecting it to the plate of the rectifier tube connect it directly to the positive of the 32-volt battery. This is a more economical arrangement. The plate booster voltage should be connected between the plate of the rectifier and the positive lead in the plug, with the positive terminal going to the plate of the tube. The added voltage should be about 90 volts, although 135 volts would be safe.

If the line voltage is 220 volts, a.c. or d.c., the circuit should be left as it is except that an external ballast resistor should be inserted to drop the voltage from 220 to 110 volts. The needed additional ballast is 360 ohms. It should be wire wound.

The Postal universal midget can be adapted to fit special requirements very easily. Thus it may be changed so that it can be used on a six-volt storage battery. The heaters have been arranged so that the conversion may be made by simply inserting a plug into a socket provided for it, this plug being the terminals of the storage and B batteries, or B battery substitute. Fig. 2 shows a skeleton circuit diagram of the heater circuit and the necessary connections to the socket into which the battery plug is inserted. The dotted lines represent short circuit straps contained in the plug. The wiring of the plug is also shown, and in this the short circuiting straps are shown in continuous lines.

Tracing the circuit after the plug has been inserted into the socket it becomes clear that all the heaters are in parallel, with the exception of that of the rectifier, which is left out of the circuit since it is not needed. The arrangement is extremely simple, yet fully effective. The plug may be used as the filament switch.

In view of the universality of the receiver, it is suitable for use in boats, automobiles, aeroplanes, camps, offices and hotels. When intended for use in an automobile a remote control cable should be employed. This is available and applicable.

As was stated, no ground is necessary with the receiver. Neither is an external antenna, for the set is supplied with an in-built pick-up system.

Levitow Appointed WINS Music Director

Bernhard Levitow, orchestra leader and director of the Levitow Symphonic Ensemble featured for years on the WJZ chain, is the new musical director of WINS, New York City. He succeeds Gregoire Franzell, resigned.

Levitow's talent for conducting orchestras was given recognition by Morris Gest when the Century Theatre was opened twenty years ago. He later accepted the musical directorship of the Bowman Hotel System. While associated with WINS he will continue as supervisory head of the hotel orchestras but will not wield the baton except in the WINS studios.

RADIO UNIVERSITY

Best Oscillator

IN THE January 28th issue you had a discussion of stabilized oscillators. Which of the many discussed is the best for a superheterodyne in which the frequency is to be variable? You do not show one that appears to be practical.—W. T. H., Toledo, Ohio.

The oscillators described are primarily for fixed frequency oscillation. The only one that could be used in a variable frequency circuit and retain the frequency stabilization is the symmetrical Colpitts oscillator but even this is not especially practical because two equal tuning condensers are necessary and each would have to be twice the value of the required effective capacity in the tuned circuit. Thus if the effective capacity is to be 350 mmfd. each would have to be 700 mmfd. and the total capacity 1,400 mmfd. It is not necessary to effect a high degree of stability in a superheterodyne oscillator and any of the variable oscillators ordinarily shown is all right. It may be tuned plate, tuned grid, or Hartley. To minimize frequency variation in one of these unstabilized oscillators, the resistance in the tuned circuit should be low. That is the most important condition.

* * *

Transformer Coupling on Diode

WOULD you recommend the use of an audio transformer after the 55 diode rectifier to get a greater output or do you think that resistance coupling is preferable? Please give reasons for your choice.—J. C. S., Butte, Mont.

If the triode of the 55 is not diode biased it is all right to use a transformer after it for then the plate current is limited at all times by the fixed bias on the grid, even if this bias is obtained from a resistor in the cathode lead. But if the triode grid is diode biased it is preferable to use a resistance load for otherwise the plate current will be excessive when no signal is coming through. When no signal is coming through the bias on the grid is zero and the plate current would be dangerously heavy unless there were a resistance in the plate circuit to limit it.

* * *

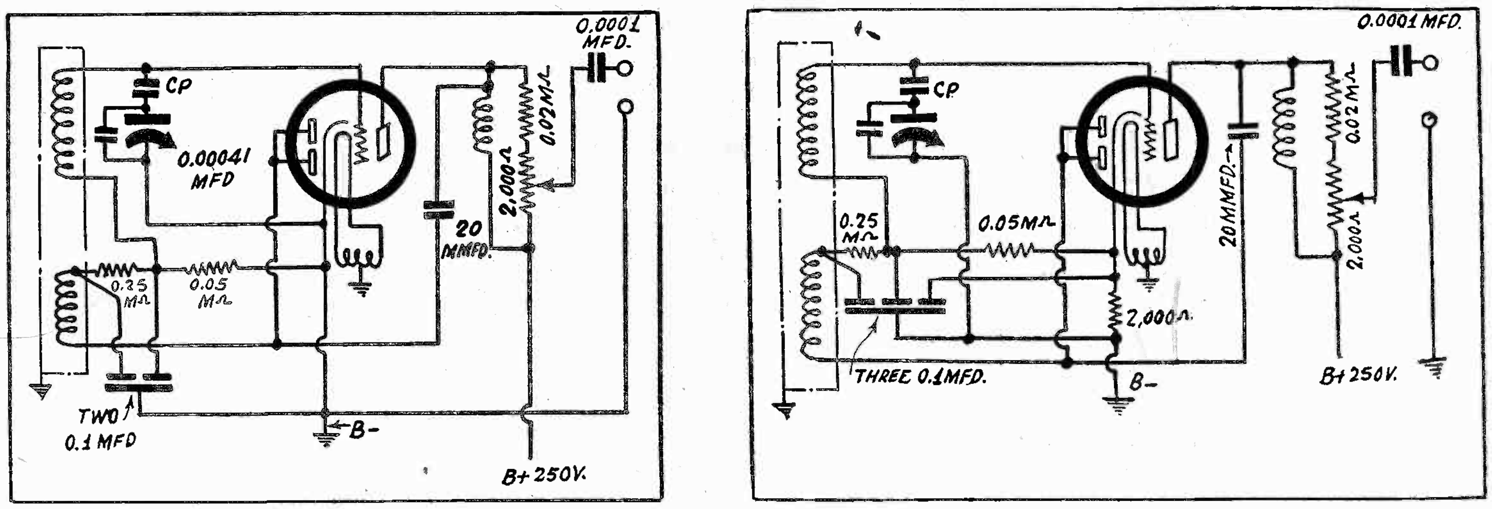
Unavoidable Noise

SINCE sensitive receivers have come into wide use, noise has been one of the limitations on sensitivity. Just how much noise is there in receivers, measured in terms of microvolts? What is the main cause of this noise?—R. W. C., Stamford, Conn.

Most of the noise in receivers is due to gas in the tube. If the vacuum is increased a great deal of the noise is eliminated. However, there is a certain noise, that due to irregular emission and called the "shot effect" that is not due to gas. Hence even if the vacuum is made perfect there would still be a limitation on the possible gain. The "shot effect" noise is about equal to one microvolt, or it may go as low as one quarter microvolt. One microvolt is about the limit of possible sensitivity. Special tubes have been made in which the total noise was of the order of one quarter microvolt. Tubes now made for reception seem to have a great deal of gas noise. Perhaps the next advance in radio tubes will be the development of special gas-free tubes to be used in the first and second stages of the radio frequency amplifier. The tube noise is amplified and it seems that if it could be minimized in the first tubes that the sensitivity could be made much greater. Of course, even now many sets are sensitive to better than one microvolt, but such great sensitivity is not useful for the noise is usually as strong as the signal.

A NEW OSCILLATOR

Practical Circuit with Stability of Both Frequency and Amplitude



At left, an exclusively diode-biased oscillator, which gives good results except that under certain conditions grid current is possible. At right, the same general oscillator, with self-bias through a cathode resistor, plus diode-bias additionally obtained. The frequency stability of this one is extraordinary.

THE 55 tube lends itself to operation of its triode unit as an oscillator, for it resembles the 112A in many respects, and then the diode unit may be used for rectification of the oscillation. If the rectified voltage is used for negative bias, a condition of relatively constant output will obtain.

The circuit may be arranged formally with a coil consisting of three separate windings: one for grid tuning, another for feeding the rectifier and the third for feedback. However, since many purposes to which oscillators are put require switching for different wave bands, it was considered advisable to find some circuit that would give the desired results with two windings, reducing from six to four the number of terminals to be switched. The circuit devised is shown in Fig. 1.

Low Resistance in Grid Return

The triode is a tuned grid oscillator with parallel plate feed. The grid, instead of being returned to the full rectified voltage (left-hand end of the tapped resistor network), is returned considerably to the right, because the resultant rectified voltage is much higher than the desired grid voltage. Moreover, the lower the resistance value between grid return and B minus, the less likelihood of a high resistance introducing an ineradicable audio tone. Such a tone not only makes it impossible to establish zero beats with carriers but from a practical viewpoint renders the oscillator virtually useless, although oscillating.

The plate voltage is fed to the plate through radio frequency choke coil of 10 millihenries inductance, and this elevates the plate to a high r-f potential and enables the use of the feedback condenser, of 0.00002 mfd., to joined anodes of the rectifier unit. Since this condition will provide regeneration at all frequencies used, the feedback coil itself must be switched or changed, but the connection to anodes need not be.

The feedback is communicated to the grid winding inductively, through the closely coupled feedback winding which is also the rectifier input winding, for the oscillation voltage (radio frequency) is fed to the anodes, and there is a continuous d-c circuit: anode to one terminal of coil, to other terminal of same coil to resistor to cathode.

The Plate Impedance

Thus as the oscillation intensity builds up, the negative bias increases, and as the rectifier is of the linear type, this increase is linear. The heightened bias in turn reduces the intensity of the oscillation, and therefore the oscillator is operated in a state of dynamic equilibrium. The plate impedance remains not quite the same throughout. As changing plate impedance is a principal cause of frequency shift, the frequency stability is of a good order. Likewise the amplitude level is practically flat, and the greater the amount of the total rectifier load resistance in the biasing circuit, the more nearly even is the amplitude. However, it is not readily practical to maintain a high resistance between tap and cathode for the biasing circuit of the rectifier, because the bias easily is too high, and instead should not be more than 20 volts negative. Or, to attain the same end, the d-c plate current may be adjusted to 8 to 10 milliamperes, with the rectifier load resistor a 250,000-ohm potentiometer, and the connection shown as a tap being the slider.

The circuit was built, using a B supply for the plate voltage, operating from the a-c main, with a center-tapped 2.5-volt winding for the heater on the same core, the heater winding center-tapped, center to grounded cathode (B minus).

High Currents and Voltages

At once it was discovered that the circuit not only may oscillate violently, but that the voltage across the rectifier load resistor, if that resistance is of the order of 1 meg., may rise to almost incredible heights. The first measurement showed that, although the applied plate voltage was 250 volts, the rectified voltage was more than 350 volts. This is another point against using the total voltage (all of the resistance between feedback winding and cathode) for biasing the triode.

Not only may the rectified voltage run exceedingly high, but under another condition the d-c plate current itself may reach tremendous values. The switch in the a-c line was turned on, with a 0-100 milliammeter in series with the plate coil (800 turns) and with the potentiometer arm obviously at some trivially low value of biasing voltage, the current rather rapidly built up to an off-scale value. The switch was quickly turned off, and the arm of the potentiometer moved to a higher resistance value. So, in making the bias test, it must be done quickly, so that the heavy current that may flow will not be of more than momentary duration. The adjustment to 10 ma plate current may be made in a few seconds, using a 0-100 milliammeter, since steps of 5 milliamperes are registered on the scale.

Effective Impedance

At the same time that the plate current was read the biasing voltage was read with a 2,000-ohms-per-volt voltmeter across the biasing section (arm to cathode).

At 10 milliamperes plate current the biasing voltage read 17 volts, but as the voltmeter reduced the voltage a little from what it would be under operating conditions, with the voltmeter out the bias went up a bit, so that 8.5 milliamperes flowed, as measured on a 0-10 milliammeter. So the adjustment to just under 10 milliamperes on the less sensitive meter is equivalent to about 20 volts actual negative bias. Thus the plate resistance is about 30,000 ohms (d-c), and on the halving principle, the a-c resistance would be 15,000 ohms. The 800-turn load reduces this impedance a little, while

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the 20,000-ohm load in parallel brings the effective impedance, with load considered, to around 7,500 ohms. The potentiometer below the 20,000-ohm load is of low resistance, and is used as an attenuator in a manner that is not frequency-discriminating, despite the loads affixed to the output. There is enough oscillation voltage so that only a small percentage need be taken off for actual use, and if the potentiometer is 2,000 ohms the frequency stability is maintained at any and all settings of the attenuator.

The tuning coil used was of the commercial type, wound on 1-inch diameter tubing, having a secondary of 127 turns of No. 32 enamel wire, and wound over it a primary of 30 turns of No. 40 single silk wire, with insulating fabric between. Thus there was close coupling, and this type of coupling is an aid to frequency stability. The coil was enclosed in an aluminum shield, 2 1/16 inches outside diameter, 2½ inches high, shield grounded. The tuning condenser was 0.00041 mfd. Across it was a 30 mmfd. compensator (used at less than full capacity).

Padding Condenser

In series with the tuning condenser is shown a padding condenser. This really consisted of two condensers, in parallel: one of a fixed capacity of 0.0001 mfd. (1,000 mmfd.) and the other a padding type of adjustable condenser as used in modern superheterodynes, 850 to 1,350 mmfd. (0.00085 to 0.00135 mfd.). Thus when a little more than 2,000 mfd. capacity was in series with 0.00041 mfd. tuning capacity, the maximum capacity setting of the tuning condenser was effectively 0.00035 mfd. This padding system need not be included unless one desires to duplicate an existing model later on, using the same calibration for the capacity may be adjusted at the high frequency end by the compensator and at the low frequency end by the padding condenser, to insure conformity to a frequency-calibrated dial scale.

Just shielding the tuning coil will not prevent radiation, and if there is coupling with the tested circuit by radiation alone there would be no way of using an attenuator without altering the tube characteristic, hence frequency, by attenuator adjustment. Therefore the entire oscillator system should be enclosed in a shield box, preferably iron or steel, with several inches distance between the coil shield and the total box shield in any and all directions, box grounded. The tube should be inside.

Accurate to 0.1 Per Cent.

The circuit will establish a clean zero beat with carriers and will test out excellently as to its frequency stability. If a station of recognized standing is tuned in, and a zero or near zero beat as established between oscillator and station carrier (using a broadcast receiver as adjunct); the audio tone heard, as a result of the beat, will not vary more than 1,000 cycles out of 1,000,000 cycles carrier, or one-tenth of one per cent., which is a far greater degree of accuracy than normally obtained from variably tuned oscillators, greater than the accuracy to which not only calibrated dials but virtually all charts used can be read. This accuracy is not quite maintained throughout the dial spread of frequencies.

Infinite Impedance Grid

The asset of frequency stability consists of obtaining the same frequency of generation at the same dial setting time and again, with virtually unchanged frequency during tests also, regardless of loads on the output (connections of tested circuit to the test oscillator). Also, the frequency remains the same although the applied voltage may change somewhat, as it will do, both in the plate and heater circuits. And by the present method the bias voltage remains about the same, too, so there is safeguarding in all three directions.

With the plate impedance held relatively constant, to acknowledge this condition requires that plate impedance change be taken up by any corresponding change in the same direction in the grid circuit. Perhaps this is not actually what takes place, but with the high negative bias and highly selective grid circuit, with no grid current ever flowing of course, the grid impedance may be assumed to be infinite, which makes the small changes in plate impedance relate to an infinite constant, the grid impedance.

There is no doubt a grid circuit loophole in the theory somewhere, but there is no doubt as to the practical results.

Why Bias Is Negative

The reduction of the theory to practice requires certainly that the rectifier load be high, and 250,000 ohms will satisfy this necessity. But then the bias would be too high normally. If the total load is to be used as negative bias supply (grid returned to left-hand extreme), then some solution would have to be provided for the audio tone due to a high d-c resistance in the grid circuit (present no matter if the bypass capacity is 8 mfd.), and likewise the coupling would have to be reduced. The feedback may be made smaller by using a smaller capacity feedback condenser, or a resistor in series with that condenser, or by using a lower plate voltage.

In any event, the bias would have to be negative to an amount determined by the plate voltage applied, and the bias adjustment made according to this requirement.

The bias is negative in all instances, because cathode is returned to ground, and this is the positive leg of the rectifier, so any and all points to the left of cathode on the load resistor must be negative. This is confirmed by the plate current readings, too, for as the arm is moved toward ground the plate current rises. How tremendously it rises has been stated.

Too High Bias

Now, if the bias is made altogether too high, that is, substantially more than 20 volts, reducing the plate current to less than 7 milliamperes, with 250 plate volts applied, then the tube motorboats, and the frequency of the motorboating affects the cathode emission sufficiently to make the cathode illumination keep pace with the frequency. The cathode gets brighter and dimmer at a frequency equal to that of the motorboating. If the motorboating is made very high in frequency, still in the audio realm, of course, the eye could not follow these changes, but the cathode would not be too sluggish to respond at these frequencies.

Since this motorboating is an interrupted audio tone it may be used as modulation, but the condition itself is an abuse of the circuit as well as of the tube, and modulation, if desired, should be supplied some other way. The modulation percentage may be as high as the limits ordinarily used, without affecting the frequency, because the operating point of the tube on its characteristic is not shifted. That is, the tube is a modulator as well as an oscillator, and will react to modulation linearly. Modulation distortion and frequency distortion therefore are jointly removed.

The a-c hum may be used for modulation by connecting rectifier return to one side of the heater winding, or, by switching from B minus to one heater side unmodulated-modulated service is afforded.

No Current Changes Noted

While a difference of 1,000 cycles out of 1,000,000 was noted in the oscillator just discussed, this may have been due to grid current. When any oscillator is totally diode-biased there may be a danger of grid current, not necessarily at all dial settings, but at least at some. This may be due to the mutual impedance of feedback and grid coils being such that at these frequencies circuit is sent skylarking.

However, if self-bias is derived from a cathode-leg resistor, and diode bias obtained additionally, then the frequency and amplitude stability rise to an exceedingly high mark. In fact, the stability was so high that when tests were made of the oscillator with instruments at hand, they did not record any change. For instance, a 0-0.5 milliammeter in the rectifier load leg (between the 0.05 meg. resistor and cathode in diagram at right) and a 0-10 milliammeter in the plate circuit, no change in current was noted when the oscillator was tuned from 1530 to 530 kc, which was its total frequency range. This indicates a high order of stability indeed. The values were 11 ma plate current, 17 microamperes rectifier current. Thus the rectified voltage is only about 5 volts.

The Ear Test

Another test was made. WJZ was tuned in (760 kc) during one of its first nights of 50 kw testing. This station maintains an extraordinarily high frequency stability anyway, but it was assumed that on these first nights of 50 kw it would be even more careful than otherwise, especially as Federal eyes and ears would be attentive to the experiment. So the test oscillator was tuned to zero beat with 760 kc, using a broadcast receiver as adjunct, and the beat was actually zero, or at least the frequency difference, if any, was below audibility, for the oscillation did not produce any recognizable sound nor did it interfere in any way with the program. Then the oscillator was left thus for forty-five minutes, and at no time did the beat become audible, so that either the oscillator was approximately as steady in frequency as the station's wave (which was accurate to better than 66 parts in a million, or 66/1000 of 1 per cent.), or, if there was any greater change, both test oscillator and station wave changed exactly the same amount in the same direction, a great unlikelihood. It was the most stable test oscillator with which the author ever had any experience.

The stability is not present until the extra bias provided by the rectifier is low enough, for as the plate current is reduced to say 5 milliamperes and thus approaches cutoff, the instability becomes great enough to make the needles of the two meters oscillate. So the resistor, marked 0.05 meg., if it produces this result (which may be read on an ordinary 0-10 plate milliammeter), should be reduced in value until the trouble disappears.

Grid Leak

When tests were made for grid current it was found that at no setting of the dial was there any trace of such, and this in part accounts for the stability, for while a grid leak will act as a stabilizing agency in an oscillator, even a self-biased one using the cathode-leg circuit, the leak tends to level the operating condition only when there is grid current, for only this current produces an effect from the leak as bias control. The leak method is good for the low radio frequencies of a given span, but at the high radio frequencies, when the oscillation intensity is less (due to the relatively increased effect of the circuit r-f resistance) the plate current increases rapidly, hence the plate impedance has been changed a great deal. Since the flow of grid current is like that of the rectified current

(*Continued on next page*)

A New Battery-Operated TEST OSCILLATOR

By C. L. Morehouse

STABILITY

(*Continued from preceding page*)

in the diode-biased circuits, it is obvious that at low oscillation intensities there is less grid current, hence less counter-effect by the leak. That is, the leak method is unstable at the higher frequencies because the leak, due to too small grid current, does not contribute enough negative bias.

While it would seem that the oscillation intensity must be greatest when the plate current is highest by the leak method, such is not the fact, as can be proved by measuring the output r-f voltage at the high frequencies, when plate current is highest. The output is much less than at the low frequencies when the plate current is only one-sixteenth as great. The variation in a given case was from 0.5 ma to 8 ma plate current.

Oscillators Important

Oscillators today are in about the state that automatic volume controls were two years ago, and no doubt due to the interest in oscillation, and recognition of the importance of frequency, amplitude and modulation stability, there will be considerable progress in early months. Some of the outstanding radio engineers are giving their attention to oscillators, and various methods of stabilizing the frequency function have been developed already. There is much antagonistic theory, but the leading workers are getting results, and theory conflict may be ascribed to a lack of sufficient particular knowledge about oscillators. The subject has not been delved into nearly enough, so while engineers develop frequency-stabilized circuits of great importance, some of them may be quite wrong in their theory, and will have to join with the rest in making a study to ascribe the correct cause to the experimentally verified result.

The stabilized circuit shown at right (page 17) is perhaps in the class of the experimentally verified, with inadequate theoretical explanation. It is better to admit the inadequacy of the theory than to present a theory that glosses over the tough spots.

Quick Work

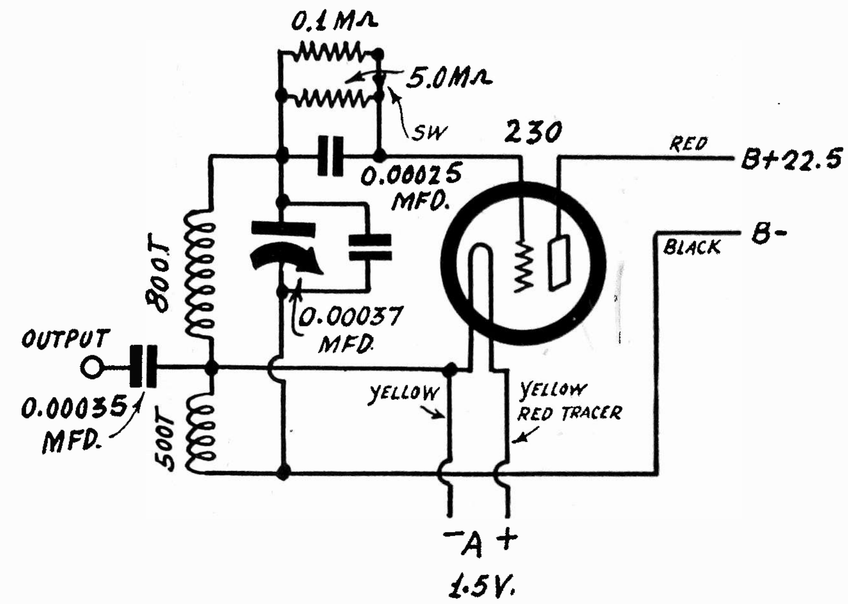
It is recognized that a constant impedance plate circuit is important to frequency stability, and yet the contribution of the diode bias to the circuit is small, compared to the self-bias from the cathode-leg resistor. And, again, when the bias is too great (whether obtained through diode or self-bias) the instability becomes serious. The information for adjusting to a condition of equilibrium has been given, and it is recognized that the diode bias, though small, is important. Or perhaps it is larger than assumed, since it is governed by the incipient oscillation amplitudes, and variations in plate impedance are prevented because the bias rises to meet the oscillation amplitude, and thus establish zero difference in actual bias. The signal or oscillation itself tends to drive the grid positive, but the voltage across the rectifier load resistance is then increased and the negative bias rises. Since there is no change in plate current over the dial span the actual bias does not change. The fact that the rectified current does not change, either, would be due to the instantaneous character of the action, for the stabilization may be effected during a single cycle, that is, in 1/530,000 of a second, at one extreme, or 1/1,530,000 of a second at the other extreme.

Where the Frequency Shifts

The importance of frequency stability will be recognized by all who have studied the subject. Those whose work has been mainly experimental, and who have tried short-wave superheterodynes, particularly at high frequencies, or ultra frequencies, must know that oscillator wobbulation may be considerable. Indeed, the signal may be tuned out by the wobbulation, without any one molesting the oscillator dial. Change in intermediate frequency due to change in condenser capacity due to moisture, temperature, strain etc., would not account for it, since the intermediate frequency is low compared to the signal, and the signal would not be tuned out unless the intermediate frequency changed vastly. Yet a slight change in the oscillator would cause the trouble.

The diagram at right is recommended as one highly suitable for the ultra frequencies, and may be used also in broadcast superheterodynes or for test oscillators of a high order of merit.

So far truly stabilized oscillators have not been used in broadcast superheterodynes, nor even in short-wave superheterodynes, but circuits with such stability may be expected soon.



A battery-type oscillator, that works well with only 22.5 volts on the plate and 1.5 volts on the filament. A special circuit is used, one developed by Edward M. Shiepe (Massachusetts Institute of Technology). Modulated or unmodulated service may be enjoyed.

MANY service men work in localities where some customers' homes are not wired for electricity, others have have a-c, still others d-c, hence the service man needs a battery type oscillator to be useful no matter what the customer's circumstance. Such an oscillator is shown in Fig. 1, and while it resembles a battery-type oscillator previously discussed in these columns, it has some new features. One of these is that a single 1.5-volt dry cell will serve as filament supply of the 230 tube, while 22.5 volts will be sufficient for plate supply.

This oscillator produces oscillations from 50 to 150 kc. That is the fundamental range. Some intermediate frequencies are within this span. Other intermediate frequencies are in the second harmonic span, 100 to 300 kc, or, rather, in the 150-300 kc portion thereof, as the frequencies lower than 150 kc are better taken from the fundamental. The third harmonic will yield 150 to 450 kc, which virtually completes the intermediate frequencies. The broadcast band is taken care of by the tenth harmonics (500 to 1,500 kc).

If a coil having an inductance of 20 millihenries (preferably a small honeycomb r-f choke type, about 1 inch outside diameter), is tuned with a variable condenser of 0.00037 mfd., with a 30 mmfd. compensator across the tuning condenser, the aforementioned fundamental band will be covered, and since there exists commercially a special dial for this span, with fundamentals imprinted on one line and all commercial intermediate frequencies not in the fundamental range on the next line, if the circuit is built as prescribed the set-up will be pre-calibrated. The only adjustment possibly necessary will be at the

(*Continued on next page*)

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high frequency end, when the compensator is set so that a beat is established at the proper dial setting (as read on the dial) with a station of known frequency being received on a broadcast set. Take 1,400 kc, for instance. Suppose a station of that frequency can be received well. Without connecting the oscillator mechanically to the set, but merely relying on radiation, the compensator should be adjusted so that the reading is 140. The tenth harmonic is being used, so 140 represents 1,400 kc. The rest of the dial will be found to come out well. The accuracy is not perfect, but the error at no time should exceed 2 per cent., and the average accuracy of reading should be 1 per cent., so that at many frequencies (particularly between 600 and 800 kc) the reading will be on the dot.

The Tuning Coil

The battery-model oscillator should be built so that the pair of A battery leads comes out at one side and the pair of B battery leads comes out at the other side. That is, these pairs should be kept apart, to avoid capacity coupling, as the two circuits actually are included in the tuning arrangement, which is one of the special features previously hinted at.

The tuning coil consists of 1,300 turns, (two extreme lugs) with a tap at 500 turns. It will be found in the commercial honeycomb coils specially made for this purpose that the external lead of the winding has a short transparent piece of adhesive binding it to the form, and this lead is brought to one extreme lug at the factory. This is the grid connection. The other connections are self-explanatory, when one sees the coil, since the central lug represents the tap and obviously goes to A minus, while the other extreme goes to B minus. In this way the plate current is sent through the 500 turns, and since the two windings are closely coupled (considering the tapped single windings as two) the feedback is intense. That is why for broadcast frequencies, in conjunction with a receiver, be it sensitive or insensitive, no coupling to the set from the oscillator is necessary, except that arising from radiation. The oscillator may be at a distance of up to 40 feet from the receiver, and still radiation will provide abundant coupling.

Modulated-Unmodulated Service

Now, the oscillator in general would simply oscillate, and there would be no modulation, which would be fine if one desired merely to beat with station frequencies, but when lining up an intermediate channel tube hiss and extraneous noises like that faint characteristic will hardly do, and modulation is preferable.

While this circuit is in general the counterpart of the popular a-c model constantly-modulated oscillator, it is different in this essential particular: a switch is included so that one may have modulated or unmodulated service. The reason is that to provide modulation on the basis of grid blocking (so-called, although nobody has satisfactorily explained what the action really is) a high value of leak is required, say 5 to 7 meg. But when modulation is thus present it is difficult to obtain zero beat, although zero beat is a valuable feature. In the a-c model zero beat is infallible, for the line frequency is used for modulation, with a-c on the plate. And in the battery model the same infallibility arises if the leak value is reduced to around 0.1 meg., for then modulation disappears and beats may be struck with carriers.

The switch will be at left, on the top panel of the battery model, while the output post will be at right. The only other panel device will be the tuning knob-escutcheon. The top may be completely removed by taking out the four corner screws, as a subpanel is attached to the assembly, the condenser is a part of that assembly, and as condenser is affixed to the top panel, so there is virtually a single-unit of construction. This removal is necessary to insert the 230 tube.

The output is taken from the tap through a condenser, the value of which is not critical, but which may be 0.00035 mfd.

No. A switch is shown, so it is necessary to connect the batteries as diagrammed, for operation, and inoperation the A minus lead should be disconnected from the cell.

LIST OF PARTS

Coils

One 20 millihenry tapped r-f choke coil.
Condensers.
One 0.00037 mfd. tuning condenser, 3/8-inch shaft 1 1/8 inches long; 30 mmfd. compensator built in.
One 0.00025 mfd. grid condenser with clips.
One 0.00035 mfd. fixed condenser.

Resistors

One 0.1 meg. pigtail resistor.
One 5 to 7 meg. tubular resistor.

Other Requirements

One UX tube socket.
One frequency-calibrated dial, 50 to 150 kc, with intermediate frequencies imprinted on upper tier; 3/8-inch diameter hub; escutcheon.
One cabinet, with top panel and subpanel; top panel cut out for escutcheon.
One battery switch.
One output binding post.
Two pair of outleads 6 inches long; one pair yellow, and yellow with red tracer, for fi A supply; other pair, red and black, for the B battery connections.
One 230 tube.
Hardware.

Operating Instructions

The operating instructions follow:

(1)—Complete the battery circuit.

(2)—Open the switch if modulation is desired, close it if no modulation is desired.

(3)—To line up or otherwise test a set at broadcast frequencies, simply set the oscillator working, and turn the dial knob until one-tenth the desired frequency is read, e. g., for 800 kc turn to 80, for 600 kc to 60 etc. No connection is necessary between test oscillator and broadcast set except that arising from radiation.

(4)—To adjust the intermediate channel of a superheterodyne, run a wire from the output post of the test oscillator to the plate prong of the first detector, with detector in place, if access below the chassis is handy, or, if not handy, remove the first detector tube, and metallically connect extreme of output wire to the plate spring of the socket. Set the switch for modulation, set the dial for the desired frequency, and adjust the condensers on the intermediate coils until the loudest response is heard in the speaker.

If a receiver has two or more intermediate stages (three or more i-f coils), it may be difficult to achieve resonance this way, because of various frequencies to which different coils are adjusted, so if the note does not come through, connect output lead to the grid of the tube ahead of the second detector, adjust the coil feeding the second detector, move output lead to next preceding grid, adjust next preceding coil, until the first detector is reached, when put test oscillator output lead at plate of the first detector, as previously stated, and readjust all the intermediates, starting with the first, one at a time, leaving the test oscillator with its output lead at its original first detector-plate position.

Some Frequencies Discussed

Since the fundamental frequencies are low, if the test oscillator is set at 76, for instance, it will strike a beat with or send forth a modulated wave at 760 kc, in broadcast band work. Also, if the test oscillator is not disturbed, but the set dial is turned, there will be beats at higher frequency points on the receiver. These would be due to higher order of harmonics. The table below helps clear this up:

Oscillator at	*Harmonic of Oscillator*	*Frequency Response in Set*
76	10th	760
76	11th	836
76	12th	912
76	13th	988

That is, the steps are in frequencies equal to the dial setting indicated on the test oscillator (76 added in each instance).

Likewise if the receiver is a set at any one frequency you can get signals from the oscillator at several of the oscillator's settings, the higher the set frequency the more numerous the oscillator signals. This is because lower harmonics of higher oscillator frequencies will best beat with the same station frequency. Take 760 kc:

Oscillator at	*Harmonic of Oscillator*	*Beats with*
76	10th	760
84.44	9th	760
95	8th	760
108.57	7th	760
126.6	6th	760
152	5th	760

In the first instance the test oscillator frequency was not changed while the receiver frequencies were changed, and in the second instance the test oscillator frequencies were changed while the receiver frequency remained unchanged.

This explanation is given so that those not familiar with harmonic oscillators will not think something is wrong when these conditions manifest themselves. There is no need to pay any particular attention to them, for if you want 760 kc, turn the oscillator dial to 76. You will not be so far off in your estimate of where 76 comes in on the set (for you have station tuning to guide you) that you will adjust for 836 kc by mistake.

The dial readings are self-explanatory, except that just to the left of where 175 kc is recorded is a bar. This bar represents 177.5 kc. Just to the right of 175 kc is another bar. This represents 172.5 kc. All the other intermediate frequencies are marked separately, on the upper tier, unless they fall in the fundamental range, when they are read directly on the lower tier.

Herman Bernard.

Caldwell Demonstrates

How many may enjoy sweet music or exciting detective stories while under the surgeon's knife on the operating table, so that attention is distracted from the surgeons' conversation or the pain of the operation itself, was demonstrated over WABC and the Columbia Network by Orestes H. Caldwell, former Federal Radio Commissioner, and now editor of "Electronics." He spoke in the first of a series on "How to Get Better Radio Reception," given under the auspices of the Electrical Association of New York. Installed in the studio was the new "music therapy" equipment developed by the American Telephone and Telegraph Company, which permits the patient to hear sedative music or absorbing adventure tales, while the surgeons work, although no sound is heard in the operating room to interfere with the surgeons themselves.

STATION SPARKS

By Alice Remsen

The Great North Road

(For Tom Terris' "Vagabond Adventures")

WEAF and network; Sundays, 12:15 p. m.

**Oh, the Great North Road is a lovely road,
For it takes me to the sea;
And the sea is in my thoughts all day,
For it's there I long to be,
With the rolling tide an' the salty spray,
An' the smell o' the ocean wrack—
Oh, my heart is sad since I left my love,
An' she's hungry to take me back.**

**An' I wander down by the Great North Road,
An' I watch the ships come in—
Some with a cargo o' silk an' tea,
An' some with a load o' tin;
An' I stand an' watch as the sun goes down
Right over the edge o' the world—
An' I stand an' look at the ships which ride
At anchor with sails all furled.**

**Like painted ships on a painted sea
In the flush of a sunset glow—
Oh, my feet just ache for a deck to tread,
An' my heart just breaks to go;
But the only ship I ride today
Is the one in my thoughts an' dreams;
An' the only cargo it carries aboard
Is the cargo o' wishes an' schemes.**

**Oh, the Great North Road is a lonely road,
When I'm runnin' away from the sea;
An' its stone an' gravel irk my feet,
An' its silence is wearyin' me;
For I've turned my back on my early love,
An' I cover my face as I flee;
I harden my heart an' refuse to hear
The siren call o' the sea.**

A. R.

* * *

AND IF YOU LISTEN IN TO TOM TERRIS as he tells his vagabond adventures you'll experience a nostalgic desire to hike forth on a great adventure at once—hop a train, a plane or a ship and just go somewhere. Listen to Mr. Terris; you'll like him.

* * *

The Radio Rialto

The rialto of radio covers a multitude of places; space is nothing, for, with a little twist of the dial, the radio listener is transported from Coast to Coast; New York programs emanate from Chicago, San Francisco or Cincinnati studios, and radio stars are like old friends to the folk in far-flung, out-of-the-way places—in tiny villages, scattered farms, small towns and large cities; and radio artists themselves come from so many different places; from every state in the Union, from the tiniest of towns to the largest of cities, and these people enter your homes and your hearts. For instance, there's Joan Kay, NBC dramatic star, whose voice you have heard on such programs as Thurston, the Magician; Dr. Bundesen's Adventures in Health and Orphan Annie. . . . Miss Kay comes from a little town in Michigan, and does her work in the Chicago NBC studios, but she is heard all over the map—strange, isn't it? . . .

Then there is Lawrence Tibbet; people in New York pay fabulous sums to hear him and see him in person at the Metropolitan Opera House, but radio brings him right into your home, just with a twist of the magic dial. . . . Every locality has its local radio favorites, and sometimes these local stars become nationwide favorites. . . . Just to mention a few stars who won fame in the Middle West at WLW, Cincinnati: Singin' Sam, Gene and Glenn, Little Jack Little, Ramona, Mary Steele, Jane Froman, and the Mills Brothers; of course, you know them all, because they have entered your home many times. . . . These radio artists all graduated to stardom, through the cooperation of their friends along the radio rialto of America. . . .

Ed Wynn has an explanation as to why he writes his own scripts, even at the expense of working until five or six in the morning several times a week. To quote Mr. Wynn: "There are jokes and jokes, but in my broadcasts I doubt if I really tell more than two or three real jokes or gags. The rest is made up of lines, and the success of those lines depends not so must as on how they read as on how I say them. I write my own stuff because I feel that no one else can write it. I wish someone else could do it for me. I've tried more than a hundred gag writers. Every mail brings sample continuities and on paper they look fine; but, here's the difference: my stuff looks terrible on paper, and it might sound terrible if someone else spoke it, but it is written for me and my way of saying it, and so, it goes over. The others often write wonderful stuff, but it's stuff to be read; my lines are for Ed Wynn to speak, and no one else seems to have acquired that idea yet. I only wish they would, and save me a lot of time and trouble." . . . and Mr. Wynn is right; some of his gags are as old as the hills; the continuity is nitwitty; but when he puts it over in his own inimitable style—well, he makes me laugh, and I'm a hard audience. . . .

The Big Ben Dream Dramas have returned to the air over an NBC-WEAF network; Joseph Bell and Georgia Backus are in the leading roles; Sunday evenings, 5:15 p. m. . . . Carveth Wells, the noted writer and explorer, may now be heard over an NBC-WEAF network on Wednesdays at 10:30 p. m., under the sponsorship of the Continental Oil Company. . . . Frank Luther, NBC tenor, has rejoined Carson Robison. They may be heard together on the Barbasol Buckaroos program each Wednesday and Thursday over an NBC-WJZ network, at 7:15 p. m. Luther and Robison were partners for more than three years, and helped to bring the folk tunes of America out of the backwoods and on to the concert platform; both men were born in Kansas; Luther herded cattle and Robison worked on the railroads and in the oil fields of the Southwest. . . .

I told you last week that I was going to meet Gene and Glenn; well, I've met them, and can honestly say the week they spent in Cincinnati will be one of the high spots of my life; they are two of the sweetest characters I ever met and it is no wonder they have achieved such popularity on the air. . . . Of course, I realize that statement may sound like the well-known "hooey," but I mean it sincerely—and all the folk in Cincinnati feel the same way toward them. . . . They packed them in at the Albee Theatre, doing a very clever act. . . . By the way, do you know that Gene's brother is that well-known mimic and impersonator, Albert Carrol, one of the cleverest artists in the theatrical profession? . . . Danny Engel, who represents De Sylvia, Brown & Henderson in this part of the country, was with the boys most of the time; he is a fine chap, full of fun and life, and kept us in stitches all the time. . . .

Haven Gillespie, well-known song writer, lives in Covington, Kentucky; he pops around quite frequently and has some new songs he has written with Seymour Simons. . . . Met up with Will Collins, who has a very fine program over Station WJR, Detroit, which he calls "Shadowland"; you can hear it every Wednesday night at 11:00 p. m. . . . Frank Crumit wrote the Ohio State University's football anthem, the "Buckeye Battle Cry"; even though he really attended and graduated from Ohio University, a rival college. . . . Harry Nolan, manager of the Netherland Plaza Hotel, Cincinnati, is a Cornell graduate and was formerly in the theatrical profession. . . . Whenever Paul Whiteman introduces Ferde Grofe's "Tabloid" into his symphonic concerts, he adds several typewriters to his orchestra to achieve the proper atmosphere. . . . Peter de Rose, who is heard daily over NBC networks with May Singhi Breen, "The Ukulele Lady" (in private life Mrs. De Rose), has just collaborated on another song, "Have You Ever Been Lonely"; he has already written many popular songs, including "Somebody Loves You," "Back in the Old Sunday School" and "When Your Hair Has Turned to Silver." . . .

The latest addition to the NBC Maxwell House Showboat cast, the Show Boat Four, has been famous over the air lanes for the last four years under the name of The Songsmiths, featuring "Scrappy Lambert" and his fellow-harmonizer, Billy Hillpot; they've been popular ever since their classmates at Rutgers told them six years ago not to hide their harmony under a bush. Ben Bernie, the old maestro, introduced them to New York, and success soon followed in the form of numerous night club and theatrical engagements, and a radio audition which brought them before the microphone and has kept them there ever since. . . .

Over at Columbia Gracie Allen is still looking for her missing brother. . . . An interested listener to Columbia's broadcast of the Los Angeles opening of "Cavalcade" was the author himself; appearing with Lynn Fontaine and Alfred Lunt in the Pittsburgh production of another of his own plays, "Design for Living," Noel Coward wired the Columbia Studios in New York to be sure that WJAS, the CBS outlet in Pittsburgh, would carry the broadcast. . . . Gertrude Niesen, a Torch singer over CBS chains, is a paradoxical linguist; born of Scandinavian parents, Gertrude sings in English and Italian, speaks French fluently, and her favorite language is Latin, at which she excelled in school.

* * *

Biographical Brevities

About Gene and Glenn

Gene Carroll was born in Chicago, of a theatrical family. Glenn Rowell first saw the light of day in Pontiac, Illinois. They created in 1929 their act as it now stands.

This famous radio and vaudeville team was developed from two different radio teams, and here's how it happened: Gene, after touring in musical comedy and vaudeville, met an old school friend and they teamed up as "Jack and Gene." They met with some success in vaudeville and finally entered radio through a Chicago station, eventually landing at WLW, Cin-

(*Continued on next page*)

Station Sparks

By Alice Remsen

(Continued from preceding page)

cinnati, where they became acquainted with a similar pair, Ford and Glenn. Here Jack developed throat trouble and was forced to discontinue broadcasting. Ford and Glenn then suggested that Gene join them, and they formed a trio known as Ford, Glenn and Gene. Shortly after this Ford Rush retired to his citrus plantation in California, leaving Gene and Glenn, the present team. The result was "Jake and Lena"—a godsend to the weary public.

During the last four years they have attained remarkable popularity throughout the country by their clever radio act and are now making personal appearances, besides broadcasting over WTAM, Cleveland, and WLW, Cincinnati, for the Sohio company. Gene plays the triple role of Jake, Lena and himself; Glenn does straight, plays piano and sings. Gene is thin and wistful in appearance, but is stronger than he looks. He is five feet, seven inches; parts his light brown hair on the side; has dreamy-looking blue eyes and wears spats. Glenn is a little taller than Gene, much heavier, is very handsome and also wears spats. Both are married and have quite some families. Two dandy fellows with a million friends.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

Leonard Leschnik, 1110 Wyatt St., New York, N. Y.
Harry H. Temler, 2210 Lyon Ave., Bronx, New York City.
Emil Heikkila, 322 Helmholz Ave., Waukegan, Ill.
R. O. Crosby, 2614 Harrison St., Dallas, Texas.
Noblitt Sparks Ind., Inc,, Columbus, Ind.
J. N. Crowder, Box 1003, Charlotte, N. C.
Lyle L. Sanders, Box 415, Sinton, Texas.
Keystone Radio Co., 1650 S. Pearl St., Denver, Colo.
True R. Slocum, Jr., 5228 Agnes Ave., Kansas City, Mo.
L. W. Thomsen, 2129 18th St., N.W., Apt. 4, Washington, D. C.
Donald Eaton, Cortlandt, Ohio.
Richard Wong, 1503 Nuuanu Ave., Honolulu, T. H.
Floyd E. Dillard, 10735 Aqua Vista St., North Hollywood, Calif.
M. P. Biegen, 4 Little Ave., Middletown, N. Y.
A. C. White, R. F. D. No. 1, Gooding, Idaho.
E. R. Littlefield, Afton, Mo.
Travis Benton, Box 223, Mineola, Texas.
F. S. Crissman, Romeo, Mich.
L. Owens, 354 N. 66th St., New York, N. Y.
Harlan A. Messner, Orrville, Ohio.
Gaston Bloncourt, P. O. Box 823, San Juan, Porto Rico.
N. Allen Gray, 2726 S. Narsalis St., Dallas, Texas.
Tom Needham, 1108 W. 12th St., Pueblo, Colo.
Harold Smith, R. F. D., No. 1, Apponaug, R. I.
R. Howard, 429 Bloomfield Ave., Caldwell, N. J.
E. A. Reimers Radio Service, Fair Oaks, Calif.
H. J. Ackermann, 4619 Lee Ave., St. Louis, Mo.
John Grunmisch, 26 W. 126th St., New York City
Bob Smith, 1019 Erwin St., Elkhart, Ind.
Arthur Secrest, Jr., 315 So. State St., Westerville, Ohio
Frank Stitt, Jr., (short waves), R. D., Mt. Union, Pa.
Henry Meiers, Corps Area Ord. Office, Governors Island, N. Y.
Fred J. Kaiser, Surprise, Greene Co., N. Y.
Ralph Peters, Weatherford, Okla.
R. J. Sonko, 414 4th St., Monessen, Pa.
Wm. S. Fritch, Route No. 3, La Junta, Colo.
John A. Masteller, 2025 Erie St., North Kansas City, Mo.
Virgil Covington, B. O. RR., Dunbar Pl., Madisonville, Cincinnati, Ohio
R. F. Lagsding, 803 So. "B" St., Grand Island, Nebr.
C. King, Am. Automatic Elec. Sales Co., 840-A Park Sq. Bldg., Boston, Mass.
Jack Roberts, Ken's Radio Serv. Sta., 11 W Plaza, Reno, Nev.
Arthur V. Goeckler, 407 Center St., West Haven, Conn.
John Magaldi, Jr., (renew scanner for television.) Gem Radio & Television Corp., 815 Kimball St., Philadelphia, Pa.

CORPORATE ACTIVITIES

A petition was filed by Alfred West, debenture bondholder, in Federal Court, seeking the appointment of receivers in equity for the Radio-Keith-Orpheum Corporation, operators of a chain of theatres and moving picture theatres. In the complaint it is stated that the corporation sustained a loss of $5,660,700 in 1931 and a loss of $4,965,331 for the first nine months in 1932, and that, although the corporation is solvent, it can not, being unable to procure funds, meet maturing obligations.

A statement attached to the complaint shows that on December 31st last the corporation had a funded debt of $19,054,500, including outstanding debentures aggregating $11,600,000.

Merlin Hall Aylesworth, President of the Radio-Keith-Orpheum Corporation, made the following statement:

"My attention has been called to proceedings in the New York Federal court drawn today by one Alfred West against Radio Keith Orpheum Corporation.

"It is not unusual at this time for actions of this nature to be taken against companies in the entertainment business. I will be prepared to make a statement after counsel and officials of the company have had an opportunity to consider the contents of the petition."

* * *

CORPORATION REPORTS

(Preliminary)

Zenith Radio Corporation, three months to October 31, net loss $126,131 after all charges, compared with net loss $75,842 in the preceding quarter and net loss $69,908 in the like period of 1931. Six months to October 31, net loss $201,973 against net loss $127,609 in the 1931 period.

Servel, Inc. (refrigeration), year ended October 31, net loss $777,443 after taxes and charges compared with net profit $1,067,397 in the preceding fiscal year, equal after 7 per cent preferred dividends to 58 cents a share on 1,736,426 of common.

BANKRUPTCY SCHEDULES

Cosmos Broadcasting Co., Inc., 100 5th Ave., New York City. Liabilities, $26,299; assets, $10,490, main item being accounts, $9,003.

BANKRUPTCY PROCEEDINGS

The Irving Trust Co. was designated by Judge Patterson for: Cosmos Broadcasting Co., Inc., 100 Fifth Ave., New York, N. Y.

CORPORATE CHANGES

Assignments
In New York

Kree Electrolysis System, Inc., 253 West 55th Street. to Charles A. Pincus, 1,027 Walton Ave., Bronx, New York City.

Capital Increases

Cornell Electric Mfg. Co., Queens, L. I., N. Y., 10,000 shares to 130,000.

Directional Sending

ULTRA-SHORT wave broadcasting equipment has been installed in Vatican City by Senatore Guglielmo Marconi, thus bringing to a climax the modernization of Vatican City inaugurated by Pope Pius XI in 1931.

The latest equipment for ultra-short waves utilizes parabolic reflectors for receiving and transmitting. These reflectors, which are directional, are pointed so that the greatest amount of energy will be transmitted in the direction the waves are desired to go. Thus in one sense the ultra-short wave transmitter is not strictly a broadcast station but rather a beam transmitter. Other equipment is non-directional and therefore the directional transmitter may be used as a supplement to reach those remote areas where the broadcast transmitter cannot penetrate.

A parabolic reflecting antenna has the property of concentrating the available energy into one beam. Since the intensity of the energy in this beam is proportional to the concentration it is clear that the narrower the beam the farther it will travel with receivable strength.

TRADIOGRAMS

By J. Murray Barron

Universal Microphone Co., Inglewood, Cal., announces a new Universal remote control panel. This is a one-stage microphone amplifier and tone control which may be used for low or high impedance pickup for broadcast uses. It may also be used as a telephone amplifier, a pre-amplifier for home recording; phone mike mixing pane lfor p.a. systems, a remote control microphone amplifier and monitor panel with phonograph pick up and from telephone or control line with monitor phones.

* * *

Arthur Isler, former general manager of WMSG, announces the opening of the Manhattan Institute of Radio Technique at 155 West 46th Street, New York City. Associated with Mr. Isler are Carroll Le Van and Harffiold Currier, former head of the vocal department at Middlebury College.

* * *

The Postal assembled chassis is the first to make its appearance on the market and the very first definite effort to assist the experimenter and custom set builder to construct the popular Universal A.C.-D.C. receiver. It is put out by Postal Radio Corp., 135-137 Liberty Street, New York City. There is a free diagram and valuable information for those who want to construct and sell receivers in their locality.

* * *

One of the finest window displays of radio receivers is now attracting wide attention in New York City at the City-Davega radio store at Broadway and 42nd Street. While this is the largest chain of radio stores in the country, the business is not confined to personal purchases, as there is a special mail order business.

* * *

A novel and attractive demonstration of the adaptability of the hand mike with its use in the home with the radio receiver is given daily at Try-Mo Radio Co., Inc., 179 Greenwich Street. Notwithstanding the great publicity that has been given the subject, there is still a number who have very little idea as to the simplicity of the hook-up and the real amusement and entertainment that may be enjoyed at hardly any outlay.

Band Spreading

COULD the band spreading idea which you have disclosed be applied to a superheterodyne using the European band of frequencies for the purpose of tuning in the broadcast band? If so, what advantage would be gained?—T. Y. S., Chicago, Ill.

It could be applied all right for the principle is not limited to any particular range of frequencies. The European band covers approximately the band from 150 to 400 kc. Hence if the tuner in the long-wave band covers this range the band spreading would be 250 kc. Since the broadcast band covers about 1,000 kc., it would require four steps to cover the whole. The advantage of this is doubtful, for it is almost as easy to tune to any station in the broadcast band directly as it would be by covering the range in four steps. The main advantage of the band spreading idea lies in the short-wave range where channels 10 kc apart are relatively very close together.

A THOUGHT FOR THE WEEK

WHY are radio service men all over the world—yes, even in Asia—subscribing in such large numbers for RADIO WORLD? *We believe we know—we are servicing the service men. And we'll continue to do that to such a degree that every mother's son of them will need this paper 52 times a year.*