SEPT. 20
1930

N. Y. SHOW NUMBER!

15 Cents
Per Copy

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

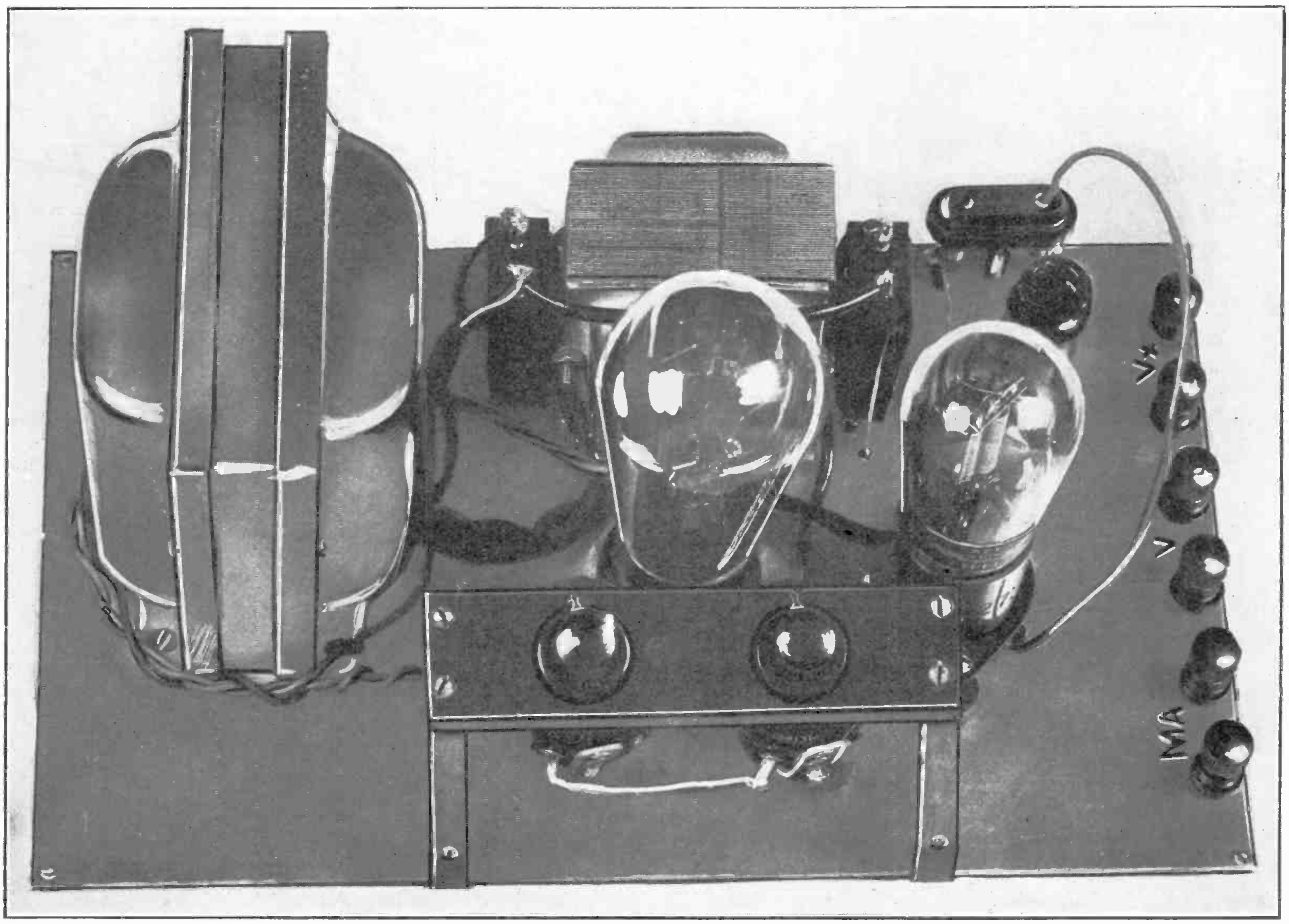
443rd Consecutive Issue—NINTH YEAR

Supertone 6-Circuit Tuner

A Comparison of R F Coils

Shows of Other Years

A VACUUM TUBE VOLTMETER



View of a Vacuum Tube Voltmeter, Using a 280 Rectifier and a 227
It Has Infinite Resistance Per Volt

RADIO WORLD, Published by Hennessy Radio Publications Corporation; Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

weeks of preparation for the event, a small group in the shack watching the coherer noticed weak action occurring within the tube, and presently, after some circuit adjustments, the coherer

radio broadcasting had begun its career. A brief period elapsed during which, no doubt, considerable experimenting took place, and during 1920-21 the Westinghouse Electric Co. set up WJZ

come in contact, and is due to a physical property constant called "specific heat."

apparatus revision, and redesign, before television will be received by the public.

New Facts on the 232

By J. E. Anderson

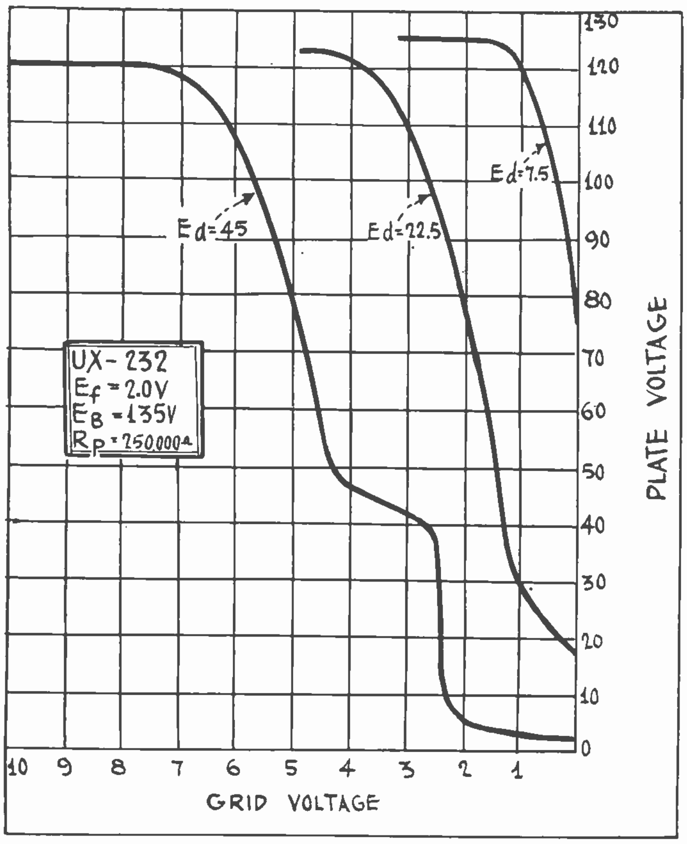


FIG. 61
CURVES SHOWING THE RELATION BETWEEN THE CONTROL GRID VOLTAGE AND THE EFFECTIVE PLATE VOLTAGE ON A 232 SCREEN GRID TUBE UNDER CONDITIONS SPECIFIED.

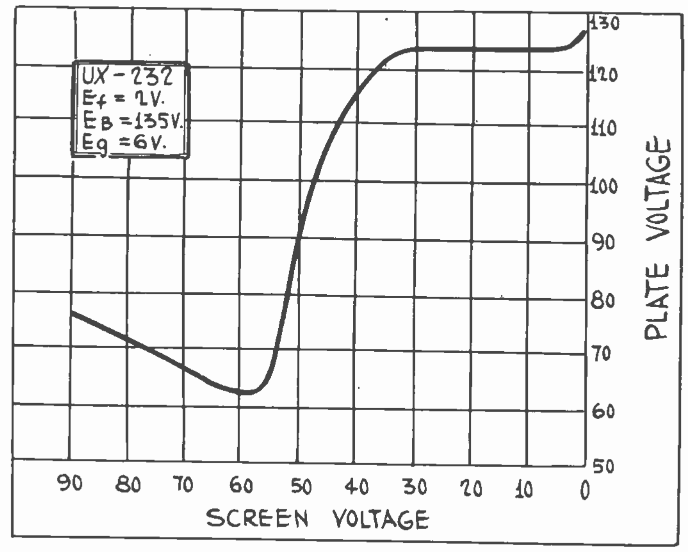


FIG. 64
A CURVE SHOWING HOW THE EFFECTIVE PLATE VOLTAGE ON A 232 SCREEN GRID TUBE VARIES WITH THE SCREEN VOLTAGE, UNDER THE CONDITIONS STATED AND A LOAD RESISTANCE OF 250,000 OHMS IN THE PLATE CIRCUIT.

[This is the seventh weekly instalment of "Modern Radio Tubes." The first instalment appeared in the August 9th issue, which dealt with the small battery tubes. Subsequent instalments have discussed some of the larger battery tubes, including the new 2-volt series. Next week additional information will be given about the 232, 222, and 224 screen grid tubes.—EDITOR.]

LAST week we promised additional information on the 232 screen grid tube, especially curves taken with the vacuum tube voltmeter described.

In Fig. 61 we have a set of three curves showing the relationship between the control grid voltage and the effective plate voltage under conditions stated on the graph. Curves are plotted for three different screen voltages, namely 7.5, 22.5 and 45 volts. Note that when the screen voltage is 45 volts, the plate battery voltage being 135 volts, the effective plate voltage at zero grid bias is only 2.5 volts. As the bias increases the plate voltage also increases, at first slowly, then abruptly, then more slowly again, and then rapidly. It finally approaches a value of 120 volts. The curves for the other screen voltages do not show so many changes in the rate of increase but each tends toward a definite limit, the 22.5 volt curve approaching 122.5 volts and the 7.5 volt curve approaching 125 volts.

A study of the curves in Fig. 61 yields much useful information. First, if the tube is to be used as a grid bias detector with 135 volts on the plate and .25 megohm in the plate circuit, the operating bias should be 7.5 volts when the screen voltage is 45 volts, 4.5 volts when the screen voltage is 22.5 volts, and 1.5 volts when the screen voltage is 7.5 volts. In each case the operating point falls at or very near the point of greatest curvature. The detecting efficiency in all these cases is about the same. Of the three curves that for 22.5 volts on the screen is best for power detection because it permits a greater signal voltage before distortion sets in, for the signal can swing from 4.5 volts to about one volt, an input amplitude of 3.5 volts and an output amplitude of 93 volts.

Amplification With 232

It is clear from the 45 volt curve that the tube cannot be operated as an amplifier with 1.5 volts on the control grid, or even with 3.0 volts. If the tube is to function at all as a voltage amplifier under the specified conditions, it is necessary to make the bias about 5 volts. At this bias the effective voltage on the plate is 78 volts, and the slope of the curve, which is the voltage amplification, is 36.

When the screen voltage is 22.5 volts the optimum grid bias is about 2 volts, where the slope of this curve is 41. Thus even for amplification, a screen voltage of 22.5 volts is better than a higher voltage. Not only is the voltage amplification higher, but the highest permissible signal amplitude is greater. It does not follow that a somewhat lower screen grid voltage will not give better results. In fact it appears that a screen voltage of 15 volts and a grid bias of one volt make a good combination.

A good voltage amplification may be obtained even when the screen voltage is as low as 7.5 volts. For example, if the grid bias is made 0.25 volt and the signal swing is confined to half volt double amplitude, the voltage amplification is 56.

Other grid voltage, plate voltage curves will be published on this tube as soon as they are available, especially curves for different applied plate battery voltages.

Screen Voltage, Plate Voltage Curves

The curve in Fig. 64 shows how the effective plate voltage varies with changes in the applied screen voltage under the conditions stated on the graph. The curve was taken at minus 6 volts on the control grid because at this value the tube is a good detector. The object of taking the curve was to find the screen voltage at which the changes in the effective plate voltage would indicate a high detecting efficiency. The highest efficiency appears to be when the screen voltage is about 35 volts, because at this point the curvature of the characteristic is greatest, except at the point of minimum voltage, which is not suitable. It would seem therefore that when the plate voltage is 135 volts, the screen voltage 35 volts, the control grid bias 6 volts, and the plate resistance is 250,000 ohms, the tube will function effectively as a modulator of a Superheterodyne if the signal voltage is impressed on the control grid and the local oscillation on the screen grid.

Additional curves will be taken to investigate the operation of the tube at other screen and bias voltages.

222

THE 222 tube is another four element tube designed for use on a battery filament supply. It has a filament voltage rating of 3.3 volts and a current rating of 0.132 ampere, which is of the thoriated type.

The plate, screen and control grid voltages given in the table are average and apply when the tube operates into a radio frequency tuned circuit. They do not apply when the tube works into a high resistance. Moreover, they are average values and considerable variation is permitted in any one, although the plate voltage should not exceed 135 volts. When the tube is

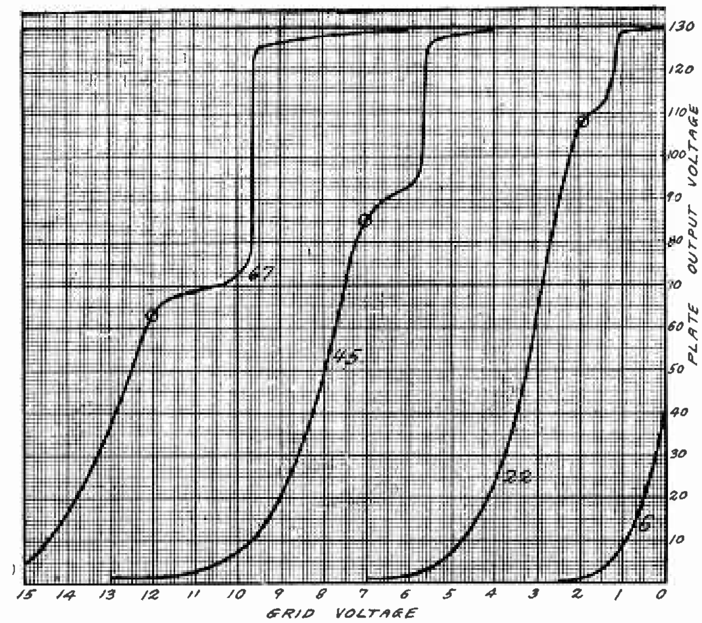


FIG. 70

A FAMILY OF GRID VOLTAGE, PLATE OUTPUT VOLTAGE CURVES FOR THE 222 SCREEN GRID TUBE FOR FOUR DIFFERENT SCREEN VOLTAGES AND ONE MEGOHM LOAD RESISTANCE. THE ORDINATES ARE VOLTAGE DROPS IN THE LOAD RESISTANCE.

working into a high resistance, other adjustments are necessary if distortionless amplification is to be obtained from the tube.

CHARACTERISTICS OF THE 222

Filament voltage	3.3
Filament current, amperes	0.132
Control grid bias, volts	—1.5
Screen grid voltage	45.
Plate voltage	135.
Mutual conductance, micromhos	350.
Plate resistance, ohms	850,000.
Plate to control grid capacity, maximum, mmfd.	.025
Base, standard UX.	

In Fig. 68 is a family of three plate voltage, plate current curves for the 222 tube tubes with a screen voltage of 22.5 volts Three load lines are drawn across the curves, representing three different plate load resistances. R1 is for a load resistance of 100,000 ohms, R2 for 250,000 ohms, and R3 for 615,000 ohms. All are drawn through 180 volts on the plate voltage axis, and therefore if the circuit is resistance coupled the plate battery voltage is 180 volts.

If the load resistance is 250,000 ohms and the grid bias 1.5 volts, the middle load line indicates an amplification of about 33 times, because a change of three volts in the control grid voltage causes a change in the effective plate voltage of 100 volts, from 45 volts a zero bias to 145 volts at 3 volts. This is a much lower amplification than it is commonly assumed that the screen grid tube gives. The 615,000 ohm load is not practical because the load line cuts the curve for zero bias below the knee, where the distortion is great. The highest resistance that can be used when the plate battery voltage is 180 volts and the screen voltage is 22.5 volts is 250,000 ohms.

Fig. 69 shows a similar set of curves taken with a screen voltage of 45 volts. Three load lines are also drawn across these curves, R1 for 100,000 ohms, R2 for 275,000 ohms and R3 for 750,000 ohms. The two lower lines cut the curves at the left below the knees and therefore they cannot be used for the amplification would be seriously distorted. The highest resistance that can be used is about 100,000 ohms. With this load and a bias of 1.5 volts, the amplification is about 28, for the plate voltage changes from 90 to 175 volts when the grid voltage changes three volts. Even with this load in the circuit it is necessary to make the battery voltage 275 volts, for there is where the 100,000 ohm load line would cut the plate voltage axis if it were extended.

Grid Voltage, Plate Voltage Curves

A more useful set of characteristics is that reproduced in Fig. 70, which gives the relationship between the grid voltage and the effective plate voltage for the 222 tube when the plate battery voltage is 135 volts and the plate load resistance is one megohm. The curves are for four different screen voltages as indicated.

High grid bias detecting efficiency is indicated at 2 volts bias for the 6-volt curve, at 6 volts for the 22 volt curve, at 11.5 volts for the 45 volt curve, and at 17 volts for the 67 volt curve. The last point is beyond the curve, but it may be obtained by observing the similarity of the curves.

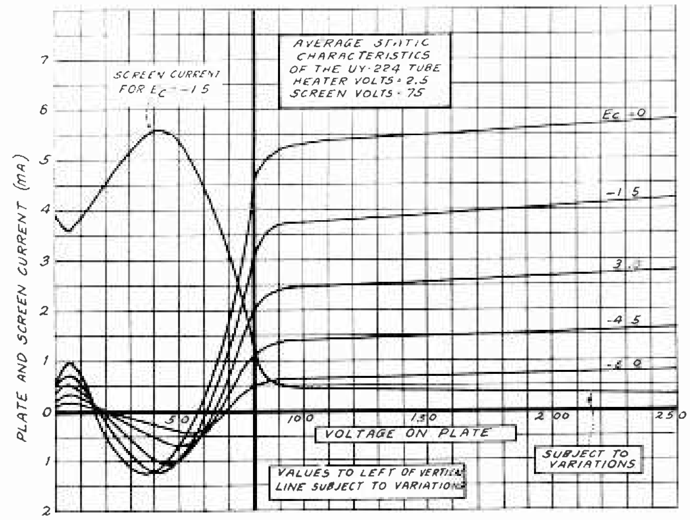


FIG. 71

A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR THE 224 SCREEN GRID TUBE. THE SCREEN CURRENT FOR A CONTROL BIAS OF 1.5 VOLTS IS ALSO GIVEN.

On the 67 volt curve there is no point at which amplification is satisfactory. Hence the tube should not be used in resistance coupling with one megohm in the plate circuit and a plate battery voltage of 135 volts. The 45 volt curve indicates good amplification when the bias on the control grid is 8 volts. If the signal amplitude about this point is one-half volt, the amplification is 37 times.

The 22 volt curve indicates best amplification when the control grid bias is 3 volts, and if the signal varies one-half volt about this bias the amplification is 50 times. We previously found for the 232 screen grid tube that the amplification was better at 22.5 volts than at 45 volts, so in this respect the two tubes behave similarly. For that tube, we concluded that a screen voltage of 15 with a bias of one volt would give good amplification. For the 222 the screen grid voltage might be reduced to 15 or 17 volts with a control grid bias of 1.5 volts. It must be remembered that the local resistance on the 222 in this case is one megohm.

The curves in Fig. 70 present a different appearance from those in Fig. 61. The difference is only that in Fig. 70 the voltage drop in the plate load resistance is plotted and in Fig. 61 the actual effective plate voltage is plotted against the grid bias. The curves in Fig. 61 can be thrown into the form of those in Fig. 70 by subtracting each voltage value from 135 and replotting. Or one set of curves can be viewed upside down.

224

THE 224 is a screen grid type tube designed for operation on alternating current. It is of the indirectly heated types. That is, the alternating heating current flows through a conductor inside the cathode and insulated from it. The cathode is heated by radiation and heat conduction from the hot filament.

The normal heater voltage is 2.5 volts, although it will work well with as low heater voltage as 2.25 volts. The normal heater current is 1.75 amperes.

The tube is primarily intended for radio frequency amplification in AC operated receivers, and as radio frequency amplifier it is capable of giving a very high gain per stage. It has a much higher amplification factor than either of the preceding screen grid tubes, a higher mutual conductance, and a lower internal plate resistance. The plate-to-control grid capacity is very low, and therefore the tube can be used in circuits with a high voltage gain without the need of special neutralization. The main operating constants of this tube will be found in the table of characteristics.

In Fig. 71 is a family of plate voltage, plate current curves for this tube. The curves have been drawn for a screen voltage of 75 volts and five different control grid voltages. The heavy vertical line is drawn at 80 volts on the plate, which is 5 volts higher than the voltage on the screen. The typical abrupt change in the course of the curves occurs in this as in all the curves for the other screen grid tubes. The tube will not function as an amplifier unless the effective plate voltage exceeds the voltage on the screen, in this case by about 15 volts. This is the minimum permissible voltage on the plate during a signal voltage cycle.

While the expected amplification from this tube could be obtained by drawing load lines across the curves in Fig. 71, as has been done for other tubes, we shall obtain the amplification from grid voltage, plate voltage curves, which will be published later.

The Supertone 801, a Self

By Herm

THE Supertone 801, shown in Fig. 1, is the six-circuit tuner that has been under experiment for almost five months, and concerning the development of which several articles have been published in these columns.

Each time the circuit appeared it was somewhat different, but its main features have been the use of six tuned circuits, with 224 tubes as radio frequency amplifiers and a 227 as detector, the latest favorites in circuit construction, automatic volume control and tone control, being provided, also.

The diagram is complete, as shown, except for the automatic volume control and a resonance indicator.

It is suggested that if the circuit is to be built, that it be operated experimentally without the automatic volume control, and that the control be wired in after everything else is in good working order. This precaution is suggested because of the general unfamiliarity existing regarding automatic volume controls, and mistakes that are easily made in connecting up such devices, whereby no reproduction at all is heard. Then the builder may not find the trouble in a week. The control method has been published in these columns before, in conjunction with this circuit, but the details of its incorporation will be published next week.

It will not be necessary to refer to any past issues to gain a complete knowledge of the construction, servicing and operation of the tuner.

Does Not Tax Power Amplifier

It will be seen that a B supply is built in. To gain loudspeaker reproduction you need a power amplifier, and the usual effect of introducing such a heavy drain on a power amplifier as a six-circuit tuner imposes is to reduce severely the capabilities of the power amplifier. The applied voltage, where it is supposed to be 180 volts, may drop to about 150 volts, and the preliminary audio stages will overload before the power tube will.

It has been the hope of manufacturers of power amplifiers for radio use that a tuner would be developed that would not ask more of the power amplifier than should be asked, and as the present tuner asks nothing, but rather gives instead, the expectation should be regarded as fulfilled. However, the user himself should have the same attitude as the power amplifier manufacturer, since the goal is the same: to permit working the power amplifier at the intended gain and the same undistorted maximum voltage or power level as was intended.

Ten Features Listed

The features of the tuner are:

(1)—Six tuned circuits, with three band pass filters.
(2)—Total shielding, including shielding of tuning condensers.
(3)—Built-in B supply.
(4)—Complete filtration at all points.
(5)—Automatic volume control.
(6)—Tone control, with switch to release the tone-control entirely.
(7)—Screen grid radio frequency amplification.
(8)—Uncommon strength of mechanical construction.
(9)—AC operation.
(10)—Beautiful appearance.

It is generally regarded as advisable to have a resonance indicating device in connection with automatic volume control. A sensitive milliammeter would serve the purpose, but a method is being worked out for using a pilot lamp, as dial illuminator, so that the degree of illumination will show resonance, which is simpler and costs next to nothing, whereas the milliammeter would cost several dollars.

How Band Pass Filters Work

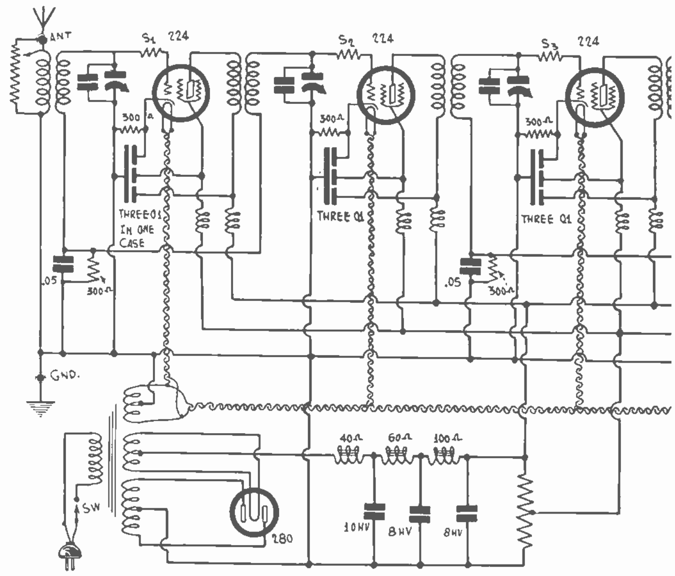
The six tuned circuits all feed tubes, and yet there are three stages of band pass filtration. The method of band pass filtration used is to return the ground currents of a pair of tuned circuits through a capacity-resistor parallel circuit (300 ohms and .05 mfd.), which gives the proper admittance band, flattening the peak of the resonance curve so that higher selectivity may be attained than otherwise, and yet without any serious impairment of upper sidebands.

The total shielding consists of the shielding of the tuning condensers and of the coils and tubes, as well as of the wiring.

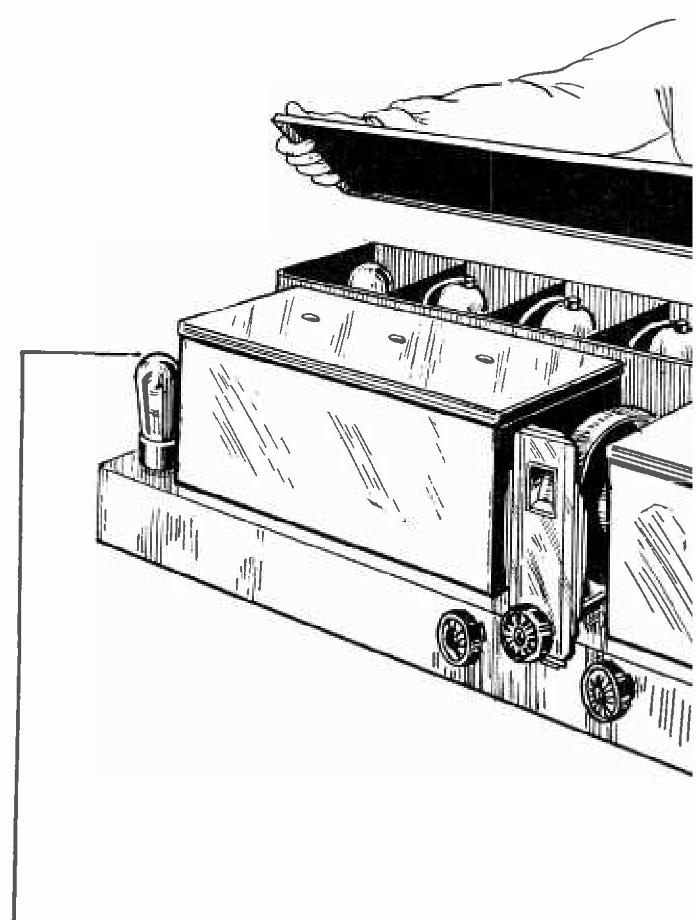
Two three-gang condensers, .0005 mfd. for each section, are used. Each three-gang is shielded. Besides, there are partitions inside the shields whereby the respective sections of a condenser are shielded from each other.

The same partition method is used in the coil-tube shield, which is one large shield, with compartments.

All these compartments are spot-welded in place, and all shielding is 1-16 in. steel, which is a thicker wall than most



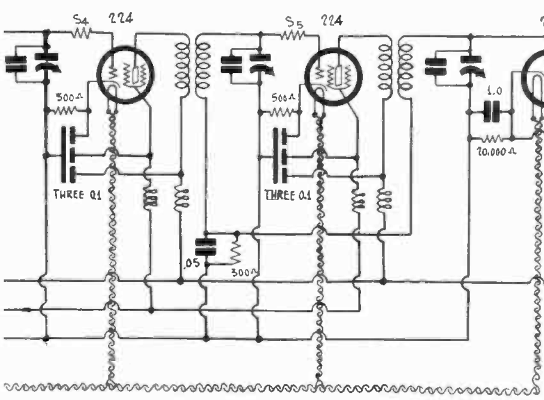
THE DIAGRAM OF THE SUPERTONE 801, A SIX-CIRCU
MATIC VOLUME CONTROL AND TONE CONTROL, AND
AUTOMATIC VOLUME CONTROL, AS THAT WILL BE D
THE CIRCUIT FIRST BE BUILT



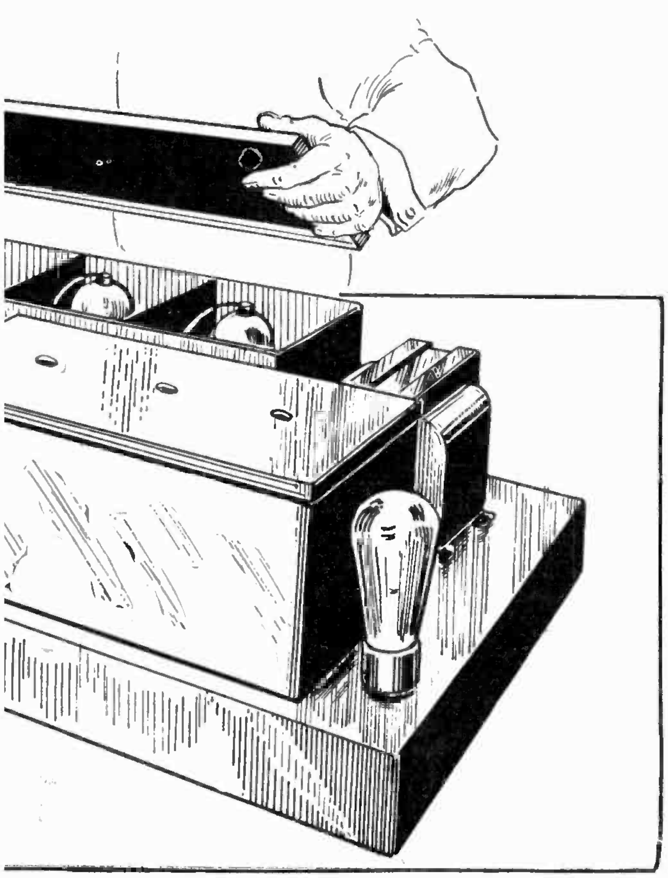
THE APPEARANCE OF THE SUPERTONE 801 IS SHOWN
MADE DURING A DEMONSTRATION IN SUPER

Reliant Six-Circuit Tuner

n Bernard



' TUNER EMBODYING BAND PASS FILTRATION, AUTO-
VITH B SUPPLY BUILT IN. THE DIAGRAM OMITS THE
CUSSED IN DETAIL NEXT WEEK, AND IT IS ADVISED
'ITH THAT CONTROL OMITTED.



BY THIS ARTIST'S DRAWING FROM THE ORIGINAL,
:ONE LABORATORIES IN BROOKLYN, N. Y.

chassis makers are equipped to work. The RF and detector tubes are inside the compartments with the coils that feed them.

Cover on Bottom, Too

A bottom piece covers the shield, so that there is no opening to permit the wiring to pick up signals, and in this way selectivity is better and squealing is held in check, which it isn't under other circumstances, even with the use of grid suppressors of substantial resistance value. The suppressors are S1, S2, etc.

The built-in B supply uses a 280 rectifier and delivers about 180 volts, or just a little more, the same applied voltage for all plates, which makes for convenience. The power transformer has a filament winding (2½ volts, 16 amperes) for the five 224 RF tubes, the 227 detector and the 227 automatic volume control tube, as well as a 5-volt winding for the 280, and a 440-volt AC winding, center-tapped, for the plates of the rectifier. The power transformer is shown at right in Fig. 2, and the rectifier tube is the one at right front.

Each Plate and Screen Lead Filtered

The completeness of the filtration may be observed by noting the radio frequency chokes, one in each plate lead and one in each screen grid lead, with an RF choke in the detector output, as well as an audio choke in that output, so that no direct current is fed to the first stage audio coupling unit of the power amplifier. This unit most likely would be a transformer, and the needed high primary inductance is kept as high as possible by passing only modulation current through the winding.

The audio choke in the detector lead has an inductance of 30 henries when 65 ma flow, but as about 1 ma will flow, the inductance is then nearly 1,000 henries, hence the series circuit that feeds the audio amplifier input has no short-circuiting effect on the inductance of the primary of the first audio transformer of the power amplifier.

Uses "Choke Input"

In the B supply a "choke input" is used, as this method protects the life of the rectifier and incidentally of the first filter condenser, too, due to the choke taking up the strain that otherwise would result when turning on the supply. Across the rectifier output, therefore, no condenser is placed.

The total choke, consisting of a single winding with two taps, hence four connections, has a DC resistance of 200 ohms, divided into 40, 60 and 100-ohm sections. At the end of the 40 ohms is a 1.0 mfd. high voltage condenser, of paper dielectric (rating, 500 volts AC, continuous working voltage), while at the end of the 60-ohm section, which is the center of the entire choke, is an 8 mfd. electrolytic condenser, and at the end, in the reservoir position, is another 8 mfd. electrolytic. The electrolytics have a rating of 500 volts DC, continuous working voltage.

The current drain is only about 35 milliamperes for the tubes and 20 milliamperes for the rest, yet the provision for filtration is better than what is provided usually for 100 ma drain. Also, the condensers are worked in a B supply that furnishes less than 200 volts DC output, yet are of the type suitable for 300 volt DC output and more.

Condensers Distinguished

The filter condensers are referred to as HV in the diagram, meaning high voltage, to distinguish them from the other or bypass condensers, which are rated at 200 volts DC, continuous working voltage.

The automatic volume control feature will be treated next week, as already stated, and the fact is mentioned again only because that would be the next in line for discussion, according to the list of ten features previously given.

The tone control consists of a series condenser and a variable resistor. The effect is to reduce the high audio frequency response to a degree determined by the amount of resistance used. Hence the resistor is adjustable. A switch will cut the tone control completely out of circuit. An optional tone control will be shown soon.

Screen grid radio frequency amplification is the most popular, because of the greatest gain obtainable with the least number of tubes. It is not to be thought that six tubes in a tuner, with a control tube and a rectifier to boot, are a few tubes, but to obtain the same degree of amplification, with other RF tubes, a greater number of tubes would have to be used, and still there would be no way of obtaining reception at such high gain below 400 meters, as the set would oscillate uncontrollably.

The uncommon strength of the assembly is a consideration not to be dismissed. The chassis itself is amply strong enough to hold up everything without yielding.

(Continued next week)

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. The reply is mailed to the member. Join now!

RADIO UNIVERSITY

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

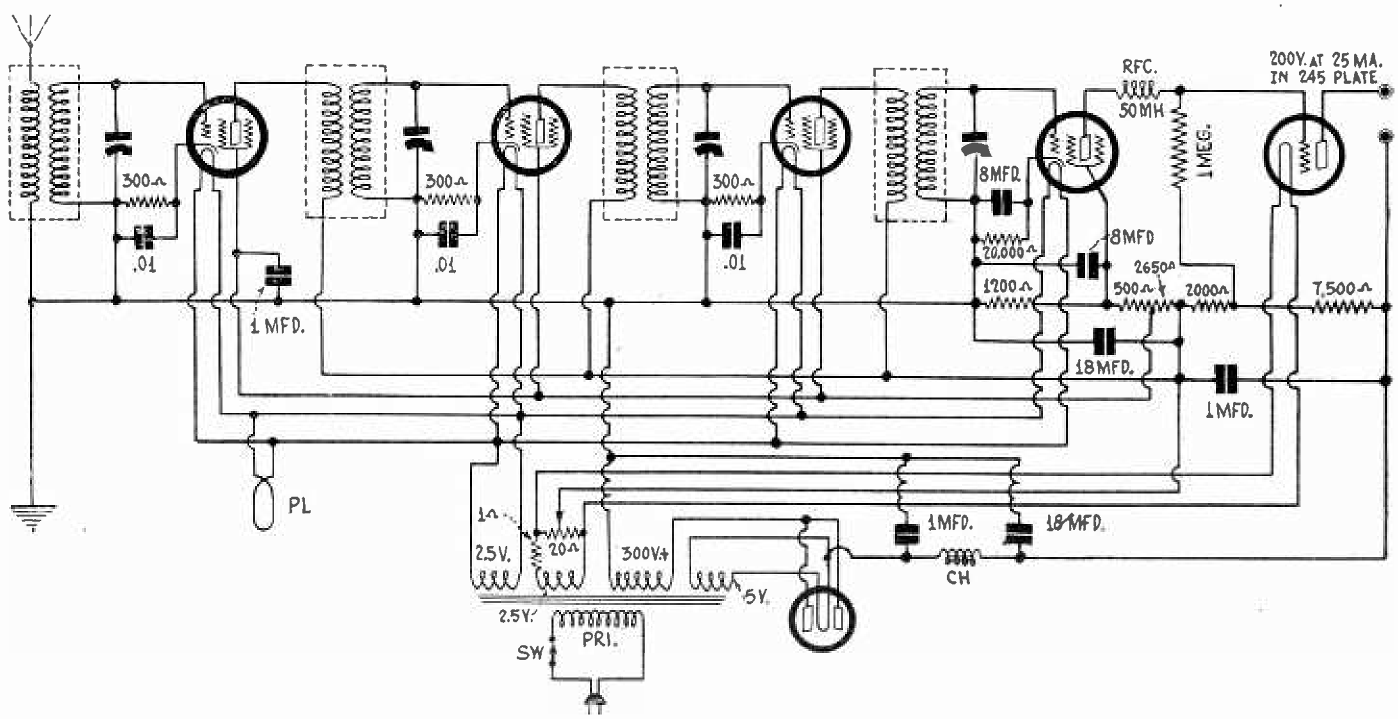


FIG. 848

THE CIRCUIT OF A TUNED RADIO FREQUENCY AMPLIFIER UTILIZING FOUR SCREEN GRID TUBES, ONE 245 OUTPUT TUBE AND ONE 280 RECTIFIER. THE AUDIO AMPLIFIER IS OF THE LOFTIN-WHITE TYPE.

Complete Screen Grid Set

I SHOULD like to see the circuit diagram of a screen grid radio frequency amplifier with Loftin-White detection and amplification following it. Please show values on the circuit or give them in the reply.—W. H. W.

A circuit of this type is reproduced in Fig. 848. All the essential values are given on the diagram except those of the tuners. The tuning condensers may be regular .0005 mfd. and the coils wound to match these condensers.

* * *

Selecting Grid Bias

YOU recently published a circuit in which 1,000 ohm grid bias resistors were used both for the output tube and the preceding tube, which was resistance coupled. The tubes were both 227s and the applied plate voltage was the same for both. Now if the output tube is properly biased, the preceding tube certainly cannot be, in view of your repeated statements that the applied plate voltage and the amplification factor determine the optimum bias. The drop in the 1,000 ohm resistor in the resistance coupled circuit is certainly much less than the drop in the 1,000 ohm resistor in the output tube. Please explain the discrepancy.—R. E. P.

Yes, the bias voltages on the two tubes are widely different. While the applied plate voltage and the amplification factor determine the bias, they do not determine the optimum bias under all conditions. A lower bias may be used on the resistance coupled tube because the signal amplitude is not so great on this tube as on the output tube. It is only necessary to provide enough bias on this tube to prevent the grid from going positive during any part of the cycle.

* * *

What a Bolometer Is

YOU have made frequent reference to a bolometer for measuring alternating current. What distinguishes a bolometer from any other AC meter?—T. R. S.

A bolometer is a current measuring device which operates on the principle of change of resistance of a wire. The alternating current heats the wire and the heat causes the resistance to change. There is a definite relationship between the current and the change in the resistance. Hence, if we can measure the change in the resistance due to the current, we know what the current is. Allowance must be made for heat radiation, but this is taken care of in the calibration of the instrument.

Avoid Long Heater Leads

WHAT is the advantage of building the filament transformer for heater type tubes into the set or converter? When an adequate 2.5 volt winding is available in the power supply circuit it would seem that it is more economical to use that.—W. E. S.

It is necessary to avoid long heater leads because the voltage drop in the leads might be so high that the tubes do not get enough heater current. The current is heavy, 1.75 ampere per tube, and it does not take much resistance to cut the voltage excessively. Suppose the converter has 4 tubes of this type, requiring a total current of seven amperes. It takes only 0.0715 ohm to cause a drop of 0.5 volt, and that drop is too great.

* * *

Tubes Turn Blue

I HAVE built a power amplifier and power pack utilizing one 280 tube for rectification and 245 in push-pull in the power stage. The voltage across the voltage divider measures 315 volts., which is about right before I put the power tubes into the circuit. When I put them in, however, the voltage drops below 300 volts and both power tubes turn blue. Can you explain this trouble?—C. D. B.

The first thing to suspect is that there is no grid bias on the power tubes. This may be due to the omission of the bias resistor or to a short circuit of the resistor. If this is not the trouble, it may be that the tubes are defective, that is, gassy. However, this is not likely, since both tubes turn blue. The short-circuit is more likely, and it may be that the condenser across the grid bias resistor is at fault.

* * *

Necessity of Television Synchronization

WHY is it necessary to insure exact phase synchronism in television reception? That is, why is it necessary not only to have the scanning disks at the transmitter and the receiver run at the same speed but also in phase?—D. N. G.

One thing that happens when the two scanning disks are not in phase may be illustrated with the movies. When the film slips a few cogs on the sprocket, the upper half of the picture is at the bottom and the lower part at the top. There is a similar effect in television, only that it is more complex. Take any small area on the original scene, a very small area. There is a certain light value pertaining to that area, and it is also surrounded by other similar areas having different light values. On the viewing screen of the receiver the particular small area must be represented in exactly the corresponding position, with respect to the other surrounding small areas as well as to the picture as a whole, and it must also be represented by the correct relative light value. It is clear that if the speeds of the two discs are not the same, the relationship as to position of the different small areas will not be the same. Particularly, the areas in different scanning lines will be shifted out of their true positions. Let us illustrate with symbols. Designate any three successive scanning lines by L, M, and N. Also designate the small areas in the lines by numerical subscripts. Thus L6, M6, and N6 are three areas in a vertical line. L5, M5, and N5 are three areas in a vertical line just left of the (6) line, and L7, M7, and N7 three areas in a vertical line. If the scanning discs run in step, the areas will be reproduced in this order, but if they are running slightly out of step, areas L5, M6, and N7 might be reproduced in a vertical line. If the discs are still more out of step, the areas L4, M6, and N8 might be in a vertical line.

* * *

AC in Resonant Circuit

IS the alternating current in a resonant circuit in radio receiver large enough to be measured with a thermo-couple type milliammeter having a full scale deflection of 115 milliamperes?—W. H. W.

That depends on many factors, such as the stage in which the tuned circuit happens to be, the frequency of the current, the intensity of the carrier impressed at the antenna, the resistance in the tuned circuit, and on the amplification. If the receiver is used with a power detector, there will be plenty.

* * *

Bias on 232 in Resistance Coupling

IF the plate battery voltage on a 232 screen grid tube is 135 volts and the plate coupling resistance is 250,000 ohms, what should the screen and control grid voltages be to give the best amplification? About how high is the amplification and how much signal voltage can be applied safely without meeting a lot of distortion?—C. F. K.

The steady grid bias should be about 2 volts and the screen voltage 22.5 volts. The amplitude of the signal may be about one volt. That is, the signal may be permitted to fluctuate between minus one and minus three. The output voltages will be 30 and 108 volts and therefore the amplification will be 39. Curves showing this are published elsewhere in this issue.

* * *

Definition of Decibel

PLEASE give a definition of decibel in terms understandable by us radio fans who are not expert mathematicians. So far I have not seen a definition that meant anything.—C. W. J.

Since the decibel is a logarithmic unit, the definition must necessarily be given in terms of logarithms, and one who does not understand logarithms will not understand the definition. But since logarithms are very simple, it will only take a few moments to get acquainted with them. When amplification or loss or any other relative quantity is expressed in terms of decibels, there is always one quantity which is taken as standard or reference. Usually it is called zero level. It is never zero. Any other quantity of the same kind may be expressed as a certain amount lower or higher than the standard on the ratio basis. For example, the input voltage to a certain tube may be 5 volts. This may be taken as zero level. The output voltage of the same tube, or the input voltage to the next tube, can then be expressed as a certain number of times larger, and the number gives the amplification. Suppose the second number is 40 volts. Thus the amplification is 8 times. The gain expressed in decibels is 10 times the common logarithm of the number 8. This logarithm is 0.9031, which may be obtained either from a slide rule or from logarithmic tables. Since the number of decibels is 8 times the common logarithm, an amplification of 8 is equal to 9.031 decibels. When there is a loss instead of a gain, the number is negative. For example, suppose we have a step-down transformer having a voltage ratio of 8, and if we use the primary voltage as zero level, the loss in voltage is given as —9.031, which is ten times the logarithm of 1/8.

Another use of the decibel is in comparing the amplifications at two different frequencies, and it is customary to use the amplification at 400 cycles per second as zero level. Then the amplification at any other frequency is given as so many decibels above or below the amplification at 400 cycles. Let the gain at 400 cycles be 500 times and that at 1,500 cycles as 600. How many decibels is the amplification at the higher frequency up, that is, above that at 400 cycles? Well, the ratio is 600/500, or 1.2. The common logarithm of 1.2 is 0.0792. Hence, the amplification at 1,500 cycles is 0.792 decibels up.

* * *

Effective Resistance of Parallel Circuit

HOW is the effective radio frequency resistance of a parallel resonant determined? Does it depend in any way on the effective resistance of the tuning coil and that of the tuning condenser?—C. L. W.

The resistance of a parallel resonant tuned circuit is L/RC, where L is the inductance in henries of the tuning coil, R the series resistance in ohms of the coil, and C the capacity of the tuning condenser in farads, the resistance of the condenser assumed to be negligible in comparison with that of the coil.

* * *

Hum Variation With Plate Current

IN what manner does percentage of hum in the output of a tube like the 226 vary with the amount of current in the plate circuit? Is there a definite value of current which gives less hum than any other?—G. W. F.

There is always a definite current value that gives least hum but this current depends on the filament voltage. When the plate current is very small, the percentage of hum is very great, but it drops rapidly as the current increases. When the filament voltage is 1.5 volts, the rated value, the minimum comes when the plate current is 3 milliamperes, as the current increases beyond this value the percentage hum increases slowly. When the filament voltage is 1.2 volts, the variation is similar, but the minimum hum comes at 2 milliamperes. Other filament tubes behave similarly, but the hum when minimum is much larger.

* * *

Phase Difference

CAN you illustrate the meaning of the phase difference between a voltage and a current; for example, a 90-degree phase difference?—C. D. A.

Fig. 849 shows two curves, one for voltage and one for current. They are 90 degrees out of phase, or a quarter period out of phase. The voltage is leading the current because at an instant when the voltage is maximum the current is zero, and when the voltage is zero immediately after the current has attained its maximum.

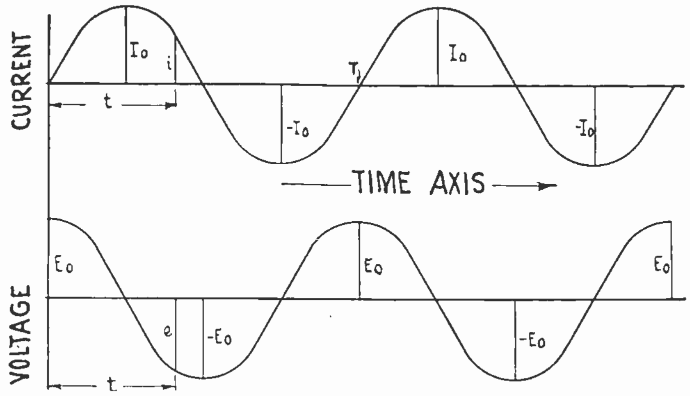


FIG. 849

TWO-SINUSOIDAL CURVES, ONE FOR VOLTAGE AND ONE FOR CURRENT, ILLUSTRATING THE TIME-RELATIONSHIP BETWEEN THEM WHEN THEY ARE 90 DEGREES OUT OF PHASE.

KTNT—Muscatine, Iowa ....5 Kw. KWSC—Pullman, Wash. ....2 Kw., 500 KTLC—Houston, Texas.........................100

FRANKLIN

TRANSFORMERS

for

Radio Receivers
Radio Broadcasting
Neon Tube Bombarding
All industrial purposes

MOTORS

Fractional H. P. for all purposes

We will appreciate the opportunity of quoting on your requirements

FRANKLIN
Transformer Mfg. Co.
607-9 Twenty-Second Ave. N.E.
Minneapolis, Minn.

KEY TUBES

Quality First

The following constitute the thirteen most popular tubes used in radio today. Despite the severely low prices the Key tubes are firsts of the very first quality. The tubes are manufactured under licenses granted by the RCA and its affiliated companies.

All prices are net and represent extreme discount already deducted.

GUARANTY RADIO GOODS CO.,
143 West 45th St., N. Y. City. (Just East of Broadway)

Enclosed please find $.............. for which ship at once tubes marked below:

☐ 224 AC screen grid $1.43
☐ 245 AC power tube $1.10
☐ 226 AC amplifier .... .68
☐ 227 AC det.-amp. .... .85
☐ 222 battery SG $1.88
☐ 112A power tube .... .78
☐ 171A power tube .... .78
☐ 201A battery tube .... .53
☐ 240 hi mu tube $1.60
☐ 250 power tube $4.95
☐ 210 power tube $3.25
☐ 280 AC rectifier $1.00
☐ 281 AC rectifier $2.95

Name ....

Address ....

City.................................. State...........

☐ Put cross here if C. O. D. shipment is desired. Canadian remittance must be by postal or express money order.

HAMMARLUND DOUBLE DRUM DIAL—Each section individually tunable. List price $6—our price, $3. Guaranty Radio Goods Co., 143 W. 45th St., New York.

"SECONDS"

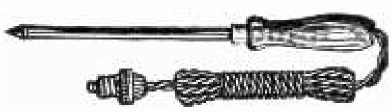
TUBES that fall a trifle below the most exacting laboratory specifications may be obtained at prices that seem incredible. They are called "seconds" and they are "seconds," but they are not "thirds." Note the prices. Remit with order.

201A	.50c	224	.70c
UV199	.70c	245	.75c
UX199	.70c	280	.75c
200A	.70c	281	.85c
240	.70c	210	.90c
227	.70c	250	$1.00

DIRECT RADIO CO.
Room 504
1562 Broadway, N. Y. City
(Between 46th and 47th Streets)
MAIL ORDERS FILLED

"MATHEMATICS OF RADIO."—A great help to everybody interested in radio. $2 postpaid. Radio World, 145 W. 45th St., N. Y. City.

SOLDERING IRON FREE!



Works on 11 ... power, 50 watts. A serviceable ... with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.

RADIO WORLD
145 West 45th St. N. Y. City

Songwriters Service Co.

6719 Hollywood Boulevard, Dept. R. W.
Hollywood, California

Talking Pictures offer new opportunities. Your songs personally submitted to Picture Studios, revised for publication by Hit Writers. Words, Music, Arranging, everything pertaining to songs.

Two for the price of *One*

Get a FREE one-year subscription for any ONE of these magazines:

☐ CITIZENS RADIO CALL BOOK AND SCIENTIFIC DIGEST (quarterly, four issues).
☐ RADIO (monthly, 12 issues; exclusively trade magazine).
☐ RADIO ENGINEERING (monthly, 12 issues; technical and trade magazine).
☐ RADIO INDEX ((monthly, 12 issues) Stations, programs, etc.
☐ SCIENCE & INVENTION (monthly, 12 issues; scientific magazine, with some radio technical articles).
☐ AMERICAN BOY—YOUTH'S COMPANION (monthly, 12 issues; popular magazine).
☐ BOYS' LIFE (monthly, 12 issues; popular magazine).

Select any one of these magazines and get it FREE for an entire year by sending in a year's subscription for RADIO WORLD at the regular price, $6.00. Cash in now on this opportunity to get RADIO WORLD WEEKLY, 52 weeks, at the standard price for such subscription, plus a full year's subscription for any ONE of the other enumerated magazines FREE! Put a cross in the square next to the magazine of your choice, in the above list, fill out the coupon below, and mail $6 check, money order or stamps to RADIO WORLD, 145 West 45th Street, New York, N. Y. (Just East of Broadway).

Your Name ....

Your Street Address ....

City .... State..................

DOUBLE VALUE!

☐ If renewing an existing or expiring subscription for RADIO WORLD, please put a cross in square at beginning of this sentence.
☐ If renewing an existing or expiring subscription for other magazine, please put a cross in square at the beginning of this sentence.

RADIO WORLD, 145 West 45th Street, New York, N. Y. (Just East of Broadway)

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

7 cents a word — 10 words minimum — Cash with Order

TESTED TUBES—201A, .43; 226, 227, 171A, 224, 245, 280, .48. Unshielded 85 milliampere filter chokes, .49. Waterman Radio, 2140 Kirby West, Detroit, Mich.

COLOSSAL BARGAIN—A 4-tube AC 105-120 Volt, 50-60 cycle, custom made receiver, in table model cabinet, with Mayolian B eliminator, A battery, Westinghouse trickle charger, C bias batteries, Relay switch, 5 tubes (includes Raytheon rectifier). One dial finger tuning, 171 output. Operates dynamic. Humless, sturdy performer. Can be heard by appointment. Will install free in residence if in or around New York City. A. Basbein, 1116-56 Street, Brooklyn, N. Y.

1929-1930 CORRESPONDENCE RADIO COURSE. 62 texts $60. Particulars dime. Stephen Plavetich, 1597 East 47th Street, Cleveland, Ohio.

LOFTIN-WHITE AMPLIFIER $30—Wired and Tested. Robert Murphy, 1108 Ridgewood Drive, Fort Wayne, Indiana.

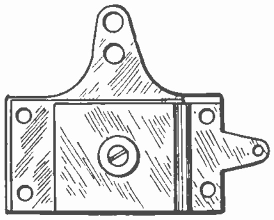
ELECTRAD LOFTIN-WHITE DIRECT-COUPLED AMPLIFIER NEVER USED $17.50. USED FRESHMAN PORTABLE 210 POWER AMPLIFIER $10.00, WITH TUBES $13.75. REAL BARGAINS. H. DE LANEY, 35 REMY AVE., MANSFIELD, OHIO.

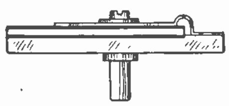
POWER UNIT CONSTRUCTION—The book that enables you to wind your transformers, chokes, and figure correct size resistors for the voltage control, and other valuable information. Price .50. Shipped C. O. D.. Ralph B. Davis & Co., Prestonsburg, Ky.

BARGAINS in first-class, highest grade merchandise. B-B-L phonograph pick-up, theatre type, suitable for home, with vol. control, $6.57; phono-link pick-up with vol. control and adapter, $3.50; steel cabinet for HB Compact, $3.00; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips, 18c. P. Cohen, Room 1214, at 143 West 45th Street, N. Y. City

Accurate Tuning Condensers and Accessories

EQUALIZER

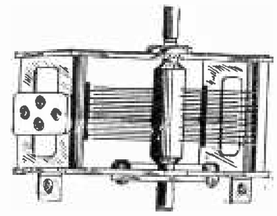




CAT. EQ-100 AT 35c

The most precise and rugged equalizing condenser made, with 20 mmfd. minimum and 100 mmfd. maximum, for equalizing the capacity where gang condensers are used that are not provided with built-in trimmers. Turning the screw alters the position of the moving plate, hence the capacity. Cross-section reveals special threaded brass bushing into which screw turns, hence you can not strip the thread. Useful in all circuits where trimming capacity of 100 mmfd. or less is specified. Maximum capacity stamped on

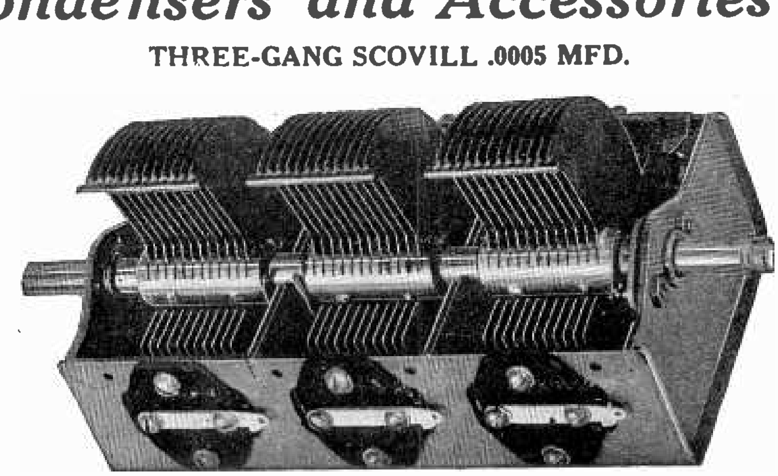
SINGLE .00035



CAT. KH-3 AT 85c

A single .00035 mfd. condenser with nonremovable shaft, having shaft extension front and back, hence useful for ganging with drum dial or any other dial. Shaft is ¼ inch diameter, and its length may be extended ⅜ inch by use of Cat. XS-4. Brackets built in enable direct subpanel mounting, or may be plied off easily. Front panel mounting is practical by removing two small screws and replacing with two 8/34 screws ¾ inch long. Condenser made by Scovill Mfg. Co.

THREE-GANG SCOVILL .0005 MFD.



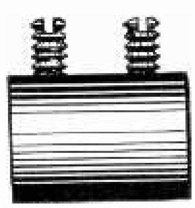
One of the finest, strongest and best gang condensers ever made is this three-gang unit, each section of full .0005 mfd. capacity, with a modified straight frequency line characteristic. The net weight of this condenser is 3¼ lbs. Cat. SC-3G—5 at $4.80.

HERE is a three-gang condenser of most superior design and workmanship, with an accuracy of at least 99¾ per cent. at any setting — rugged beyond anything you've ever seen. Solid brass plates perfectly aligned and protected to the fullest extent against any displacement except the rotation for tuning. It has both side and bottom mounting facilities. Shaft is ⅜ inch diameter and extends at front and back, so two of these three-gangs may be used with a single drum dial for single tuning control. For use of this condenser with any dial of ¼" diameter bore, use Cat. XS-8, one for each three-gang. Tension adjusters shown at right, either side of shaft.

SALIENT FEATURES OF THE CONDENSER

(1)—Three equal sections of .0005 mfd. capacity each.
(2)—Modified straight line frequency shape of plates, so-called midline.
(3)—Sturdy steel frame with rigid steel shields between adjacent sections. These shields minimize electric coupling between sections.
(4)—The frame and the rotor are electrically connected at the two bearings and again with two sturdy springs, thus insuring positive, low resistance contact at all times.
(5)—Both the rotor and the stator plates are accurately spaced and the rotor plates are accurately centered between stator plates.
(6)—Two spring stoppers prevent jarring when the plates are brought into full mesh.
(7)—The rotor turns as desired, the tension being adjustable by set-screw at end.
(8)—The shaft is of steel and is ⅜ inch in diameter.
(9)—Each set of stator plates is mounted with two screws at each side of insulators, which in turn are mounted with two screws to the frame. Thus the stator plates cannot turn sidewise with respect to the rotor plates. This insures permanence of capacity and prevents any possible short circuit.
(10)—Each stator section is provided with two soldering lugs so that connection can be made to either side.
(11)—The thick brass plates and the generous proportions of the frame insure low resistance.
(12)—Provision made for independent attachment of a trimmer to each section.
(13)—The steel frame is sprayed to match the brass plates.
(14)—The condenser, made by America's largest condenser manufacturer, is one of the best and sturdiest ever made, assuredly a precise instrument.

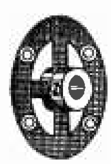
RIGID AND FLEXIBLE LINKS



CAT. RL-3 AT 12c

For coupling two ¼ inch diameter shafts, either coil shaft and condenser shaft, or two condenser shafts, a coupling link is used. This may be of the rigid type, all metal, where the linked units are not to be insulated.

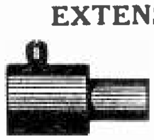
The rigid link, Cat. RL-3, has two set-screws, one to engage each shaft, and is particularly serviceable where a grounded metal chassis is used, as the returns then need no insulation.



CAT. FL-4 at 30c

Flexible insulated coupler for uniting coil or condenser shafts of ¼ inch diameter. Provides option of insulated circuits

EXTENSION SHAFTS, TWO SIZES



CAT. XS-4 AT 10c

Here is a handy aid to salvaging condensers and coils that have ¼" diameter shafts not long enough for your purpose. Fits on ¼" shaft and provides ⅜" extension, still at ¼". Hence both the extension shaft and the bore or opening are ¼" diameter. Order Cat. XS-4.

For condensers with ⅜" diameter shaft, to accommodate to dials that take ¼" shaft, order Cat. XS-8 at 15c.

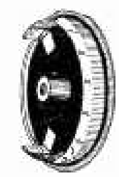
.00035 TWO-GANG

A two-gang condenser, like the single type, KHS-3, but consisting of two sections on one frame, is Cat. KHD-3, also made by Scovill. The same mounting facilities are provided. There is a shield between the respective sections. The tuning characteristic is modified straight frequency line. Order Cat. KHD-3 at $1.70.

DRUM DIAL

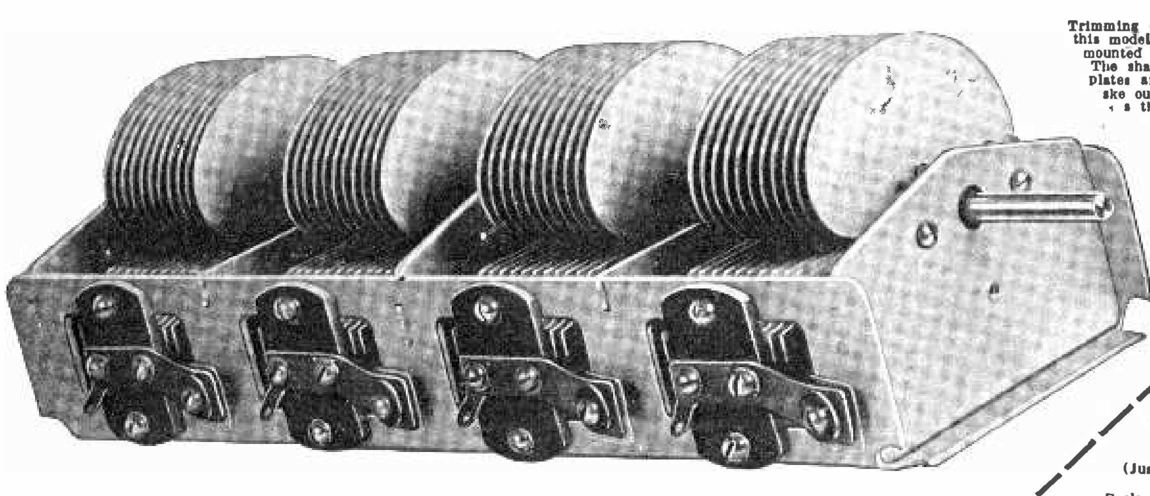
CAT DD-0-100 @ $1.50

A suitable drum dial of direct drive type is obtainable for ¼" shafts or ⅜" shafts, and with 0-100 scales. An escutcheon, is furnished with each dial.



FOUR-GANG .00035 MFD. WITH TRIMMERS BUILT IN

Trimming condensers are built into this model. The condenser may be mounted on bottom or on side. The shaft is removable, also the plates are removable, so you can take out one section and operate as a three-gang.



Four-gang .00035 mfd. with trimmers built in. Shaft and rotor blades removable. Steel frame and shaft aluminum plates. Adjustable tension at rear. Overall length, 11 inches. Weight, 3½ lbs. Cat. SPL-4G-3 $3.95.

A four-gang condenser of good, sturdy construction and reliable performance fits into the most popular tuning requirement of the day. It serves its purpose well with the most popular screen grid designs, which call for four tuned stages, including the detector input.

Ordinarily a good condenser of this type costs, at the best discount you can contrive to get, about twice as much as is charged for the one illustrated and even then the trimming condensers are not included. The question then arises, has quality been sacrificed to meet a price? As a reply, read the twenty-six points of advantage. The first consideration was to build quality into the condenser. The accuracy is 99¾%.

SHORT WAVES

Tuning condensers for short waves, especially suitable for mixer circuits and short-wave adapters. These condensers are .00015 mfd. (150 micro-microfarads) in capacity. They are suitable for use with any plug-in coils. Order Cat. SW-S-150 @ $1.50. To provide regeneration from plate to grid return, for circuits calling for this, use .00025 mfd. Order Cat. SW-S-250 @ $1.50.

GUARANTY RADIO GOODS CO.,
143 West 45th St.,
N. Y. City
(Just East of Broadway.)

Enclosed find $..........for which ship designated parts:

....

Street Address....................... .....

City................ State....... ....

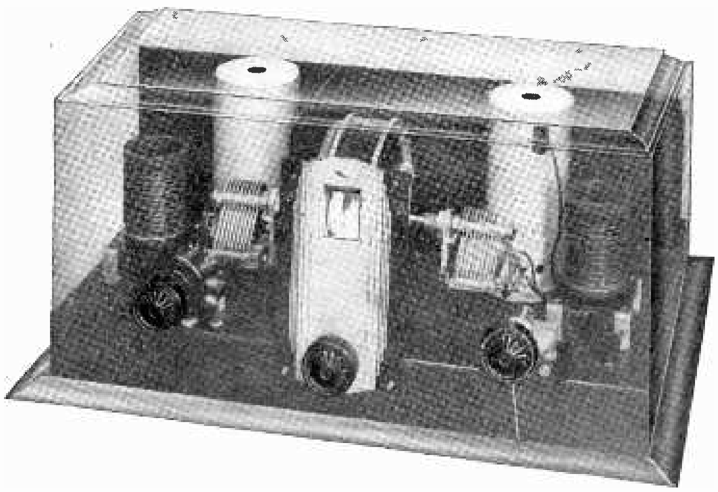
the following merchandise as advertised:

☐ Cat. XS-4 @ 10c
☐ Cat. KH-3 @ 85c
☐ Cat. XS-8 @ 15c
☐ Cat. KHD-3 @ $1.70
☐ Cat. RL-3 @ 12c
☐ Cat. DD-0-100 @ $1.50
☐ Cat. EQ-100 @ 35c
☐ Cat. SC-3 G-5 @ $4.80
☐ Cat. SPL-4 G-3 @ $3.95
☐ Cat. FL-4 @ 30c
☐ Cat. SW-S-150
☐ Cat. SW-S-250

ALL PRICES ARE NET

HUMLESS A. C. Operation

on the Short Waves
with the New A. C. THRILL BOX



COMBINES every requirement of the expert Short-Wave Experimenter and Amateur, and the Radio Enthusiast who wants good loudspeaker reception of SW broadcasts from all over the world. Not a compromise between a Short Wave and Broadcast circuit. A. C. Model gives FULL A.C. OPERATION. No hum, even with head phones. DOUBLE SCREEN-GRID with grid-leak detection. Special New R-39 Type R.F. Coupling Transformers. No special tubes required. Uses standard heater tubes throughout. Single dial operation, easy to operate and log. Uses New NATIONAL Projector Dial. No grunting or backlash, no hand capacity; Loud Speaker operation from Foreign Stations; push-pull audio with special phone-jack after first stage.

Thoroughly shielded chassis. Easy to assemble and wire. Ideally suited not only for Short Wave Broadcast reception, but for all S. W. amateur and communication uses. Easily adapted for still wider spread of amateur bands, if desired.

Also available in new battery model, using the new UX 230, 231 and 232 tubes.

Write Us Today! Use Coupon

NATIONAL

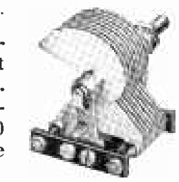
PRECISION SHORT-WAVE
RADIO PRODUCTS

The New NATIONAL A. C. SW-5 THRILL BOX is easily assembled by anyone with genuine NATIONAL Radio Parts. Some of the more outstanding of these are described below.

R. F. Transformers

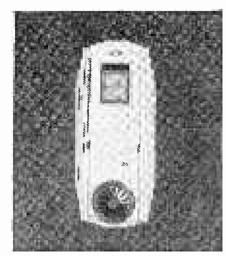
Standard set of four pairs covering from 21.2 to 2.61 m.c. Special coils can be supplied for the 33—21.2 m.c. and the 2.61—1.5 m.c. ranges. Forms are moulded R-39, the new low loss coil material, developed by Radio Frequency Laboratories. Blank forms also available for winding experimental coils.

The Condensers



The type S-100, specially designed for short-wave work, not a cut-down broadcast condenser. Insulated main bearing and constant impedance pigtail. 270 degrees straight frequency line plates.

The Dial



The NATIONAL Projector Type Drum Dial, standard equipment on the A. C. Thrill Box, has the same easy control that is characteristic of the National Velvet-Vernier Dials. Equipped with non-metallic drive, avoiding clicking and de-tuning. The dial scale is projected in magnified form on to a ground glass screen which reads the same from any position, without parallax. The escutcheon, of beautiful modern design, is finished in brush silver.

The Power Unit

A separate unit, with handy cable and soft rubber covered connecting plug. Designed for humless operation, incorporating special R. F. filter in addition to double section hum-filter. Employs UX-280 Rectifier tube and licensed under R. C. A. Patents.

Send Today!

COUPON

NATIONAL COMPANY, INC.
Sherman, Abbot and Jackson Sts., Malden, Mass.

Gentlemen: Please send me complete information on the NEW National S. W. 5 THRILL BOX. ( ) A.C. ( ) Battery Operated.

I am interested in S. W. Apparatus for Experimental and amateur use (check here) ( )

Name ....

Address ....

RW-9-30