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1930

RADIO WORLD

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438th Consecutive Issue—NINTH YEAR

How to Introduce Automatic Volume Control, Tone Control and Band Pass Filter In An Old Set

Double Push-Pull Audio, with Thorough Filtration, in a Model Power Amplifier

A Portrait of Electro-Magnetism

Modern Radio Tubes: A Discussion of 201A, 220 and 240

Is Push-Pull Resistance Coupling a Myth?

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.

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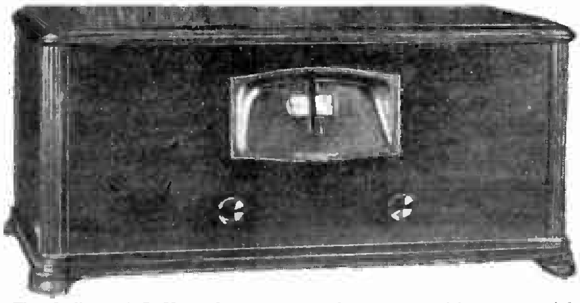
Balkite Push-Pull Receiver



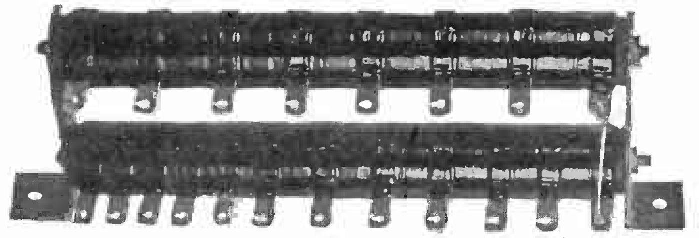
The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v. 50-60 cycles; in a table model cabinet, genuine walnut, made by Berkey & Gay.

Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high and the wiring is done with extreme expertness, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal undercover, so there is no stray pickup. Cat. BAL-A5, list price $135; net price......... **$44.00**

New Multi-Tap Voltage Divider



The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

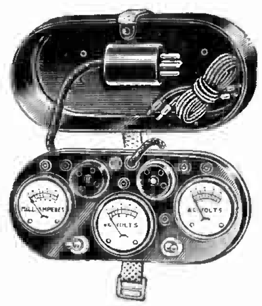
Order Cat. MTVD, list price $6.50, net price.................... **$3.90**

Silver-Plated Coils

Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat., G-RF-3CT, list price $5.00; net price.................... **$2.48**

R-245 Set and Tube Tester



With the R-245 Tube and Set Tester you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: Plate current, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 10 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connections to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX199, UX120, 210, 171, 171A, 112, 112A, 245, 224, 222, 226, 227, and pentodes.

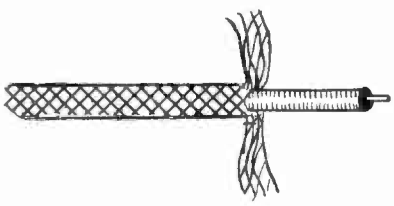
When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately, all three reading at the same time.

Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no mater if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

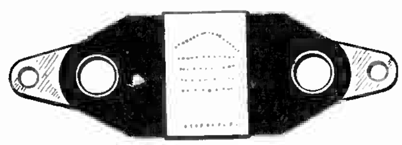
Order Cat. R-245. List price, $20; net price........... **$11.40**

Shielded Lead-in Wire



No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot **5c**

Fixed Condensers

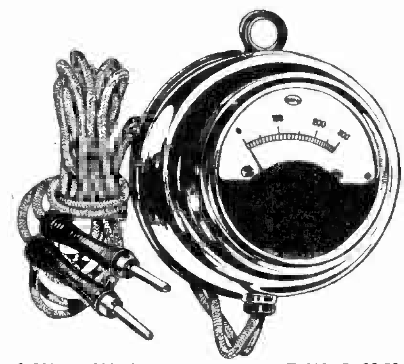


Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.006	20c
.00025 mfd.	10c	.00025 with clips.	20c
.0003 mfd.	10c	All are guaranteed electrically perfect and money back if not satisfied within five days.	
.00035 mfd.	15c		
.001	17c		
.0015	17c		
.002	18c		

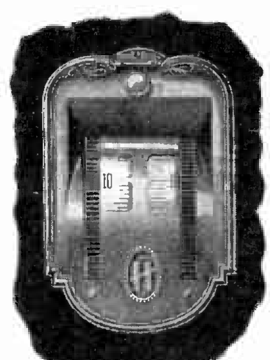
Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters



0-300 v., 200 ohms per volt. Cat. F-300 @ $2.59
0-500 v., 233 o.p.v. Cat. F-500 @...... 3.73
0-600 v., AC and DC (same meter reads both); 100 ohms p.v. Order Cat. M-600 @ 4.95

Double Drum Dial

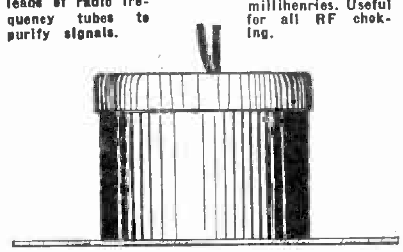


Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price $6.00; net price **$3.00**

Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to purify signals.

An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for all RF choking.



In some instances one outlead is connected to case, so use this lead for B-plus or for ground, otherwise ground the case additionally. Order Cat. SH-RFC. List price, $1.00; net price **50c**

Guaranty Radio Goods Co., 143 West 45th St., New York, N. Y.
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☐ MTVD @ ... 3.90 ☐ F-300 @..... $2.59
☐ G-RF-3CT @ 2.48 ☐ H-DDD @... $3.00 ☐ F-500 @..... 3.73
☐ R-245 @..... 11.40 ☐ SH-RFC @... 50c ☐ MICON.... @ ....
☐ MICON.... @ ....
☐ If C.O.D. shipment is desired put cross here.

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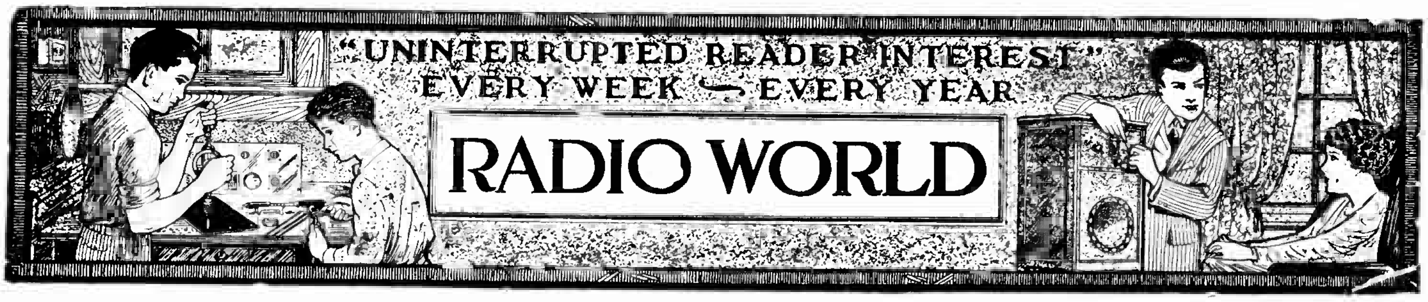

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No Resistance Push-Pull!

By Brunsten Brunn

THERE has been much talk about resistance coupled push-pull amplifiers. The one obstacle in the path to the successful design of such amplifiers has been the practical impossibility of coupling a single-sided detector to a push-pull resistance coupled amplifier, that is, an amplifier which appears to be push-pull.

Various schemes have been proposed for making the coupling but nearly all of them have been based on misunderstanding. In most cases one side of the push-pull amplifier has been dead, and that is just the difficulty—to couple a one-sided detector, or amplifier, to a push-pull amplifier without killing one side. In other cases both sides have been alive all right, but not in the manner that made a balanced amplifier. There was no consideration whatsoever of phase of the signals impressed on the two sides.

A prime requisite of a push-pull amplifier is that the signals impressed on the two sides be exactly equal in absolute value and exactly opposite in phase at all frequencies.

The closest approach to the proper coupling is that which utilizes a phase inverter tube. A tube inverts the phase of the signal and therefore by means of a tube it is possible to approach the desired coupling. It is a simple matter to adjust the absolute values of the signals so that they are equal.

Difficulties with Phase Inverter

But the phase inverter tube solves the problem only approximately. The main difficulty is that stopping condensers must be used, and condensers introduce phase shifts differing from 180 degrees, and the amount of shift depends on the frequency. The signal going through the phase inverter tube is changed in phase differently from that going directly to the other side of the amplifier. The difference may be small but the fact is that it does exist. Of course, by suitable choice of constants it is possible to make the difference very small, especially in the audible range of frequencies. And we are not much interested in what goes on at other frequencies.

Edward Loftin and S. Young White have applied the phase inverter tube to their well-known method of direct coupling and the resulting amplifier delivers a satisfactory quality. But whether there is any improvement in the quality by virtue of the push-pull arrangement is a question, for the single-sided amplifier also delivers a very satisfactory quality. It would be necessary to analyze the output with a sensitive analyzer to determine whether there has been any reduction in the harmonics of even order. The ear is not keen enough to detect the difference, although it can tell that the volume has been increased.

Doubt Resistance Push-Pull

There is serious doubt about the possibility of resistance or direct coupled push-pull at all, because the mid-points of the coupling resistors and the grid leaks are at ground effectively. It can be shown that the sum of the signal voltage drop in R1 and R2, Fig. 1, does not contain the harmonics of even order, but the drop in each one contains them all. The signal voltages are not averaged before they are impressed across the two grid leaks R3 and R4, because the junction of R1 and R2 is grounded, but the signal voltage in R1 is transmitted to R3 as it is, harmonics and all, and likewise the signal voltage in R2 is transmitted to R4 just as it is. It is not the half of the voltage drop in R1 and R2 that is transmitted to either R3 or R4.

Hence, whatever harmonics are developed in the plate circuit of the upper tube in the first stage are transmitted to R3 and to the grid of the upper tube in the second stage. The same applies to the case of the lower two tubes.

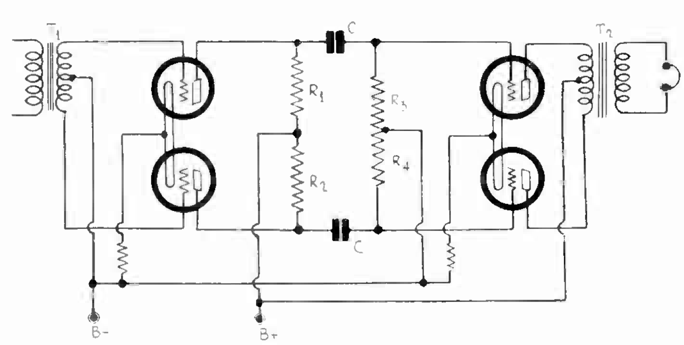

FIG. 1
A RESISTANCE COUPLED AMPLIFIER APPARENTLY PUSH-PULL THROUGHOUT, WHICH IN FACT IS NOT TRULY PUSH-PULL BECAUSE OF THE GROUNDING OF THE MID-POINTS OF THE COUPLING RESISTORS AND THE GRID LEAKS.

Indeed the situation is worse, for it is not really the voltage drop in R1 that is transmitted to R3, but the voltage drop between the plate of the upper tube and the filament of that tube. Likewise, it is not the voltage drop in R2 that is transmitted to R4 but the voltage drop between the plate of the lower first-stage tube and the filament of that tube. Now, there is always an impedance between the junction of R1 and R2 and the common filament point. In this impedance the even harmonics of the output of the two tubes flow, and also the odd harmonics if the tubes are not equal and operated equally. The voltage drop in this impedance is such that it adds to the signal input to one of the output tubes and detracts from that of the other. The signals put on the output tubes are therefore quite different, even if the first tubes are exactly equal and exactly equally operated.

Therefore, a circuit which in form is push-pull resistance coupled is really an unbalancer instead of a balancer. It is true that the unbalancing impedance can be reduced by means of by-pass condensers so that the effect is very small, but there is always some left to cause unbalance. But even when this impedance is zero, there is still no true push-pull action because the grounding of the mid-points of the coupling resistors and the grid leaks precludes the possibility. In effect, even under the best conditions, the tubes are working in parallel, except in so far as the input transformer T1 and the output transformer T2 perform the push-pull function.

The input of the circuit in Fig. 1 is all that is required of a push-pull amplifier. The secondary is center tapped and the total voltage developed across it is divided equally and in opposite phase. However, harmonics of even order existing in the primary of this transformer are not balanced out. They are carried over to the secondary and there become a part of the signal that is impressed on the tubes. These harmonics are in the signal for good and cannot be extracted by any balancing arrangement.

If it were possible to couple the output tubes by means of R3 and R4 without grounding the center it would still be possible to obtain true push-pull action out of the resistance coupled amplifier. This cannot be done if the same voltage sources are to be used for the two stages, and even when separate sources

(Continued on next page)

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Bringing an Exist

By Herman

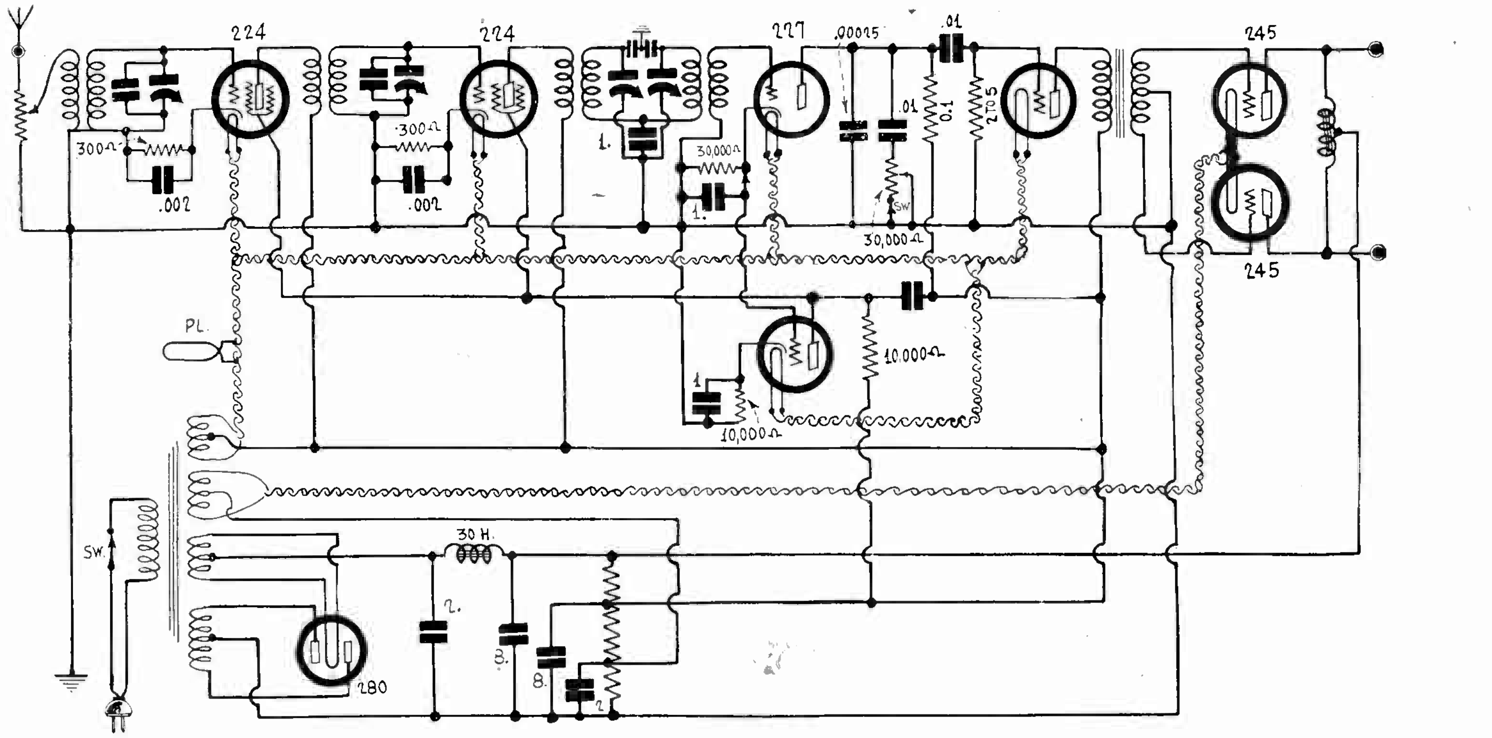

FIG. 1.
AN EIGHT-TUBE SET, CONVERTED FROM LAST YEAR'S DESIGN, TO INCORPORATE AUTOMATIC VOLUME CONTROL, TONE CONTROL AND BAND PASS FILTER.

MANY who possess an eight-tube chassis and have been reading about latest improvements in radio receivers are interested in enjoying the advantages of these improvements, but not quite to the extent of discarding their present receiver. Therefore, some suggestions will be presented for conforming an existing eight-tube receiver to the inclusion of automatic volume control, tone control and band pass filter.

Since the tone control is an easy inclusion, let us take up the automatic volume control first.

There are eight sockets, these for three stages of radio frequency amplification, detector, first audio, push-pull second audio, and rectifier. If the usual tube arrangement is used in the receiver it will be three 224s, two 227s, two 245s and a 280.

May Include Band Filter

To incorporate an automatic volume control we require a tube, and this may be taken from the radio frequency amplifier. If you have a four-gang condenser in the set, you may introduce a band pass filter, which would use the tuning apparatus already there, but free the desired socket. Fig. 1 shows the diagram with the band pass filter.

The heater and filament wiring of the receiver is left intact, the rectifier circuit is not changed, the number and types of tubes are no different and the audio amplifier need not be molested. A resistance-coupled push-pull audio amplifier is shown only to make the circuit complete, but not to encourage any audio change. As a tube is to be gained for automatic volume control, this may be the third RF tube, and the band pass filter is to be located at the detector input.

In Fig. 2 the arrangement for automatic volume control is detailed. Usually a volume control is shown as receiving a radio frequency input, the circuit being so arranged that increased amplitude of the carrier increases plate current and increases the voltage drop in a resistor, hence increases the negative voltage applied for bias of RF tubes connected to the resistor, or decreases the voltage if the screen grids are connected to the volume control tube.

The reason for the difference, that is, the control tube is used for increasing negative grid bias or decreasing positive screen bias, is either that the governed circuits are connected differently to the volume control tube, or that tube is worked at different points on its characteristic curve. A tube may be so biased, positively or negatively, so that when carrier amplitude increases, the plate current either increases or decreases. In general, low negative bias, as for amplification, causes the plate current to decrease with carrier intensity increase; high negative bias and some positive biases, cause the plate current to increase with carrier intensity increase.

Biasing Resistor Is Control Input

The volume control tube that is at present under discussion simply receives as its grid-to-cathode input the DC voltage drop in the detector's biasing resistor. Therefore if your receiver uses grid-leak condenser type of detection, it is necessary to change over to negative bias detection. This can be done easily, by shorting out the grid-leak-condenser, changing the grid return from cathode to ground, increasing the plate voltage, and putting between cathode and ground, a biasing resistor with by-pass condenser across it. For resistance coupling, as shown, 50,000 ohms is maximum value, while around 30,000 ohms may be preferable. For transformer coupling used

Can Push-Pull Resis

(*Continued from page 3*)

are used there is usually enough capacity between the center point of the filament in the last stage and ground to upset the balance, or the averaging effect that would be obtained in R3 and R4.

As soon as the mid-tap connection is removed from R3 and R4, even order harmonics do not exist across the two resistances but this does not obtain when the mid-tap is grounded, whether directly or through a large condenser.

Push-Pull Output

The output of the circuit is truly push-pull in so far as the plate circuit is concerned. Even harmonics introduced in the plate circuits of the output tubes are averaged, that is, nullified, by the output transformer so that in the secondary only the fundamental and the higher odd harmonics appear.

This is on the assumption that the signals impressed on the grids of the power tubes are equal in magnitude and opposite in phase. But we have seen that the coupler between the stages upsets the balance because the junctions of the plate coupling resistors and the grid leaks are grounded.

An Interstage Transformer

If we have a push-pull interstage transformer in place of the resistance couplers we have true push-pull throughout. The primary of this transformer is center tapped and effectively grounded. Therefore even order voltages occur across each half, and of course even order harmonic currents flow through each half also, for otherwise there would be no voltage drops. But these harmonics flow through the primary windings in opposite phase and therefore they nullify each other's magnetic effect on the core. Hence there will be no even order harmonic voltage induced in the secondary. If the secondary is center-tapped, the

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ing Set Up to Date

Bernard

after the detector, instead of resistance coupling, the biasing resistor may be lower, around 15,000 to 20,000 ohms, due to the larger plate current. It is advisable, in the event of transformer coupling, so to arrange the circuit that the detector plate current does not exceed 1 milliampere, for even the finest types of transformers of moderately low ratio, say, 1-to-3, are designed for an inductance of around 200 henrys at 1 milliampere, while if as much as 3 milliamperes flow, the inductance declines to well below 100 henrys. A high effective inductance in the detector plate circuit is doubly desirable. By using 30,000 ohms and 0.5 ma, the inductance is far above 200 henrys and 15 volt negative bias results.

The biasing resistor's input is made to the volume control tube in such manner that the volume control's grid is positive for all settings of the potentiometer arm except zero. Since the cathode of the detector tube is positive, by the amount of the detector grid bias, all that need be done is to connect the detector cathode to the volume control tube's grid, while the control tube's cathode goes to ground, to effectuate the reversal.

The output of the volume control tube has a resistor plate load, bypassed sufficiently to establish a high time constant and remove modulation from the plate circuit. Without a high time constant the low notes of the modulation might be subdued or eliminated.

The time constant, of a resistor with parallel condenser, is the product of the resistance in ohms and the capacity in farads. If the resistor is 30,000 ohms and the condenser is 1 mfd., then the time constant is 30,000 x .000001 farad, or .03. The time constant is in seconds, so that attenuation would start in at 33 cycles per second. Hence for a receiver that reproduces well as low as 30 cycles, the capacity in conjunction with 30,000 ohms may better be 2 mfd. As it is more economical to make the resistance higher, rather than the capacity alone, the time constant can be increased simply by so circuiting the control tube as to pass less plate current. A bucking resistor will do this. It is placed in the cathode leg to ground. Thus the control tube, instead of having a 15-volt positive grid, at 13 ma plate current, would have a 3 or 4 volt positive grid, at about 6 milliamperes.

By connecting the plate of the volume control tube to the screen grids the automatic volume control is established.

Something has been said about the danger of attenuating or eliminating the low frequencies of modulation by an incorrectly designed volume control circuit. If we examine critically the operation of the present design we will discover whether any such injurious effect results even though the preliminary precaution was taken of establishing elsewhere in the circuit a suitable time constant, high enough to sustain the low-note amplification of modern receivers and the range of modern speakers.

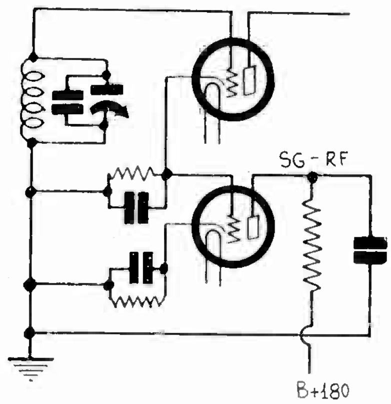

FIG. 2
DETAIL OF THE DETECTOR INPUT AND AUTOMATIC VOLUME CONTROL.

Looking at the detector tube in Fig. 1 we find that as the carrier intensity increases, the plate current through the biasing resistor increases, for this is a negative bias detector, and modulates upward. So far there is a small automatic volume control action right in the detector tube, if biased at its most sensitive point in this general region, because the louder the signal, the stronger the carrier, the higher the bias, and removal in either direction from the point of most sensitive detection decreases volume. However, the relative effect is altogether slight.

Now, with the detector biasing resistor as the inverted input to the control tube, any increase in carrier intensity increases the positive bias on the control tube and increases the plate current in that tube. Due to the bypass condenser across the detector biasing resistor, there is no radio frequency input to the control tube, only direct current, and the volume control tube is worked not as a detector or as an amplifier but as a voltage regulator. Electrically this is the use of a vacuum tube as a variable resistor.

Now, across the plate resistor in the control circuit we have a large capacity. This is the only filter needed. Its object is to remove the signal voltage. While the input to the control tube was DC, it was unsteady DC, of the type known as pulsating, the pulsations arising from the modulation. Now we have removed the modulation from the circuit that connects to the screens of the radio frequency amplifying tubes. Is this not a reversion to the same evil condition that arose in another particular, and was solved then, only to be ignored now? It is not.

The reason is plain when one stops to think that the screen voltage is merely a positive bias, and we apply our biases as free from modulation as is possible or practical, which is why you see bypass condensers across all biasing resistors, save only in some truly symmetrical push-pull circuits. Hence as we do not want any modulation current in the screen grids, little fault can be found with a system of getting rid of it. And, come to think of it, don't we always connect a relatively large condenser from screen grid to ground, to steady the potential on the screens?

The tone control consists of an adjustable resistor in series with a fixed condenser. The object is to reduce the strength of the high audio frequency notes, thus bringing out the lows. The condenser is of relatively large capacity for this position, .01 mfd. So, if the resistor were shorted out of circuit there would be sharp reduction of the high audio frequencies. The more resistance engaged, the less the attenuation of the highs. Thus a continuously adjustable tone control is used, but it need not be in circuit all the time. If, for listening to talks, it is desired to bring out the highs strongly, the switch built into the adjustable resistor is used.

The constants are given on the circuit diagram, so that any one desiring to select values will have some guide. It is understood, however, that if any existing receiver is to be made over, it does not have to be rebuilt entirely, but only changed in the particulars stressed: principally the provision made for the automatic volume control tube and the tone control.

For these purposes two 30,000 ohm potentiometers with switch attached should be used, and if the switch is of the AC type, so much the better, for then the switch on the detector biasing resistor may be used as an AC line switch. The B supply need not be changed. If it has a double filter choke, that is all right.

The capacities used in the set now may be left as they are, even if they are smaller than those prescribed in Fig. 1 or Fig. 2, unless you experience hum, in which event you may use larger capacity, or may make the first audio stage, if transformer coupled, into a resistance-coupled stage as shown, thus reducing the drain about 9 milliamperes, a reduction of more than 10 per cent. Then the hum would be reduced about 25 per cent., without any change in filter capacities.

ance Coupling Exist?

induced voltage, free from even order harmonics, will be divided equally between the two output tubes, and the voltages will be in opposite phase.

Some Advantages

While the double resistance coupled circuit does not perform the push-pull action, it nevertheless has some advantages over a single-sided resistance coupled circuit. The odd harmonics are practically balanced out of the common impedance, and this includes the fundamental, since this is the first odd harmonic. If the balance is perfect there is no effective feedback through the common impedance, at least on the odd harmonics. Hence the double circuit may be quite stable even if either half alone is unstable. Even if the balance is not perfect, the stabilizing effect is quite great, and a circuit rarely motorboats. Since there is practically no feedback there is no distortion of the signal due to regenerative or degenerative action. The distortion referred to here is amplitude distortion and not wave form distortion.

Result of Test

There is another advantage arising from the same condition. If the supply voltage contains a residual ripple this will not give rise to a hum which it would do in a single-sided circuit, or at least the hum will be greatly reduced.

A circuit of this kind was set up and tested on these two points. It was fed by unfiltered current from a 110 volt DC supply. There was no appreciable hum but when one side of the amplifier was killed the hum was intense. A resistance was also put in series with the voltage supply so as to provide a common impedance to produce oscillation. When either side was used there was motorboating but when the two sides were used there was none.

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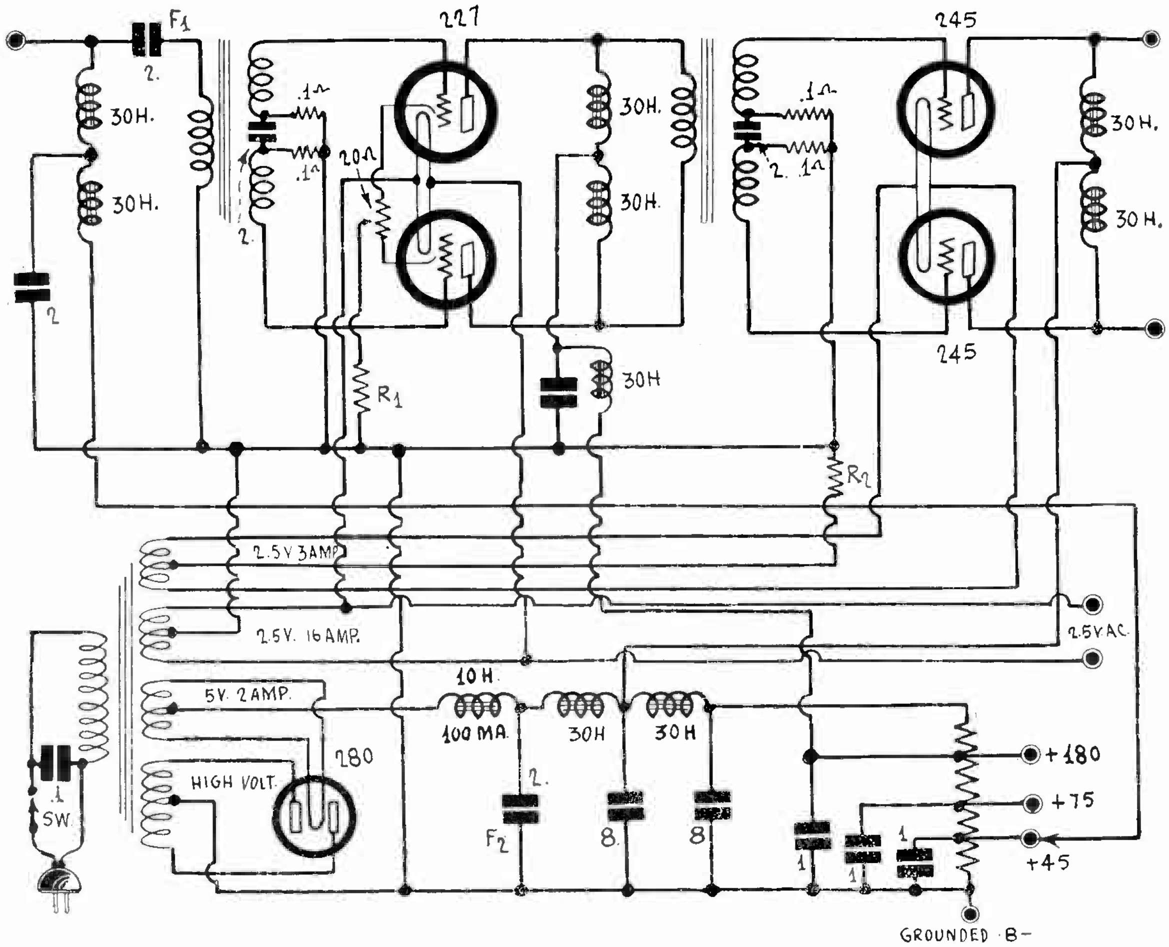
Thorough Filtrat in Double Pu

By H. B.



A PUSH-PULL circuit is a symmetrical one. It is a balanced circuit. At any given instant the voltages are equal on each of the two tubes in the push-pull stage, but opposite in phase. Thus, in the use of transformer-coupled audio, much better quality is possible from push-pull. The circuit action is such that the even order harmonics are balanced out, which is important because of the relatively strong second harmonic wave that may be present.

LIST OF PARTS

Two Amertran push-pull input transformers.
One Polo 245 power supply transformer.
Two five-prong (UY) and three four-prong (UX) sockets.
One subpanel.
Binding posts: one input (blank); two output, comprising a unit; two phonograph pickup, comprising a unit; one ground; one plus 45; one plus 67 (the nearest marking obtainable to 75); one 180; two 2.5 volts AC.
R1—One biasing resistor, 650 ohms, 1 watt.
R2—One biasing resistor, 833 ohms, 5 watts.
One three-section choke, 10 henries, 30 henries, 30 henries, respectively; rating, 100 ma.
F1 and F2—Two 2 mfd. high voltage condensers, 550 volts AC continuous working voltage.
Two 8 mfd. Aerovox dry electrolytic condensers.
One 0.1 mfd. condenser, 300 volts AC continuous working voltage.
Four 0.1 meg. resistors.
Seven 30 henry chokes, 65 ma rating.
Eleven 1 mfd. bypass condensers, 200 volts DC rating continuous working voltage (eight paired to constitute four 2 mfd. in amplifier).
One 20-ohm potentiometer.
One Multi-tap Voltage Divider.
Two 227 tubes, two 245 tubes and one 280 tube.

The general argument in favor of push-pull is that it is highly suitable for the output stage of an audio amplifier. The curative effect is enjoyed, hence the push-pull advantage is maintained at a high level of excellence, and the frequency distortion kept well below working standards, is the argument.

Where Push-Pull Doesn't

Sometimes one sees push-pull radio frequency circuits, sometimes push-pull detector circuits, and once in a while push-pull resistance-coupled audio circuits. As for RF, the advantages do not seem to be inviting, while as for push-pull detectors and push-pull resistance-coupled amplifiers, many believe that there are no such things, for although the circuit looks like push-pull, the actual functioning is that of simple cascaded stages.

However, very little has been written about a two-stage audio amplifier with transformer coupled push-pull in each stage. It seems to have been a neglected circuit for no good reason. Yet if push-pull is desirable in a transformer-coupled output stage, on which nearly all are agreed, it follows that push-pull is desirable in the preceding stage, for the same reasons.

The idea has gained ground that the grid swing of the first stage is modest, so the larger power handling capacity is not needed, and also that the push-pull output is a sort of a clean-up of any undesirable effects previously introduced. But the improvement is cumulative when double push-pull is used. If the last stage has less of the objectionable to suppress, then it performs better the less work that it has to do, just as a car with a lighter load will climb the hill more easily.

Stability Must Be Achieved

Since first-class audio transformers are readily available, the outstanding ones on the American parts market being Amertran and Ferranti, it follows that transformer-coupling may be accompanied by oscillation just as is resistance-coupling. The sensitivity of the amplifier at low frequencies causes the feedback through the common impedance of the B supply to set up reproducible low-frequency oscillation, which if low enough is

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ion and Matching
sh-Pull AF

Herman

called motorboating. Therefore the same precautions that must be taken in the case of resistance coupling should be taken with transformer coupling. It is a compliment to a transformer that a circuit using it can motorboat.

Therefore, since stability has now become a problem even in transformer coupling, when finest transformers are used, push-pull in each stage is a step in the direction of stability, while adequate filtering takes care of the rest of the problem. The filtration should be excellent both in the B supply and in the respective audio stages.

Fig. 1 shows a power amplifier, using two push-pull transformer-coupled stages. The detector (not shown) feeds two 227s, which in turn feed two 245s.

The input is filtered in two ways: the plate current is separately sent through two choke coils while the signal current is delivered through F1, a 2 mfd. condenser; one of the two choke coils is by-passed by a condenser to form an inductance-capacity filter. The object of keeping plate current out of the primary is to maintain the primary inductance at maximum and prevent saturation of the transformer core. The inductance-capacity filter stabilizes the detector.

Uses Parallel Plate Feed

The 227 stage furnishes a parallel plate feed. This also keeps the plate current out of the primary, and the chokes used as plate loads have an inductance-capacity filter, too, for stability.

When it is remembered that the satisfactory functioning of an audio amplifier depends largely on its stability, and that even slight oscillation, while not noticeable as such, does distort the signal badly, the reason for taking every possible precaution to prevent instability of even the slightest degree will become apparent.

The output may be taken from an output transformer without condensers, an output transformer with condensers, a center-tapped choke without condensers, or a center-tapped choke with condensers. The diagram shows the center-tapped choke without condensers, the same system in effect that was used in the parallel plate feed preceding.

Even the grid circuits are filtered. The transformers, if the center tap is brought out as one lead, may have grid return made through a resistor of high value, 50,000 ohms or more. If the secondary has two leads brought out for grid return, each may be separately filtered, as shown in Fig. 1, with a relatively high resistance from each lead to ground, while a 2 mfd. condenser joins the leads.

Works, But Who Knows Why?

This resistor-capacity filter, of .1 meg. and 2 mfd., does help get rid of oscillation, but just why that should be is not so obvious. Maybe it's wise not to look a gift horse in the mouth. One theory might be that the audio frequency is forced through the 2 mfd. condenser, which has a lower impedance to audio frequencies encountered in radio, than has the 0.1 meg. resistor. In fact, the impedances of the two are equal at 0.8 cycle, while the condenser's impedance is less, the higher the frequency, and the resistor's impedance is the same throughout. However, the grid is an open circuit!

A more substantial view seems to be that the 2 mfd. condenser has a reducing effect on the transformer secondary leakage and the distributed capacity between the grid and the filament.

It can be seen from the diagram that the same type of transformer, the so-called push-pull input type, may be used in both stages, since the first stage requires only single winding anyway, and the second stage uses a single winding primary and but gets the centered B return through a pair of choke coils.

Choke Input

The B supply has a 280 rectifier, with a choke system consisting of three sections. The rectifier tube has no condenser directly across the output, hence the filter system has what is called a choke input. The purpose is to prolong the life of the rectifier tube, and also protect the filter condensers, as when turning on the set high current is avoided, for the benefit of the tube, and the choke keeps the voltage down in the following train of the filter.

The first choke is of low inductance, around 10 henries at 100 milliamperes, and the first filter condenser is 2 mfd. The second and third condensers are 8 mfd. electrolytics.

The hum would be higher than otherwise with the condenser next to the rectifier omitted, hence three sections of choke instead of two, and three condensers, follow the "choke input."

No bypass condensers are necessary across the biasing resistors R1 and R2, if excellent transformers are used, for the symmetry being accurate to a fraction of a per cent., the tubes alone introduce a possibility of unbalance, but can be matched, so that just the same amount of plate current flows through each. An unbalance due to the signal would be taken care of by an unbypassed common biasing resistor, unbalance arising from the tubes would not be cured. Therefore a combination of the two systems is used: a potentiometer of small resistance total, say, 20 ohms, and a biasing resistor of 650 ohms in the common circuit.

Common Bias for Output

Only a common biasing resistor can be used in the last stage, however, because of the single identity of the filament or electron emitter. With the 227 tubes, however, each tube has a separate emitter, the cathode, while the heater alone is common to two or more tubes.

A similar potentiometer could be used in the plate circuits of the last tubes, but would not be worth while.

While push-pull is excellent for hum elimination, it is a good plan to gain as much matching as practical, and the special biasing of the first stage does that.

The 2.5-volt high-current secondary is brought out to two binding posts, to serve heaters in any tuner which may be powered by the transformer. The following posts are advisable: one input; two output; ground (B minus); plus 45, plus 75, plus 180 volts and 2.5 volts AC. Plus 45 may be used for detector plate where grid leak-condenser detection is used, or for screen grid connections also; 75 volts for screen grids, if the RF circuit will stand that much without oscillation; 2.5-volt AC, as explained. All told, twenty different voltages may be brought out, due to taps on the multi-tap voltage divider.

As a precaution against the introduction of noises from the power line a 0.1 mfd. condenser is placed across the primary. This should have an AC working voltage rating of at least 200 volts.

High Power Requires Special Tube Cooling

In all high power broadcasting stations operating today, the vacuum tubes used to produce the radio waves are of such high power and dissipate so much heat that special means are necessary to keep the temperature of these tubes within reasonable limits.

To perform this cooling function, the vacuum tubes are so constructed that the plate of the tube may be immersed in a water-cooling jacket so that the water flows actually in contact with the outside of the copper plate of the tube and, in this way, carries off the excess heat generated in the tube.

It is of the utmost importance that the cooling water circulation never fail, as the heat generated is so great that, without the cooling water, the tube would be melted by the heat in a few seconds.

System Dissipates 45 kw

At WBAL, Baltimore, Md., four high-power water-cooled tubes are employed in the last amplifier stage of the radio transmitter and three water-cooled rectifier tubes are used to supply the direct current to excite these tubes, says **G. W. Cooke, chief** engineer. The heat generated by these seven tubes requires that the water-cooling system be capable of carrying off 45 kw of energy from the system. This large amount of heat going into the water soon would heat the water to the boiling point and it is therefore necessary to pump this water at the rate of 21 gallons per minute through the tubes and through a cooling radiator.

Since WBAL increased its power to 10 kw, the added heat generated by the tubes required that additional facilities be provided to dissipate this heat. A cooling structure has been erected outside the transmitting building which houses a special multi-tubular radiator through which the cooling water is pumped and a five-foot airplane type propellor driven by a five horsepower motor forces a powerful blast of air through the radiator to carry off the heat.

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The Science of Proper

By John C.

A LARGE NUMBER of experimenters like to build sets of their own design, and while they work out the electrical circuit properly, fall short of producing best performance because of failure properly to locate the parts. Standard kits dispense with this work on the part of the builder, for the designer has attended to it, but the pioneering experimenter has to supply his own solution, hence it is fitting to outline some of the considerations.

The assembly process usually begins with the assembly of tube sockets to the chassis, but in an AC set it is just as well to mount the power transformer first.

If any drillings are not correct, first ascertain the distribution of the transformer's external field. Connect the transformer primary to the AC line. Use a small search coil, 10 turns on 1, 1½ or 2 inch diameter, with earphones across it, and then arrange drillings so that power transformer may be located as far away from RF coils as possible and so that filter chokes may be mounted next in the weakest part of this field even though they are necessarily closer than most of the other apparatus. The weakness of the field may be determined by the low intensity of the hum.

Mount the rest of the top panel apparatus where directed if mounting holes are provided; but if they are not provided, it becomes necessary to cast about for some kind of a guide.

It has been hinted that it is desirable to mount the power transformer in such a way relative to the RF coils (whether shielded or not) so that the power transformer's external field is coupled as weakly as possible to these coils.

Protection of RF Coils' Field

Therefore it follows as a logical deduction that it is most desirable to have the immediate external field of these RF coils free from the distorting influence of any additional iron masses or electric fields of a foreign character; and so locate the inductively wound resistor (voltage divider) underneath the power transformer, because the steel chassis in between acts as a shield sufficient to prevent too cumulative an effect, mainly hum in the plate supply voltage. If the voltage divider is put on top, use a screen shield around it. Ground the shield.

The location of the tuning condenser is likewise fixed if its mounting holes are already drilled, but if not, several mechanical arrangements are possible. If, however, a drum dial is to be used, the condenser must be mounted either to the left or to the right of this dial, and if the flat type dial is used the condenser is of course mounted behind this type of dial either directly on the top of the chassis or on "stilts," depending on the mechanical demands of final cabinet mounting, or the front elevation of the chassis.

If the variable condenser is of the "bathtub" solid die cast frame type, it usually matters little how the condenser is mounted, but if the frame is of the stamped and usually "open" type, some undesirable additional fixed capacity may be avoided by "stilt" mounting.

But if you have this kind of a "cut out" condenser chassis to mount and you wish to take advantage of the aforesaid mounting without actually using it, cut or drill away that portion of the chassis underneath the "cut away" part of the condenser chassis.

Cures for Small Shields

Mount the RF coils in their assigned positions, bringing out as many differently colored leads as there are lead terminals on the coil. Note the identity of these leads.

If there are no proper mounting arrangements provided, however, the use of a steel chassis demands that some precautions in RF coil mounting be taken, if the coils are shielded and the shields are small, say, 2 inches or less in diameter.

The external field diagram of a coil is doubtless known to most set constructors. But for the benefit of those who haven't thought about this detail, the RF coils are really open core transformers, and are also single layer solinoids with external field extending both ways from the center of the coil's radius and parallel to this radial axis.

Most set designers, for reasons of convenience, mount RF coils so that the radial axes extend perpendicularly away from the top surface of the chassis. Thus the shield bottom or chassis top completes the shielding effect.

Because the presence of a steel or iron disk or equivalent piece of magnetic metal, of usual stock thickness, closer than one inch to the coils winding seriously reduces the inductance, it may not be possible to cover the wave band, unless full .0005 mfd. tuning capacity is used, and anyway there will be strong eddy current losses.

Usually the shields furnished are of the open end "can" type and are correct, when assembled over the coils as instructed, but if there should be failure in tuning in the full wave band, it may be necessary to elevate the shields so as to leave an opening between them and the chassis top, or also cut off the tops of the shields and use the resultant plain cylinder.

Where Turn Alteration Is Futile

Don't be tempted to remove turns from RF coils, nor add them to make resonance connections, without first observing the effect of modifying shield cans a little, as previously described. If the shields cause the trouble, removal of turns will prevent tuning in high wavelengths, while addition will prevent tuning in low wavelengths.

Shield cans that are split have to be so treated because they are too close to the coil windings initially. This slitting does not in itself mean that there's anything wrong with the coil, but that the shielding is too close. It is a space problem. It is merely

Right or

QUESTIONS

(1)—A television signal based on 60 lines to the frame and 20 frames per second can be received with a scanner designed for 48 lines by simply increasing the speed of the 48 line scanner so that it will rotate at the rate of 1,200 lines per second, that is, 60 x 20 lines.

(2)—In a colored television system utilizing the indirect system of illumination every color would be reproduced naturally. For example, the red glow of a lighted cigarette would be reproduced as a red glow.

(3)—Sound is to be recorded on two films of different sizes, one the standard moving picture film moving at 24 frames per second and the other a miniature film. The quality of the reproduced sound will be the same from both provided that the recording and playing speeds of the two films are the same, that is, the linear speed, not the frame speed. If the linear speeds are different the same quality will result from both provided that the recording and playing slit widths are proportional to the linear speeds of the films. It is assumed that the photographic processes and the optical systems are perfect.

(4)—If the recording and playing slits are too wide the high notes will not be reproduced well in a talking film.

(5)—Short-wave coils do not work well when they are surrounded by metal shielding or when they are close to any large bodies of metal because much of the energy contained in the wave is absorbed by eddy currents.

(6)—When only a low current is needed for a receiver it is possible to use a 201A or a 227 tube as rectifier in place of a 280.

(7)—A short-wave converter will work just as well if the oscillator stops for then the two tuned circuits can be tuned to the same frequency and the oscillator can be used as a radio frequency amplifier.

(8)—A high intermediate frequency is used in short-wave converters because the radio broadcast receiver is more sensitive at the higher frequency end of the dial.

(9)—It is impossible to design a power transformer so that it will work on 25 cycle current as well as on 60 cycle current, or on any current of frequency in between.

(10)—Short-wave receivers do not pick up so much static as broadcast receivers.

ANSWERS

(1)—Wrong. If this were true it would only be necessary to spin the 48-hole disc at 25 revolutions per second for that would produce the same number of scanning lines per second. It is not possible, however, for the picture would not be in synchronism. The picture would not be assembled properly.

(2)—Wrong. When the indirect system of illumination is used the apparent color of the object is not necessarily the same as the actual color. The red glow of a cigarette would reproduce black for the burning tip is carbon, which is black, that is, it does not reflect any light. The glow does not enter into the picture for its light is insignificant in comparison with the reflected light from surrounding surfaces. Moreover, the glow is constant and would therefore affect the photo-electric cells in the same manner no matter where the scanning beam happened to be. It would have the same effect as diffused sunlight.

(3)—Right. Both propositions are true. If the linear speed

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Placement of Parts

Williams

done so that a given coil which wouldn't tune the entire wave band, because of inductance drop, tunes very well directly the shield is slotted. The slot should begin 1 inch from bottom of the shield, go over the top and down the other side.

So you see the damping effect of excessive shielding corresponds to the similar effect produced by the presence of magnetic metal in the field of the coil.

It has been stated before that simple and as direct wiring layouts are to be preferred, but if one takes a brief glance at some factory receivers this fact does not seem to be always borne out.

There is no reason why screen grid, plate supply and other wires carrying no audio or RF currents should not be "bunched," especially if they are colored so as to permit ready identification when tracing, etc.

Also, these are all to be well bypassed to the ground post, and not to the chassis, although the chassis should be separately grounded to the ground post. Before beginning to wire, put the various tube sockets into their designated places and make a neat job of installing No. 16 B&S gauge or equivalent stranded tinned copper insulated wire for heater leads. Twist the pair.

Avoid Resistance Dropping Too Much Voltage

This gauge equivalent is now recommended because the use of No. 18 gauge does not offer low enough resistance when the heater circuit run exceeds 12 inches. If the use of No. 18 gauge equivalent is unavoidable, then it's always best to run separate "feeders" in order that the heater voltage at the point farthest away from the power transformer shall not be lower than 2.2 volts AC.

Directly the heater circuit is complete, it should be tested out by placing all the tubes in their sockets. Check the voltage at the tube heater prongs. Only by this means do you know what you are getting.

Follow this up by installing the screen volume control and mount its bypass condenser, if any, close to it.

You will require at least a 1 mfd. condenser for use as a bypass for each of the following runs:

Plate supply to RF tubes.
Screen grid voltage.
Detector grid bias resistor.
First audio grid bias resistor, unless push-pull is used.

These should each be mounted near the point or apparatus with which they are associated in order that extraneous RF or other undesirable pickup may be kept at a minimum.

Complete all the "high tension" lead runs first—that is, as far as the voltage divider, but leaving the ends loose. Next complete return to cathode resistors, having previously mounted and connected the cathode resistors and their associated condensers to the points designated. These, as is known, run to ground.

Voltages and Capacities

Next in order is to mount the 1 mfd. condensers securely, and as one side of each is to be grounded it's best to make a securely soldered connection for this purpose, direct to the ground binding post.

If a phonograph pickup circuit and associated controlling apparatus are specified, attach and wire these together with the output circuit to their respective moulded output jacks or binding posts, and complete the rest of the grid return circuits.

With everything in readiness, hook up all plate supply wires to the voltage divider so that:

All 224 tubes have at least 180 volts, cathode to plate supply, measured at the voltage divider.

All 245 tubes have at least 250 volts filament center to plate supply, measured at the voltage divider.

227 detector tube has 45 volts for leak-condenser type—higher, up to 180, for negative bias detection.

Detector bias resistor is usually 20,000 to 50,000 ohms.

Screen grid voltage is to be 75 volts or less.

In any case, whatever the audio system is, it is best to try to find the applied plate, grid and screen grid voltages under operative conditions, i. e., with the speaker plugged in and the volume control on "full," as when these voltages are obtained with the tubes lit up but with the volume control set "half on" or the speaker not "plugged in" there will be an error. Testers that cut into the plate include the plate load and will show lower readings on voltage, but not on current.

Reduction of Hum

Excessive hum may be reduced to reasonable levels by employing sufficient capacity in the filter system in the following places: As buffer capacity across the rectified tube output, but the breakdown voltage should be at least 1,000 volts DC for a 280 tube, or 1,500 volts DC for a 281 tube, the capacity being 2 mfd.; the addition of an 8 mfd. condenser in shunt with the voltage divider's input and another between the B— of the divider input and the point where the 245 power tube mid-tap filament transformer lead is connected, assuming the bias is taken from the B voltage divider.

The other five 1 mfd. condensers provide in most cases ample additional bypass capacity. A bypass condenser, often indicated as a detector plate RF bypass, from plate to ground, need not exceed .001 mfd., but may be larger only when this condenser is part of a tone control system.

It is a good plan to have some extra small fixed condensers when you finally get ready to adjust the tone control circuit. The usual .0002 mfd. to .001 mfd. will be found sufficient to make slight tone adjustments with. Another form of tone control uses a variable resistor in series with a condenser.

Wrong?

of the two films is the same, the wavelength of the sound for any given tone is the same, and the quality depends on the relation between the width of the recording and scanning slits and the length of the wave on the film. If the two films move at the same frame rate the relationship will still be the same provided that the widths of the recording and playing slits are proportional to the speed, for then the wavelength on the films will bear the same relation to the slit widths, and therefore the quality will be the same in the two cases.

(4)—Right. If the recording slit is too wide the high notes will not be recorded and if the playing slit is too wide the high notes that have been recorded will not be reproduced well. The principle can be illustrated with a mechanical example. Suppose first we attempt to dig a series of parallel ditches with a square pointed shovel. If the width of the shovel is greater than the separation between the ditches it is clear that we will not make a good job of it. If the width of the shovel is exactly the same as the distance between the furrows the result will be nothing but a leveling. The same thing occurs if the recording slit is equal to a wavelength of the tone to be recorded. The playing can also be illustrated. Suppose we have a board of given length and slide on it over furrowed ground. If the board is long compared with the distance between furrows, there will be no bumps, but if the length of the board is very short, compared with the distance between furrows, there will be much bumping. The playing slit must be short compared with the wavelength of the highest tone recorded for otherwise it will not follow the bumps faithfully.

(5)—Right. Eddy current losses may be very high when the frequency is high, and the higher these losses the lower is the efficiency of the coils. The losses due to eddy currents produce the same effect as if the coils were wound with high resistance wire.

(6)—Right. When B battery eliminators were first popularized they were built with 201A tubes for rectifiers and only one of these tubes was used for each eliminator. They gave a little current and quite high voltages. Whether or not such a small tube can be used successfully and economically depends entirely on the current needed. If the current is less than 10 milliamperes and the maximum voltage does not exceed 90 volts, one of these tubes can be used as rectifier.

(7)—Wrong. If the oscillator stops the circuit stops functioning, and it cannot be used as a radio frequency amplifier, for it is not connected that way.

(8)—Wrong. While it is true in many instances that a broadcast receiver is more sensitive on the short waves, this fact is not the main reason why high intermediate frequencies are used. The main reason is that if a high intermediate frequency is not used the oscillator will not function independently of the other tuned circuits at the short-wave frequencies.

(9)—Wrong. This is done all the time in some commercial receivers so that they will fit all commercial voltages. The transformers have to be designed for the lowest frequency with which they are to be operated. It will not do to design them for the highest and then use them for lower frequencies.

(10)—Right. This is one of the peculiarities of the short waves, or perhaps it would be more accurate to say that it is one of the peculiarities of static. In the tropics good summer reception is usually obtained on wavelengths below 35 meters. For higher waves static becomes troublesome.

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A Portrait of El

By Lester

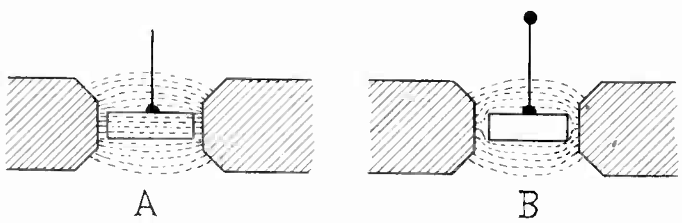

FIG. 1
(A) Magnetic flux passes through copper, and careful examination will disclose the lines converging toward it at the same time.
(B) Magnetic flux is repelled by the bismuth bar and merely flows around it.

WHEN a single or multilayer solenoid is excited by means of a unidirectional current, the current flow along the wire is said to produce a "magnetic field," assumed to be an associated part of the phenomenon of current flow.

Why does a magnetic field appear around a conductor when a unidirectional current flows along it?

If we have a sufficiently good imagination, we can doubtless visualize something about the structure of the copper conductor "along" which the current flows. Most of us know in a general way that a "solid" copper bar is composed of small pieces of cuprum or cupric crystals and that these crystals are very closely packed together, so closely in fact that the mutual attractive force between them is very great.

It can be shown that this attractive force is not mechanical, by the simple process of heating the bar, and if a sufficiently high temperature is applied to the bar it grows longer because the "attractive" force between the crystals of the bar is lessened and consequently they don't tend to hang together as closely. If a compass infinitely sensitive were placed close to the bar its steady deflection (due to the earth's magnetic field) would not change. The mass of the bar would surely change but its weight (neglecting oxidation) would remain the same, and if the temperature-raising experiment were to be continued the bar would merely fall apart, and at no time would it undergo any structural intermolecular change of any consequence, because the temperature increase merely increases the center to center separation between molecules. It does not affect the size or weight of the molecule.

Molecular Separation Lengthens Bar

When we say that a metal bar, of steel for instance, "expands" and grows longer we are too likely to think of this expansion in terms of the lengthening of the "material" of the bar rather than as an increase of molecular separation.

If you suspend a copper bar near the pole of a powerful electromagnet, a type of suspension by means of which you can locate the copper bar so that it rests parallel to the axis of the poles of the electromagnet, then when you apply a sufficiently large potential difference across the windings of the electromagnet the magnetic field flows through the copper bar (Fig. 1A).

If you can inspect the immediate region around the copper bar while it is in state of transient excitation you will find that there is a magnetic field of slightly higher density close to the bar, showing that copper is pro- or paramagnetic. That is, copper offers a conducting path to magnetism. Air does so also, but to a lesser degree.

There are many substances that readily conduct a magnetic current and which are partial to magnetic influence.

Also, there are some substances, in particular metallic substance, that exhibit a pronounced negative attitude toward a magnetic field.

Suspend a bar of bismuth in much the same way that you suspended the copper bar. Apply the magnetizing current as before. The bismuth bar will not move. If the flux path in which it is situated be examined it will be found that the flux lines diverge from the bismuth bar whereas they converged toward the copper bar. Hence when a piece of bismuth is placed in the flux path of a powerful electromagnet the effect is one of interposing added flux resistance or reluctance (Fig. 1B). Hence metallic bismuth is said to be diamagnetic, or opposed to magnetic flux conduction.

Purity Affects Magnetic Susceptibility

Note here that the degree of purity of metals has in many instances a strong influence on their magnetic susceptibility and this is especially true if ferrous substances are present.

Certain metallic salts exhibit in a limited manner the behavior of the solid metallic bars.

The principal difference then between soft iron and copper in the tests would be found in the vastly reduced reluctance presented by the iron bar. Exploration around the immediate exterior of the iron bar would reveal almost no field at all. The greatest portion of the total available lines is now flowing through the bar!

Here is an interesting theoretical experiment (which could actually be made, although I have never done it). Let us, while we are observing the flux distribution around the iron bar, very carefully remove a generous slice from its center, say a piece one and one-half inches in length and three-sixteenths of an inch square. (The original length of the bar was not given but let us suppose it was two inches.)

We would find that although there was some flux in the iron bar's self-contained air gap there was now also very considerable flux effect occurring about the immediate exterior of the bar, merely proving that the substitution of air for iron results in the reluctance of the magnetic flux circuit being increased.

An analogy to this condition is the following:

The different substances suspended in the flux of the permanent magnet may be compared to similar lengths of differently sized porous water pipes. The flux flow becomes a water flow and the short porous pipe becomes the connecting link between the two solid mains.

The bismuth sample corresponds to a small cross-section porous pipe and when the water supply is turned on the greater part of the flow escapes from the outer walls of the pipe, and if the length of porous pipe that corresponds to the copper bar (a larger pipe) be substituted, a considerably smaller escape from the porous side wall will be noticed. Finally, the largest pipe (corresponding to the iron bar) is placed in the circuit.

The total water stream is now carried by this pipe, and no surplus water escapes.

Electromagnetism is a Current Effect

Magnetic field isn't necessarily an attribute of a substance. It is an effect which accompanies the passage of either an "electric current" or it is intensified when certain substances are placed within or

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WICC Appeal Over 600 kc Is Dismissed

The court appeal taken by WICC of Bridgeport, Conn., from a decision of the Federal Radio Commission, taking the 600 kc channel from that station, has been dismissed. Also, another court has enjoined WICC from using 600 kc.

The Federal Radio Commission assigned WGBS back to 600 kc under court compulsion, in an injunction suit brought by WGBS. Pending final court disposition WGBS will use the 600 kc channel it is fighting for and WICC must not use it.

Board Obtains Writ To Review WHAM Case

Washington.

Review of the proceedings that resulted in the issue of an injunction against the Federal Radio Commission, obtained by WHAM, Rochester, N. Y., was granted to the Commission by the District Supreme Court.

The injunction was obtained when the Commission sought to reallocate stations so that less interference would be caused to and by clear channel stations. The WHAM injunction was one of several writs tying up the reallocation pending final decision on the injunctions.

Relative Spots Baritone By Name and Accent

Boston.

Edward MacHugh, WBZ-WBZA baritone artist, recently received a letter from Mrs. Ann Crowley of New York City. She stated that she had been listening to his broadcasts for the past six in.

She thought she had detected a Scotch accent in his voice and informed him that her maiden name was MacHugh. She also outlined enough of her family tree to enable McHugh to know that she was his father's sister and his only relative. Thirty years ago, as a small girl in Scotland, she had last seen Edward McHugh. He will go to New York to meet her.

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ectro-Magnetism

Chadwick

near a purely magnetic circuit. As we have learned, the field is decreased when substances which present high resistance to it are placed within its denser portions.

Ionized gases, formed when an electric spark or arc is created in air, are known to be strongly affected by the presence of a magnetic field, and as a consequence are proven to be themselves of a magnetic nature.

Bismuth vapor has been found to obey substantially the reaction of solid bismuth, so we see that metals and their vapors tend to be similar in their manifested effects.

But we started to find out what the underlying cause of magnetic field was, and the several intervening experiments have shown that it accompanies a change in the structural state of certain metals, and is not apparent at all where certain other metals are concerned.

So we may as well concentrate on the effects incident to the alteration of a stable structure by an electric current, and thereby perhaps gain a closer view of the mysterious phenomenon of magnetism.

We have previously learned that a "solid" copper bar is in reality an aggregation of closely packed crystals. The nearness to one another is in some way connected with temperature. If you can reduce the temperature of the region in which the bar is located, and ultimately attain the "absolute zero" (or —273° C), you might expect to find the magnetic properties of the bar quite different from what they were at ordinary temperatures.

The resistance of copper at this "zero," for instance, is a fraction of its normal-temperature resistance.

Roughly it's 12 ohms per mil-foot at 20 degrees centigrade.

The copper bar is composed of molecules of the same material, and these molecules are constructed of still smaller copper aggregations, called atoms, and these in turn consist of protons and electrons that are grouped in such manner that their chemical name is cuprum.

The component parts of an atom, regardless of its structure, are part and parcel of a self-contained system, the parts of which are under the effect of mutual attractive and repulsive forces which restrain their normal sphere of activity in proportion to the values of these forces and the number of positive and negative charges involved.

Want to Obey Order: "As You Were!"

And just as long as an atom or an aggregation of atoms remains undisturbed nothing spectacular happens, but if you dislodge a few charges of a given atom by applying an external electric dislodging force, or potential, the result is that the disturbed atomic structure seeks to regain its normal degree of aggregation. This manifestation of a group of charges that seek to re-establish their normal relative position results in the appearance of a form of energy which we call "magnetic."

If the value of this dislodgment force can be defined in the proper terms for the given atom it is then only necessary to multiply the dislodgment value by the number of atoms involved to get at the group definition for the solid copper bar.

It is now easier to see why a magnetic field is proportionate to the current.

It has been brought out that the copper bar is composed of individual atoms, and that these all possess a mutual attractive force; therefore this mutual attractive force is a part of the whole attractive force of the individual atom. If heat is applied, the component atoms merely move farther apart, with the result that an internal "force" is created at the expense of the charge displacement force.

The result now is that the atoms are further apart. Their individual mass is unchanged, however. The only physical change is order distribution.

Insulators Compared with Conductors

Pass the given "dislodgment" current through the heated bar. The "magnetic" effect around the bar is considerably reduced, in spite of the previously observed fact that the current flow has never been of such value as materially to heat the conductor in the first instance. So there is no doubt left that heat alone has influenced the downward revision of the externally observed magnetic effect.

Porcelain insulators appear to the touch as hard as steel or copper bars, but of course their resistance is much higher and therefore the structure of their atoms must be radically different.

Let us consider briefly a piece of bakelite tubing and place it in a powerful magnetic field just as we treated the copper and bismuth samples. After applying the exciting emf we find that the bakelite tubing apparently has not had any measurable effect upon the field.

This is the generally observed effect where the field is unidirectional, but if the character of the applied magnetic field is altered, and the observational apparatus is altered so as to conform to the now supposedly new excitation conditions, the final results may not be the same as when the unidirectional field was used.

Sheet bakelite, from which lap joint tubing is made, passes through a certain series of mangling operations, not so very unlike the action in a standard clothes wringer, incidental to its being rolled to the desired thickness.

Bakelite is originally not very hard, that is, not brittle, but quite tough before the rolling-to-size operation begins. As it is rolled to thinner sizes, however, it gets hard and at the same time offers greater resistance to further compression.

During the rolling process it occasionally happens that a roller surface becomes damaged to the extent that small particles of steel flake are embedded in the bakelite, and these are not necessarily uniformly distributed, so that a large quantity of coil tubings may be obtained that are entirely free of any metallic taint, and perhaps a dozen samples or so will act queerly when made up as coils and installed in a radio frequency circuit.

Particles Account for Erratic Tuning

The presence of these ferrous flakes tends to make a given number of turns of insulated wire appear to possess higher inductance than a coil of a similar number of turns wound on a tubing sample not so affected.

The writer has conducted radio frequency tests on several hundred samples of tubing that were at the bottom of mysteriously inoperative sets otherwise satisfactory.

Resonance discrepancies of the order of 10% on a frequency basis were observed, which of course meant that even if the tuned circuits did operate on a small frequency range, they were hopelessly mistuned insofar as the regular 1,000 KC broadcast band was concerned.

A source of variable-at-will unmodulated radio frequency energy supplied by a local oscillator that had constants arranged to simulate distance transmission, was picked up by a test receiver which consisted of a three-stage calibrated radio frequency amplifier, operating into a precision tuned frequency indicator.

The coils were separated at a distance that precluded effective feedback due to stray magnetic coupling and they were also carefully shielded in large copper boxes.

The terminals of the resonance frequency indicator were applicable (through a switching arrangement) to any of the intermediate stages at will.

The condenser setting was merely noted for the highest setting of the resonance indicator for similar circuit conditions for the calibrated coils, as compared to the indications of the samples under test, a comparative observation that quickly brought the offenders to light.

N. Y. Dealers Get Anti-Noise Posters

New York City.

As part of its campaign, the Noise Abatement Commission is issuing posters to radio dealers in New York City, for window display, reading as follows:

"Less noise in our neighborhood—let's make it a pleasanter and quieter place to live and work in.

"We have discontinued the playing of our radio outside our shop—it's against the law now.

"If you want to hear our radios, come in.

"Posted at the request of the Noise Abatement Commission, Department of Health, City of New York."

Edward Fisher Brown, director of the Noise Abatement Commission, said recently that many radio dealers have expressed themselves as contented with the rulings of the commission.

Civil Service

The United States Civil Service Commission announces open competitive examinations for senior radio engineer, $4,600 a year; radio engineer, $3,800, and assistant radio engineer, $2,600.

Applications must be on file with the Civil Service Commission at Washington, D. C., not later than August 27.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and fitness.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or from the Secretary of the United States Civil Service Board of Examiners at the Post Office or Customhouse in any city.

RECEIVER FOR UNIVERSAL

Chicago.

A receiver was appointed for the Universal Wireless Communications Company. The main offices are in Buffalo, N. Y. The company, organized two years ago, obtained forty continental short-wave message channels from the Federal Radio Commission. Suits alleging patent infringement preceded the receivership.

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120, 201A an

By J. E.

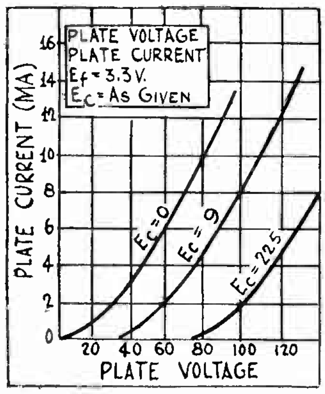

FIG. 12
PLATE VOLTAGE, PLATE CURRENT CURVES FOR THREE DIFFERENT GRID BIAS VOLTAGES FOR THE UX-120 TUBE.

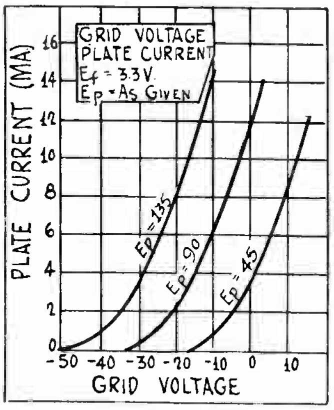

FIG. 11
GRID VOLTAGE, PLATE CURRENT CURVES FOR THE UX-120 POWER AMPLIFIER TUBE FOR THREE DIFFERENT PLATE VOLTAGES.

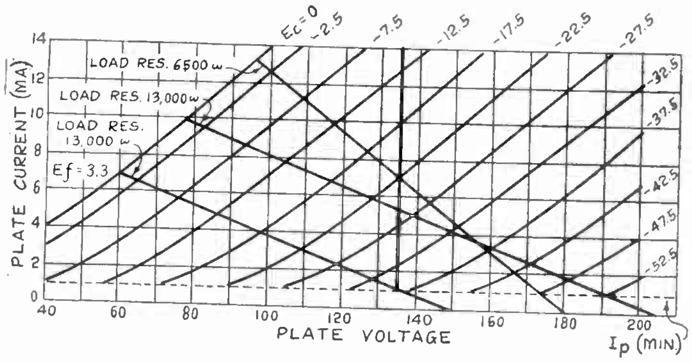

FIG. 13
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES FOR DIFFERENT GRID BIAS VALUES FOR THE UX-120 POWER TUBE. THESE CURVES ARE USEFUL IN CALCULATING THE POWER OUTPUT CHARACTERISTICS OF THE TUBE.

120

THIS is the smallest of the power tubes and has been designed as output tube in receivers utilizing the -99 tube in the preceding stages of the circuit. It has the same filament rating as the -99 but it requires a filament current of .132 ampere. Its base is the small standard UX base and it fits into a standard UX socket. The filament is of the same material as that of the -99, namely, thoriated tungsten.

Its amplification factor is 3.3 and its maximum undistorted power is 110 milliwatts. For this output the applied plate voltage should be 135 volts and the grid bias should be 22.5 volts.

CHARACTERISTICS OF THE 120

Filament voltage	3.3
Filament supply voltage	4.0, 4.5, or 6.0
Filament current, amperes	0.132
Filament power, watts	0.436
Amplification factor	3.3
Plate voltage, maximum	135
Grid bias, at 135 volts on plate	22.5
Maximum power output, milliwatts	110

Curves showing the relation between the grid voltage and the plate current for three different plate voltages are shown for this tube in Fig. 11. We note from this graph that when the plate voltage is 135 volts and the grid bias is 22.5 volts the plate current is 7 milliamperes, which is the DC current in the plate circuit that should be expected when the load resistance is small compared with the internal resistance of the tube, which is 6,500 ohms. We also note that when the plate voltage is 90 volts a grid bias of 9 or 13.5 should be used.

Plate Circuit Characteristics

In Fig. 12 are given three plate circuit characteristic curves at three different grid bias voltages, namely, zero, 9 and 22.5 volts. These curves are mainly useful in determining the value of an unknown plate voltage when the plate current and the grid bias are known. For example, suppose we know that the grid bias is 9 volts and that the reading of a milliammeter in the plate circuit is 5 milliamperes. We follow the curve for Ec equals 9 until we come to the horizontal line for 5 milliamperes and find that these curves cross on the vertical line representing a plate voltage of 80 volts. Hence our unknown voltage on the plate is 80 volts, provided that the tube is normal and the rated filament voltage of 3.3 volts is applied.

For the purpose of measuring an unknown plate voltage by this method it is always possible to use one of the grid voltages represented in Fig. 12. The easiest value to get is zero, but this should not be used if it is suspected that the unknown plate voltage is more than about 100 volts.

Since a bias of 22.5 volts is usually provided when one of these tubes is used, this is also a convenient value to use, and it should be used when the plate voltage is high. Low voltages cannot be measured with a high grid bias because the plate current will be zero. The curve shows that the plate current is practically zero when the effective plate voltage is 70 volts.

Dynamic Characteristics

The most useful curves is a family of such curves giving the relationship between the plate current and the plate voltage for a large number of different bias values covering the working range of the tube. Such a family of curves for the UX-120 is given in Fig. 13. In this graph the plate current is not plotted down to zero but only to one milliampere, which is the minimum current that should be permitted if the distortion is to be kept low. This minimum is shown by a dotted line parallel with the axis of plate voltage.

The straight diagonal lines across the characteristics are load lines. The steepest of these load lines is for a resistance in the plate circuit of 6,500 ohms while the other two are for load resistances of 13,000 ohms. A load line is drawn through a point on the plate voltage axis equal to the voltage applied in the plate circuit with a slope which is the reciprocal of the resistance in question. Thus the steepest curve has a slope of 1/6,500 ampere per volt and passes through 180 volts on the voltage axis because the voltage in the circuit is 180 volts. This curve also passes through 135 volts at 22.5 volts bias so that the effective voltage on the plate is 135 volts.

The other two curves have slopes of 1/13,000 ampere per volt but one represents an applied voltage of 150 volts and the other an applied voltage of 210 volts.

These curves may be used for determining the output power from the tube. Take the steepest curve, for example. When the plate current is one milliampere the grid bias is 47.5 volts and the plate voltage is 175. When bias is 2.5 volts, the plate voltage is 100 volts and the plate current is nearly 12.5 milliamperes. Thus the change in the plate voltage is 75 volts, which is twice the amplitude of the plate voltage change, or the amplitude is 37.5 volts. The change in the plate current is 11.5 milliampere, and therefore the amplitude is 5.75 milliamperes. The product of 37.5 volts and 5.75 milliamperes is 216 milliwatts. However, this is the product of the amplitudes. The effective power is the product of the root mean square values of the voltage and the current, and this product is only one half the product of the amplitudes. Hence the output power is 108 milliwatts.

This power is not quite the maximum obtainable for we can allow the grid bias to go to zero. If we do this we have a plate voltage range between 175 and 95 and a plate current range of 1 and 13. Hence the double amplitude of the voltage is 80 volts and the double amplitude of the current is 12 milliamperes. Therefore the amplitudes are 40 volts and 6 milliamperes. Hence the power is 40 x 6 x 0.5 or 120 milliwatts. This is larger than the rated output because we used approximate values only. The former value is more nearly equal to the rated output of 110 milliwatts.

Maximum Undistorted Output

The maximum undistorted output is obtained when the load resistance is twice the internal plate resistance of the tube, or when it is equal to 13,000 ohms. The higher of the two loads lines for 13,000 ohms crosses the one milliampere line at 190 volts and the zero bias line at 77.5 volts on the plate. Hence the double amplitude is 112.5 volts and the amplitude is 56.25 volts. The corresponding plate currents are 1 and 10 milliamperes. Hence the double amplitude of the signal current is 9 milliamperes and the amplitude is 4.5 milliamperes. Therefore the double power is 253 milliwatts and the maximum undistorted power output is 126.5 milliwatts. To get this output the root mean square of the signal voltage must be 18.5 volts and the bias should be 26.25 volts.

If the bias is limited to 22.5 volts and the signal root mean square voltage to 15.9 volts, the maximum power output will be

ıd 240 Tubes

Anderson

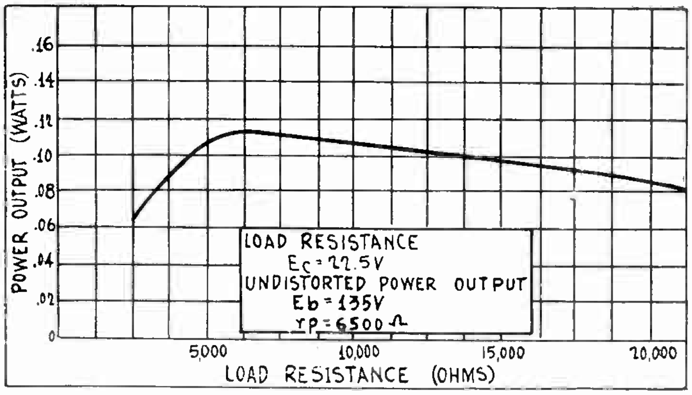

FIG. 14
A CURVE SHOWING THE RELATION BETWEEN THE UNDISTORTED POWER OUTPUT OF THE UX-120 TUBE AND THE LOAD RESISTANCE.

98 milliwatts. A root mean square signal voltage of 15.9 represents a voltage having a peak value of 22.5 volts, which is the limiting value when the bias is 22.5 volts.

The curve in Fig. 14 shows the variation in the output power as the load resistance varies, the plate current being limited to one milliampere. This curve shows that the output decreases rapidly as the load resistance decreases below 6,500 ohms and that it decreases slowly as the load resistance increases above that value. Since the quality improves as the load resistance increases it is clear that it is better to operate the tube with a load resistance greater than 6,500 ohms, that is, a load equal to the internal resistance of the tube.

In Fig. 15 is a four-tube circuit incorporating three UX-199 and one UX-120. All the necessary design values are given on the circuit, except the specification of the radio frequency tuning coils, but these may be any standard radio frequency coils wound for .0005 mfd. condensers. The first is an antenna coupler and the other is a three circuit tuner.

The filament resistances are proportioned on the basis that the filament voltage supply is a six-volt storage battery, and also so that the terminal voltage is 3 volts when the voltage ot the battery is just six volts. These values are chosen because they are standard and may be obtained in any radio store. If the battery is kept fully charged at all times the terminal voltage will be slightly greater than 3 volts, since the fully charged battery has a voltage of about 6.2 volts. The tubes will work satisfactorily on three volts, and sometimes they are rated at this voltage.

In the filament circuit of the first tube are two 20-ohm resistors, one in each leg, and in addition to this there is a 30-ohm rheostat for volume control, which is placed in the positive leg. The voltage drops in the bias resistors placed in the negative legs of the radio frequency amplifier and the first audio frequency amplifier are sufficient, but a battery of 22.5 volts should be put in the grid circuit of the power tube. The bias on the grid of this tube will be about 25.5 volts, which is a suitable bias when the plate load is 13,000 ohms and the applied voltage is 135 volts.

201A

THE 201A is a general purpose tube—that is, one that can be used as radio frequency amplifier, detector, or audio frequency amplifier. As radio frequency amplifier it can be used both in tuned and untuned circuits; as detector it can be used both with grid leak-condenser and grid bias, and as audio frequency amplifier it can be used in transformer, resistance, and impedance coupled circuits. It can also be used as a low power output tube.

The filament is of the thoriated tungsten type and is rated at 5 volts, .25 ampere, and 1.25 watts. It is designed to work on a six-volt storage battery but may be used on any other pure DC source having a voltage not less than 5 volts.

The tube has a standard UX base and therefore fits into a standard UX socket. However, it is provided with a pin on the side of the base so that it also fits into the old type bayonet socket.

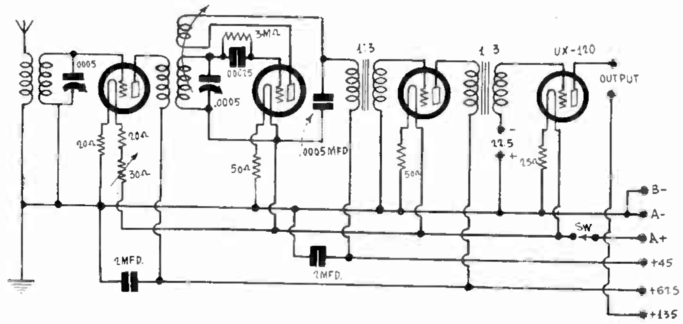

FIG. 15
A FOUR-TUBE RECEIVER DIAGRAM INCORPORATING THREE -99 TUBES AND ONE UX-120 POWER TUBE DESIGNED TO OPERATE ON A SIX-VOLT STORAGE BATTERY.

CHARACTERISTICS OF 201A

Filament voltage	5.0
Filament current, amperes	.25
Filament power, watts	1.25
Filament supply voltage	6.0
Amplification factor	8.0
Plate voltage, maximum	135
Grid bias, volts, at 135 volts on plate	9.0
Grid-plate capacity, mmfd.	9.8
Grid-filament capacity, mmfd.	5.6
Plate-filament capacity, mmfd.	5.6

Use as Radio Frequency Amplifier

This tube is used extensively as a radio frequency amplifier, and it is especially useful for this service. However, the grid-plate capacity of 9.8 mmfd. is comparatively high and therefore if best results are to be obtained in tuned radio frequency amplification it is necessary to provide some means for neutralizing its effect. The use of a rheostat, either in series with the filament or in series with the plate lead, is not a good substitute for neutralization, for it decreases the amplification. A balancing arrangement such as either the Hazeltine or the Rice systems should be used.

In tuned amplification the tuned circuit of each coupler should be in the secondary and the primary should not be too closely coupled to the secondary, for close coupling not only broadens the selectivity but also makes the circuit difficult to stabilize. The ratio of turns may be about one-to-four, provided that the primary turns are placed on the same form as the secondary and at one end, or on a separate form placed near one end of the secondary winding.

The plate voltage for radio frequency amplification may range from 45 to 90 volts, but a suitable grid bias should always be used, for, unless a bias is used, the selectivity will be poor, the amplification low, and the life of the plate battery and of the tube will be short. When a high plate voltage and a low voltage are used, the amplification may be higher than when a lower plate voltage is used, but this gain is at the expense of tube and battery life. It is poor economy. It is best to follow the recommended combinations of plate voltage and grid bias.

Use as Detector

The tube is a reliable detector and relatively free from tube noises. It operates well on any plate voltage from 22.5 to 67.5 volts and on any filament terminal voltage from about 4 to 5 volts. However, it works with less microphonic disturbances when the rated voltage is used, and therefore this is recommended, which is 5 volts. It is well to use cushioned sockets to prevent microphonic action. Sometimes it is even necessary to load the tube with a lead cap to stop vibrations. These precautions against microphonic disturbances are not necessary where the total audio frequency output is low, or where only a low audio frequency amplification is used, but are necessary where the gain is high and when the output from the receiver is great. It is the sound from the loudspeaker that usually causes the greatest trouble when the detector tube is so mounted that it may be set into mechanical vibrations. Sometimes mechanical vibrations transmitted through the receiver structure cause the trouble.

When a tube is microphonic, any jars of the tube or the receiver will set up transient musical sounds, and any sound from the speaker of the same pitch may cause continuous "singing" or "howling."

Very few of the tubes are subject to microphonic disturbances and when one is encountered it usually signifies a defect in that particular tube, such as a weak or broken internal structure. When the trouble is met, it can often be remedied by shifting

(Continued on next page)

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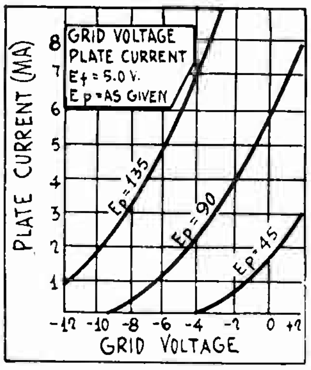

FIG. 16
THREE GRID VOLTAGE, PLATE CURRENT CURVES FOR THE 201A TUBE FOR DIFFERENT PLATE VOLTAGES.

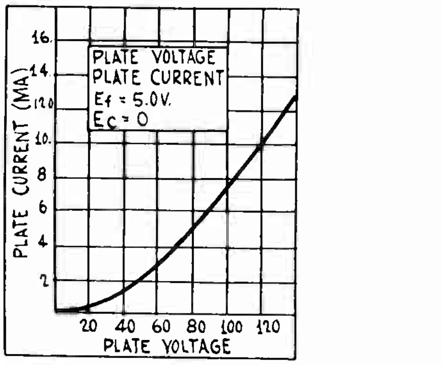

FIG. 17
A PLATE VOLTAGE, PLATE CURRENT CURVE FOR THE 201A TUBE WITH ZERO BIAS AND NORMAL PLATE CURRENT.

(*Continued from preceding page*)

the tubes around, selecting a rugged tube for the detector socket. As a rule, a structurally weak tube can be used safely in the radio frequency amplifier.

The usual value of grid stopping condenser is .00025 mfd. and an average value of the grid leak resistance is 2 megohms. When the signal is weak, a higher sensitivity will be obtained with a higher resistance, and when the signal is very strong, distortion due to overloading may be avoided by lowering the value of the resistance. It should be remembered that if the sensitivity is increased by increasing the grid leak resistance, the increase is mostly on the low and medium frequencies. Hence, when it is important that the high audio frequencies be reproduced, it is preferable to use the recommended values of grid leak and grid condenser and then secure the necessary sensitivity by adding amplification to the circuit.

Use as Grid Bias Detector

The tube can also be used as a grid bias detector. The sensitivity is not so high when this method of detection is used, but superior quality results on strong signals.

GRID BIAS FOR DETECTION

Plate Voltage	Grid Bias
45	3.0 to 4.5
67.5	4.5 to 6.0
90	9.0 to 10.5
112.5	10.5 to 12.0
135	13.5 to 15.0

As an audio frequency amplifier it should be used with plate voltages from 45 to 135 volts, depending on the position of the tube in the circuit, or on the signal voltage that the tube is required to handle. Whatever plate voltage is used, the recommended grid bias voltage should be used to minimize distortion. The proper values are given in the chart of tube characteristics.

When the tube is used in transformer coupled circuits, any good transformers may be used, since most coupling transformers have been designed to work with tubes having similar characteristics. In impedance coupled circuits the plate load impedance should be as high as practical, the secondary of audio frequency transformers being suitable.

For resistance coupling the plate load resistance may have a value between 50,000 ohms and 250,000 ohms, 100,000 being a good average value. It is essential that the resistance be free from noise-producing defects and that it have a sufficient current-carrying capacity to stand up in service. The current in a 100,000 ohm resistance may be of the order of one milliampere.

In impedance and resistance coupled circuits a stopping condenser must be used, and a prime requisite of this condenser is that it be leak-proof. It should preferably be of the mica dielectric type. Its capacity need not be larger than .02 mfd., but it should not be smaller than .006 mfd. This applies to ordinary broadcast reception. The value of the grid leak associated with the stopping condenser depends somewhat on the voltages involved, on the particular tube following the resistor, and on the value of the stopping condenser. As far as low note reproduction is concerned, the product of the stopping condenser capacity, in farads, and the grid leak resistance, in ohms, need not exceed .02 second, but it is not advisable to use a much lower value unless conditions enforce it. It may be that leakage through the condenser and the tube following it will be so high that the required leak resistance cannot be used. If so, it may be lowered to secure stable operation.

The required grid voltage for any plate voltage is the same for impedance and resistance coupling as for transformer coupling and depends on the applied plate voltage.

Use as Output Tube

As an output tube the 201A will deliver 55 milliwatts undistorted power when the applied plate voltage is 135 volts and the grid bias is 9 volts to a resistance load equal to twice the internal resistance of the tube. With 90 volts on the plate and 4.5 volts on the grid, the maximum output power is 15 milliwatts.

In Fig. 16 are three curves giving the grid voltage, plate current characteristics of the 201A tube for three different plate voltages. In Fig. 17 the plate voltage, plate current characteristic for zero bias and normal filament voltage is given. As in the case of the corresponding curves for the previous tubes, this curve is mainly useful in determining the effective plate voltage when the plate current is known.

Fig. 18 is a family of plate voltage, plate current curves over the operating range of grid voltages for the 201A tube (301A), together with two load lines, one for 20,000 ohms and another for 100,000 ohms. The minimum current in this case is taken as one-half milliampere, as shown by the dotted line.

Use as Voltage Amplifier

The 100,000 ohm load line crosses the zero bias curve at 50 volts on the plate and the dotted line at a bias of about 21 volts and a plate voltage of 210 volts. Thus the change in the plate voltage is 160 volts. This change is produced by a change in the grid bias of 21 volts. Therefore the voltage amplification is 160/21, or 7.62. To get this result it is necessary that the voltage in the plate circuit be 250 volts and that the bias on the tube be 10.5 volts.

Somewhat better quality is obtained if the minimum current is made one milliampere. We note that the load line crosses the one milliampere line at 150 volts on the plate and 13.5 volts on the grid. Therefore the voltage change is 150 — 50, which is produced by a grid voltage change of 13.5 volts. Therefore the amplification is 100/13.5, or 7.41. This requires a grid bias of 6.75 volts.

In the first case the double amplitude of the output voltage is 160 volts and in the second case it is 100 volts. Either is large enough to load up a 245 power tube operated at maximum plate voltage, since this requires a signal amplitude of 50 volts to load it up. This tube also requires a plate voltage of 250 volts, so that the plate returns of both the power tube and the 201A may be connected to the same point. The output voltage under these conditions is also for any of the battery operated power tubes. Indeed, with a smaller output tube it is not necessary to use such high plate voltage on the 201A preceding the power tube.

Use of Tube as Rectifier

Sometimes it is desirable to use the 201A tube as a low voltage rectifier. When it is so used, the grid and the plate are tied together to form the anode. The relation between the rectified current and the root mean square voltage applied between the filament and the anode is given in Fig. 19. This shows that the rectified current with 10 volts applied is 3 milliamperes.

One practical application of the tube as rectifier is to supply a grid bias for amplifier tubes. When it is used for this purpose a load resistance and a filter are connected in the circuit and a portion of the voltage drop in the resistance is used for bias. If the load resistance is high, it is possible to apply an AC voltage high enough to provide a bias of 84 volts or more. Fig. 20 shows a circuit of a grid voltage supply. T may be a low ratio audio frequency transformer and Ch the secondary of a similar transformer. Rh is a high resistance rheostat by means of which the voltage drop across the 100,000 ohm potentiometer is varied until the voltage drop is equal to the highest bias desired. The slider on this potentiometer can be used for any lower voltage.

Almost any tube can be used in this manner provided the filament voltage is adjusted properly, and a —99 is particularly suitable. But in any case the tube to be used is determined by the filament voltage available.

The use of the 201A tube as radio frequency amplifier and detector is exemplified in Fig. 21. The Hazeltine and the Rice methods of neutralization are illustrated in the first and second stages, respectively.

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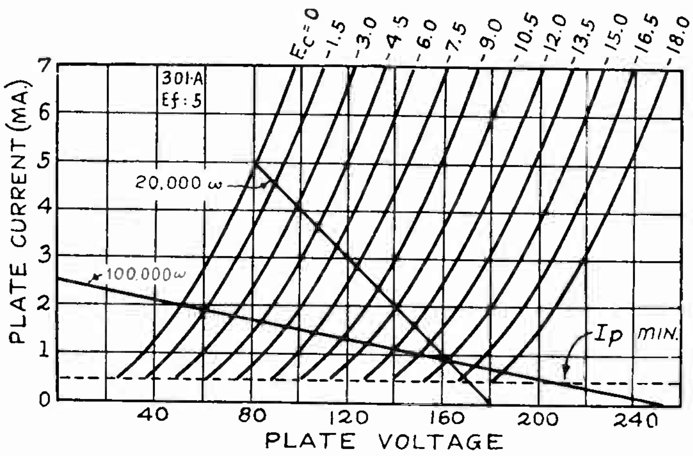

FIG. 18
A FAMILY OF PLATE VOLTAGE, PLATE CURRENT CURVES OF THE 201A TUBE FOR DIFFERENT GRID BIAS VOLTAGES IN THE OPERATING RANGE, TOGETHER WITH TWO LOAD LINES.

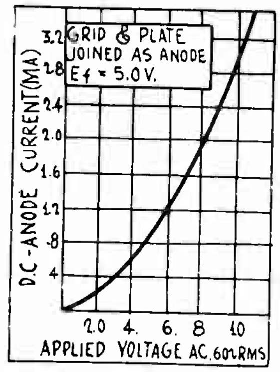

FIG. 19
A CURVE SHOWING THE OUTPUT OF THE 201A TUBE AS A LOW VOLTAGE RECTIFIER WHEN THE GRID AND THE PLATE ARE TIED TOGETHER TO FORM THE ANODE.

240

THIS is a special purpose tube designed to give a high voltage amplification in impedance and resistance coupled amplifiers. It has an amplification factor of 30 and an internal plate resistance of 150,000 ohms when the recommended plate voltages, grid bias voltages and plate coupling resistances are used. Without any load in the plate and with 135 volts on the plate and 1.5 volts on the grid the plate resistance is about 60,000 ohms.

Its base, bulb and filament are exactly the same as those of the 201A, and therefore it fits into either an old type navy socket or into the new UX socket.

CHARACTERISTICS OF THE 240

Filament voltage	5.0
Filament current, amperes	.25
Filament power, watts	1.25
Filament supply voltage	6.0
Voltage amplification factor	30.

The tube can be used as detector, either with grid leak and condenser or with grid bias, and also as audio frequency voltage amplifier. It is not suitable for radio frequency amplification because the effective grid-filament capacity is much higher for this tube than that for any of the others. This is in part due to the small distance between the grid and the filament and to the greater number of grid wires and in part to the high amplification factor. The effective capacity depends on the value of the grid-plate capacity and on the load resistance in the plate circuit. The high effective input capacity prevents amplification of high frequency voltages, and the effect is noticeable at the higher audio frequencies as well as at super-audible frequencies.

Use As Detector

When the tube is used as a detector cushioned sockets should be used, and if this is not sufficient to prevent microphonic noises, it should also be loaded down with a lead cap, as was explained in connection with the 201A tube.

It is best to use this tube as detector when followed by a resistance coupler. While it will work well with transformer coupling better response on the low notes will be obtained with resistance coupling. However, if a special transformer with very high primary impedance is available, this may be used with almost as good results as when resistance coupling is used. With transformer coupling the plate voltage should be 67.5 to 90 volts but when resistance coupling is used voltages of 135 and 180 volts are preferable. The same plate voltage may be used on the detector as on the audio amplifier stages using resistance coupling.

When the grid leak method of detection is used the grid return should be made to the positive terminal of the filament and the grid condenser should be the usual value of .00025 mfd. The plate coupling resistance should be 250,000 ohms and the grid leak should be from 2 to 5 megohms.

Somewhat better quality may be obtained with grid bias detection, but this will result in a lower sensitivity. When the plate voltage is 180 volts the grid bias for detection should be 4.5 volts and when 135 volts are used on the plate the bias should be 3.0 volts. Slightly different voltages should be tried, however, as the optimum adjustment may be somewhat different in some instances. In each case the load resistance on the tube is supposed to be 250,000 ohms.

Used As Audio Voltage Amplifier

When the tube is used as audio frequency voltage amplifier in impedance coupling, the applied plate voltage should be the same as would be used for transformer coupling, namely, from 67.5 to 135 volts, with suitable bias as given in the table of the tube characteristics. A voltage higher than 135 volts should not be used.

When resistance coupling is used higher voltages may be used safely, depending on the value of the coupling resistor that is used. And coupling resistances from 100,000 to 500,000 ohms may be used with good results. The recommended value is 250,000 ohms with a maximum of 180 volts in the plate circuit. As the plate coupling resistance is increased the voltage amplification is also increased, but this increase is more rapid at the low frequencies than at the high. Hence when it is important to amplify frequencies up to 10,000 cycles the resistance should not be made larger than about 250,000 ohms.

[This is the second of a series of articles on vacuum tubes. The first article, last week, issue of August 9th, discussed the WD-11, WD-12, UV-199 and UX-199. Next week, issue of August 25th, the 200-A, 112-A and 171-A will be discussed.—Editor.]

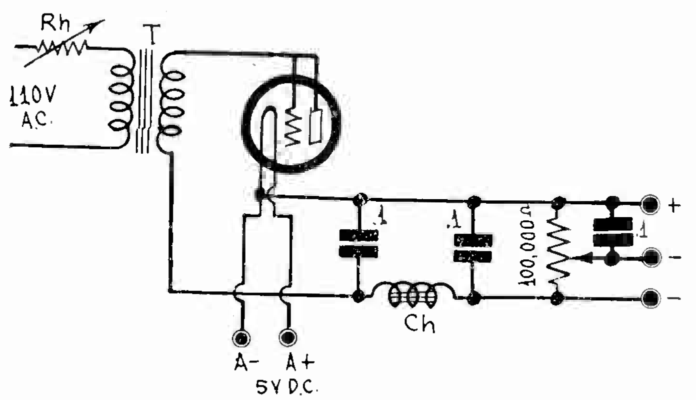

FIG. 20
THE CIRCUIT OF A GRID BIAS SUPPLY, USING A 201A TUBE AS RECTIFIER.

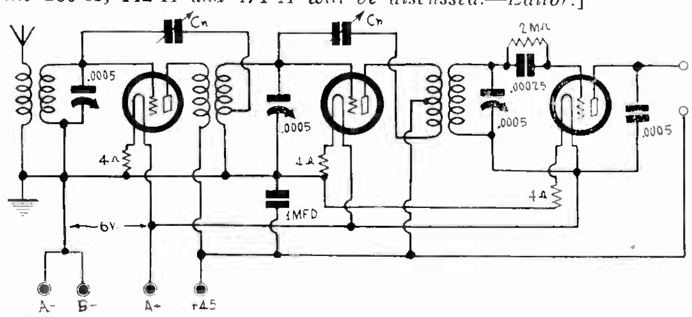

FIG. 21
A RADIO FREQUENCY AMPLIFIER AND DETECTOR INCORPORATING THREE 201A TUBES. IN THE FIRST STAGE THE HAZELTINE METHOD OF NEUTRALIZATION IS USED, AND IN THE SECOND STAGE THE RICE SYSTEM.

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Rejuvenation of Tubes

WHY IS IT that oxide coated filament tubes cannot be rejuvenated when thoriated filament tubes can be?—R. R. E.

The oxide coated filament gives off electrons as long as the oxide coating lasts. When it is burned off electrons will no longer be given off at the low temperature at which they are operated but will give off electrons when the temperature is very high, that is, so that the filament is white instead of dull red. But the emission is not good and it takes a great deal of current to keep the filament white hot. For practical purposes the tube is dead as soon as the oxide is gone. The thoriated filament gives off electrons by virtue of an atom-thick layer of thorium over the tungsten wire surface. When this layer is burned off by an overload, the emission ceases. However, thorium is mixed with the tungsten and in the rejuvenation process some of the thorium in the interior is forced to the surface to form a new layer. If the tube is not abused this thorium is forced to the surface continuously until all is consumed. When all the thorium in the filament as well as on the surface has been exhausted this tube cannot be rejuvenated.

* * *

Crowding Parts Together

SIX AND SEVEN years ago plenty of room was given to radio receivers. A five tube set occupied a space from two to five times as great as the room now devoted to ten tube sets. In those early receivers only the tubes, coils and condensers were included. Batteries were external. Now all the tubes, coils, condensers, and power supply are included in the small space. If it was necessary to devote so much room to sets in the early days, why is it not necessary to devote a proportionately larger space to the modern sets? Is there any advantage in the crowding?—W. H. B.

The lack of shielding in early receivers made it necessary to allow plenty of room between coils. The loss in amplification and selectivity due to the shielding in modern sets is compensated for by more amplifier tubes and more tuners.

* * *

When a Choke Is a Condenser

IF A RADIO frequency choke coil has a distributed capacity of one micromicrofarad and an inductance of 85 millihenry, what is the highest frequency at which it is useful as a choke coil?—C. D. W.

The natural frequency of resonance of this coil is 545 kilocycles, and this is the theoretical limit. However, the capacity is so small that the coil can be used in the broadcast band, though in this band and all higher frequencies the coil is really a condenser. Such a coil, however, would not be effective in a short-wave receiver, for at 20 megacycles the impedance would not be more than 4,000 ohms.

* * *

Oscillation Pick-Up in Super

WHICH IS BETTER, introducing the local oscillation in a short-wave converter into the screen grid circuit or into the grid circuit? Which is the best way of introducing the oscillation into the modulator when a 227 tube is used?—E. E. J.

For the same degree of coupling between the modulator and the oscillator there is no difference. The method used depends on the circuit. In some cases it is more convenient to introduce the oscillation in the screen circuit and in others it is more convenient to introduce it in the grid. When the oscillation is introduced in the grid circuit, whether the modulator be a 224 or a 227, there are many ways of doing it, and again the choice is largely a matter of convenience. One very good way is to connect the pick-up coil in the cathode lead below the grid bias resistor. This has the advantage that one side of pick-up coil may be grounded, still permitting the grounding of the rotor of the tuning condenser. This cannot be done in a directly heated tube.

* * *

Radiation of Energy

IF THERE MUST always be a return path for electricity to complete a circuit, how is it that signals can be picked up from a radio station without any connection, and particularly without any return connections? You might say that the earth constitutes the return connection, but how about communication between an airplane and ground, or between two airplanes in flight?—R. A. L.

There must be a return path, as well as a direct path, for electric currents. But radio waves are not currents. They are sent out never to return again. The fact that a radio wave may cause electric currents to flow in circuits at a distance does not change the case at all. Let us illustrate by an example in ballistics. Fire a gun and project a bullet. There does not have to be a return path for the bullet. There does not even have to be a target. The bullet in its flight has a certain amount of energy, which depends on its mass and its velocity. If the bullet strikes something having mass it can communicate some of its energy to that mass, or all of it, and when it does it sets the other mass into motion. That is about what takes place when a radio wave is radiated. It can set currents in an antenna moving and the antenna is therefore a target.

* * *

Importance of Primary Turns

ARE ANY TWO audio frequency transformers having the same ratio of turns capable of the same amplification when used between the same tubes? If not, on what does the gain depend?—N. E. M.

They are not. The ratio of turns means very little, for one transformer having a lower ratio may actually give a higher gain. Much depends on the inductance of the primary. The higher this is, maintaining a constant ratio of turns, the higher the amplification. A transformer having a low inductance primary and a high ratio of turns acts more like a tuned circuit at audio frequency than a non-resonant audio coupler. The quality from such transformers is very bad. But as the primary inductance is increased the amplification is also increased especially on the low frequencies. The inductance of the primary depends on the number of turns on this winding, the size of the core, the kind of alloy in the core, and on the amount of direct current that flows through the primary. It increases with the number of turns and the size of the core and also with the permeability of the core material. It decreases with the direct current in the primary because the current decreases the permeability.

* * *

Shielding Audio Transformers

IS IT ADVANTAGEOUS to shield audio frequency transformers just as it is to shield radio frequency transformers? If so, what kind of shielding is the best? Is it also good practice to shield the leads in the audio circuit? I have noticed in some high class amplifiers that the transformers are shielded and that the leads are inclosed in lead sheath.—W. A. W.

In a high gain amplifier it is undoubtedly advantageous to shield not only the transformers but the leads. In a low gain amplifier there is little need for it. The best shield is undoubtedly heavy cast iron surrounding the transformer. This is effective both against electric and magnetic coupling and it is sturdy enough to be shock-proof. An amplifier built with transformers thus shielded remains stable even at high gain, as far as stray coupling is concerned, and it also prevents audio frequency pick-up from external sources, such as power lines carrying alternating current. It is desirable to shield the leads in heavy lead sheaths as this helps to prevent interstage coupling and also to prevent pick-up. But these precautions alone do not insure stability if all the tubes in the amplifier are served by a common B supply for in such cases most of the interstage coupling is through the B supply. To prevent oscillation or distortion the feedback through this coupling it is necessary to filter the supply leads very carefully and thoroughly.

* * *

Voltage Drop in Filament Leads

I BUILT A short-wave converter designed so that the filament current is taken from a socket in the broadcast receiver. The leads from the socket to the two tubes in the converter are about 36 inches long. I have noticed that the tubes in the converter do not burn as brightly as those in the receiver on the same winding of the 2.5 volt transformer. It occurred to me that this might be due to the drop in the leads, because the current in these leads carry 3.5 amperes. Am I right or wrong in my assumption? If I am right what can I do to supply normal current to the converter tubes without sacrificing the plug-in arrangement?—B. E. S.

Undoubtedly you are right. You can do one of two things, or both. First, you might shorten the leads as much as possible. Second, you might use much heavier wire in the leads. A simple way of making the leads heavier is to run two or three equal wires in parallel. This would reduce the voltage drop in the leads and at the same time it would leave the leads flexible.

* * *

Magnetomotive Force

CAN YOU GIVE a brief explanation of the meaning of magnetomotive force? I believe I understand what electromotive force means, but I have difficulty grasping magnetomotive force.—P. G. A.

The two conceptions are quite similar and it seems that if one is understood the other should be understandable with the aid of analogies. The first thing we must realize is that magnetism is a kind of flux analogous to electric current. Take a coil of

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wire and send an electric current through it. We know that the coil becomes a magnet, that magnetic flux flows through the coil in one direction and that this flux returns outside the coil. Just how this occurs can be observed by sprinkling iron filings over a sheet of paper resting on a permanent bar magnet. The filings align themselves along the lines of magnetic force and become a picture of the cross section of the magnetic field. The magnetic field about a coil is similar. When no current is flowing in the coil there is no magnetism about it, but it exists as long as the current is flowing. The magnetomotive force is the force that maintains the magnetic field about the coil, just as it is the electromotive force that keeps the current in the coil flowing. To get another analogy we might imagine a long iron pipe representing the coil with a fan inside it. As long as the fan is still no air current flows through the pipe, but as soon as the fan starts the air current flows. The air flows in one direction inside the pipe and in the opposite direction outside. The air in motion would represent the magnetic field.

* * *

Coil for .0004 Mfd. Condenser

I HAVE A tuning condenser that has a maximum capacity of .0004 mfd. which I want to use in a broadcast tuner. I also have some bakelite tubing 1.75 inches in diameter and a quantity of No. 24 double cotton covered wire. How many turns of this wire will be required to make a coil that will cover the broadcast band with the condenser I have?—E. N. Y.

About 100 turns will be required for the tuned winding. It figures out to be 101 turns, but there will be some distributed capacity in the circuit which will cut down the required number of turns a little. It seems that No. 24 double cotton wire is a little too heavy for this size of form because it will make the winding nearly three inches long.

* * *

Tone Control

IF A CONDENSER of .01 mfd. capacity is connected in series with a 30,000 ohm variable resistance and the two are connected across the primary of the first audio frequency transformer are the low or the high notes cut off? What is the effect of varying the resistance?—A. L. W.

The high notes are cut off more or less because the condenser is in shunt with the line. The more resistance that is cut in series with the condenser the less is the cut-off as the high frequencies are suppressed. The maximum effect of the condenser occurs when the resistance is zero.

* * *

Sensitive AC Milliammeter

WHAT IS the most sensitive alternating current meter? I wish to get hold of one that measures alternating currents of the order of a few microamperes.—W. B. J.

Possibly the most sensitive instrument is the Duddell thermo-galvanometer. It is made of an ordinary galvanometer but in place of a moving coil of a large number of turns a single turn of heavy silver wire is used. At the lower end is a thermo-couple and the hot junction of this couple is very close to a platinum heater element through which the current to be measured flows. The current heats the platinum and the heat is radiated to the thermo-junction heating that in turn. A small direct current flows through the silver loop and this current is measured with the galvanometer. A current as small as 15 microamperes can be measured.

* * *

Use of New Tubes

WOULD IT BE practical to connect three of the new tubes, two 232 and one 230, in series on a battery made of four series connected No. 6 dry cells? How much would the current from the battery be?—F.W.Y.

It would be because the voltage required by the three filaments in series is six volts and the rated voltage of the battery is also six volts. When the cells are new the voltage will be a little higher and after they have been used some time it will be a little less than six volts. The current drawn from the battery will be only .06 amperes, and therefore the battery will last a long time before the voltage falls so low that the tubes will not function.

* * *

Adjusting Short-Wave Coils

PLEASE SUGGEST a method for adjusting the turns on short-wave coils so that there is a small amount of overlapping in their tuning ranges. I would know how to do it if I could tune in all wavelengths and if I could be sure of recognizing them, but this I cannot do. Hence I need another way of doing it.—D.I.R.

The simplest way is to set up a buzzer circuit and placing it near the receiver or tuner. This buzzer circuit should have a tuned circuit the frequency of which can be varied over the desired band. That is, the buzzer circuit is a small transmitter. Plug in your largest coil in the short-wave set and set the tuning condenser near zero, the distance from the zero depending on the amount of overlapping you wish. Leave it set. Now start the buzzer circuit and change its frequency until the buzzing can be heard as loud as possible in the short-wave set. Now leave the buzzer alone. Plug in the next largest coil in the short-wave set and set the tuning condenser near the hundred mark, the distance from it depending on the amount of overlapping desired. Now adjust the number of turns on the coil until the buzzer signals come in loudest. This process can be repeated until all the coils in the set have been adjusted. In case a buzzer is not available rig up an oscillator, using the same type of coil and condenser to determine the frequency emitted. This frequency should be modulated, which may be done by simply heating the filament with AC.

* * *

Glass Absorbs Luminous Waves

ARE THE RADIATIONS of luminous gases affected in any way by the nature of the transparent tube in which they are contained?—J. W. E.

If the glass envelope does not exert any selective absorption, the entire luminous gas spectrum is available. Usually, though, there is some selective effect resulting in some of the spectral lines being weak or absent. If there is ultra-violet light in the gas' spectrum and the envelope is lead glass, the ultra-violet is mostly absorbed. Where this frequency is desired it is necessary to make the envelope of fused clear quartz, which is expensive.

* * *

What Is Phosphorescence?

WHY ARE FLUORESCENT and phosphorescent light so named?—A. Q. U.

A light source is said to be fluorescent when it emits light of a different frequency than that which impinges upon it. When the excitation frequency ceases, fluorescence also ceases.

A phosphorescent light source is one which continues to emit light after the exciting source is removed. Phosphorescence is, therefore, a light storing process, and is exhibited by certain lower forms of marine life.

A Receiver's Wattage

Many radio set owners are at sea regarding actual current drain or current cost of their receivers. Also, they are at a loss to determine the wattage of their sets.

According to the engineering staff of the Clarostat Mfg. Co. the wattage of any radio set is readily computed by cehcking up on the wattage of the tubes. Thus the wattage for the various types of tubes runs as follows:

Tube	Watts
250	45
281	15
210	17
280	15
245	18
224	7
227	7
226	5
171	10
112	10

The cost of operating the radio set may be readily determined by obtaining the total wattage and comparing same with the kilowatt-hour rate. Thus the current for a 100-watt set, operating on a 10c. kilowatt-hour rate, costs 1c. per hour.

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NEW RECEIVER HAS RECORDER OF 6" RECORDS

The 1930-31 line of RCA Victor receivers includes a model with a small portable microphone and other recording equipment, so that phonograph records may be made at home on composition discs.

The microphone input is made to the audio amplifier of the receiver, while an inscribing device, using the principle of the phonograph pickup, is attached to what otherwise would be the speaker output. In that way the needle registers on the blank record, and one may preserve a favorite broadcast program, the first words of a precious infant, or anything else that suits the fancy.

Home Talkies Possible

With ingenuity a moving picture camera could be used to take pictures of the family, and the remarks of the "actors" recorded on the phonograph record, so that when the film is shown at the correct pace, and the synchronous phonograph motor used, one may enjoy home-made talkies. The camera part of the performance would have nothing to do with the RCA product.

The recorder will be a part of the Radiola Victrola combination, the list price of which, with the recording equipment, will be $285, or, with tubes, $308.50.

The equipment is designed to make 6-inch records, and the method of recording and the composition used enable the reproduction of the record many times before it becomes worn out.

An Improvement

Heretofore preliminary efforts to serve the public with recording devices of an inexpensive type, undertaken by non-radio manufacturers, concerned metal disc, principally aluminum, but the recording was feeble and the record soon wore out.

The Radiola Victrola will have a four-way switch, so that radio programs or phonograph records may be played, or records made of the renditions of radio programs or of friends or members of the family.

The radio receiver is of the four-circuit tuned radio frequency type.

WLW Introduces "Run" for Radio Play

Cincinnati, O.

"The Blonde Brazilian," a play written especially for radio, was produced by the Crosley Theatre at WLW on Monday, Thursday and Saturday nights in the same week at different hours.

The play was the first one to be given three radio performances in one week, a plan to be followed by the Crosley Theatre. The same schedule will prevail in successive weeks.

Walter Maher, character man in the Crosley Players, played the leading role of Harry Jones, Englishman. Maher came to radio after experience on the stage. He is credited with more "fan" letters than any other member of the WLW dramatic cast. Edward A. Byron, author of the play, directed it.

Board Intends to Cut Stations

Washington.

Instead of granting more radio facilities in overcrowded areas, the Federal Radio Commission finds it will have to "effect a reduction in the number of certain types and classes of stations," it informed the Court of Appeals of the District of Columbia, answering the injunction suit of WHAD, Milwaukee, Wis., which was denied increased time on the air.

The Commission stated that "overcongestion exists in numerous communities," and that the Fourth Zone, which includes Wisconsin, "is particularly overloaded with more than its share of broadcasting stations, and applications from this zone must be carefully examined."

PASTOR'S TALKS CALLED UNFIT

Los Angeles.

Revocation of the license of KGEF, of this city, if after admonition there is a continuance of unpatriotic and destructive political broadcasting by the Rev. Robert P. Shuler, owner of the station, is asked by George D. Lyon, former head of the Los Angeles Council of the American Legion.

Mr. Lyon submitted a formal complaint to Federal Radio Commissioner Sykes, who came here to hold hearings on several matters.

The complaint sets forth that once a week for a few years the pastor has been making speeches on political, economic and sociological affairs, but that lately he has become abusive of persons and of established governmental institutions.

"In his criticism of events and persons his intemperance of thought and expression give wide offense," states the complaint, "especially to members of various patriotic bodies. The reckless denunciations are of a character which may dangerously inflame the passions of some elements of the population, and are apparently so hostile to established institutions of the Government, such as the judiciary and other law-enforcing agencies, that in the opinion of the undersigned the public utterance of many of these utterances is contrary to public policy."

The complaint asks that the pastor be admonished to desist from continuing offensive broadcasts, that his station be placed on probation, and that, if the parole is violated, the station be ordered forthwith off the air.

Butman Heads Firm To Represent Stations

Washington.

The first organization of station representatives to be formed in the National Capital has been organized by Carl. H. Butman, former secretary of the Federal Radio Commission. The firm name is Butman, Cooke & Lowe, with offices in the National Press Building.

The firm plans to obtain for its client stations spot advertising programs, talks and announcements for national or group distribution. This organization already represents stations in different parts of the country. Very shortly the opening of branch offices in the main industrial centers of the United States will be announced.

WABC GETS 3 MONTHS MORE TO FIND SITE

Washington.

A three-months' extension has been granted by the Federal Radio Commission to WABC, key station of the Columbia Broadcasting System, to find a suitable location for a 50,000-watt transmitter. The station is now located near Cross Bay Boulevard, Queens County. New York City, and has a construction permit to erect a 50,000-watt transmitter, on condition that it obtains a site that would result in less interference than the present one, but after a year's effort no success has attended the hunt for such a site.

The station tried hard to get a location in New Jersey, and had even obtained the tentative approval of the Federal Radio Commission, but the local residents and some local stations complained. They said that the high-powered transmitter would blanket local stations and that WABC was a New York station, hence was "invading" the rights of the people of New Jersey.

Did Not Want to Offend

As the station did not want to create any ill-will in a State in which it has many thousands of listeners, it turned its attention to New York State.

One site on Long Island was picked out but again a hullabaloo about interference and blanketing was raised, and the effort to find a site did not progress. Next Hempstead, N. Y., was tried, which was farther out on Long Island, and some of the local officials were satisfied that it would be all right to locate the transmitter there, but a local radio club and some other residents complained, whereupon the ground gained was lost, and the predicament of WABC in its search for a 50,000-watt site is as acute today as it but comes in loud in the local area. The was a year ago.

The station is now using 5,000 watts, desire to use 50,000 watts arises from the better coverage, with higher signal intensity, in areas more than a hundred miles from the transmitter. Also some few existing semi-dead spots would be overcome, it is expected.

The Situation in New York City

The only station in New York City now using 50,000 watts is WEAF, one of the key stations of the National Broadcasting Company. The other NBC key station, WJZ, using 30,000 watts, has no present intention of increasing power, but has applied for 50,000 watts, so that a transmitter of that capacity may be installated, consonant with the improvement of transmission, as is going on at WEAF, to enable sending out still better quality signals, due partly to 100 per cent. modulation.

When WABC finally gets a site and builds the new transmitter, it, too, will be equipped with the latest devices for perfection of transmission, including high percentage modulation and most exact frequency control.

In some areas WABC's signal is reported consistently absent, hence its desire to improve its transmitting conditions.

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KOLSTER PLANS NEW START AS IT PAYS BILLS

A plan has been submitted by S. P. Woodward & Co., Inc., of New York, to Vice-Chancellor Church, in Newark, N. J., for the reorganization of the Kolster Radio Corporation, one of the group of set manufacturers to be thrown into bankruptcy toward the close of last season.

Obligations totalling nearly $1,200,000 are to be discharged, this is to be done through stock transactions. The obligations are mainly in the form of notes. Although made by the corporation, most of the notes bear also the personal indorsement of Rudolph Spreckles, the California sugar magnate, who was a large Kolster stockholder, and who participated in the $12,000,000 profits from the sale of Kolster stock when the market was highly bullish.

Some Creditors Paid In Full

Many of the creditors are looking forward eagerly to the reorganization, as merchandise creditors were hit rather hard, they thought, when the receivership was announced. However, some of them have been paid off since then, and got the pleasant surprise of their lives when they were paid "one hundred cents on the dollar." One concern got $18.000 that way. It was one of the "small creditors," as the full-payment plan was applied first to creditors of a certain amount or less. Others, to whom more than the minimum was owed, got 100 cents, too, but their bills were not paid in full, and they are looking forward to completion of payment soon.

No Stock Market Rigging

John A. Bernhardt, special master appointed by the Vice-Chancellor to determine whether there had been any rigging of the market in Kolster stock, as charged by one of the stockholders, found there had been no such rigging, but that stock sales by officers of the corporation were going on at a grand pace even while one of the officers in particular knew that the corporation was sustaining heavy losses.

Chromite Deposits Found in Montana

Princeton, N. J.

The Stillwell River District of Southern Montana has been found to abound with rock deposits that yield abundant chromite, useful in the plating of steel, so as to render it rust-proof and with a high-polish, non-peeling finish, of superior lustre and brilliance to nickel plating.

The discovery was made by Prof. Edward Sampson, of the geology department of Princeton University, who just returned from an inspection trip of the Montana territory.

The Transvaal region of South Africa is the chief chromite deposit area. The yield in the United States was scarce and of poor quality, rendering it hardly of commercial use. However, the recently discovered deposits in Montana are of high quality.

The 1930-31 season in radio kit construction will see several circuits exploited with chromium plated chasses and shields. The metal used is steel, of 1-16 inch thickness, and the chromium plating gives it, besides wearability, a beautiful appearance.

It has been found that foundation platings are necessary when chromium is used.

Injunction Halts State Tax on Sets

Charleston, S. C.

A temporary restraining order against enforcement of the South Carolina law taxing owners of radio receiving sets has been issued by Federal Judge Ernest F. Cochran, after a hearing on a petition filed by WBT, of Charlotte, N. C. The order was made in the test proceedings instituted by the Radio Manufacturers Association, challenging the constitutionality of the South Carolina law, the first tax on radio owners imposed in any state.

In granting the restraining order, pending hearing of a petition for an interlocutory injunction before a three-judge court, Judge Cochran said it appeared that immediate and drastic enforcement of the radio tax law might cause irreparable damage and loss. The state law would levy a graduated tax of from 50c to $2.50 on owners of radio sets. In the three test cases the plaintiffs alleged that radio is interstate commerce subject only to Congressional regulation and not to State or local taxation.

608 STATIONS GET RENEWALS

Washington.

All save one of the country's 609 broadcasting stations began operations recently with a license renewal for three months.

The solitary exception was WRK, at Hamilton, O., which did not file an application for renewal pursuant to regular procedure of the Federal Radio Commission. This station was notified by telegraph by the Commission that any operation would be in violation of the radio law, since the station's old license had expired.

It was explained at the Commission that under new procedure stations are required to file applications for the renewal of their licenses in advance of the date of expiration. Failure to do so, it was pointed out, is tantamount to forfeiture of license, since the Commission has no license before it to renew.

The blanket extension of licenses for the three-month period includes thirty-one stations which have been awarded only "temporary licenses," due to failure to adhere to Commission regulations or to the terms of the radio law.

These stations in all sections of the country must stand trial before October 31st, when the current license period expires, and show cause why their license should not be revoked.

The folowing new station was licensed:

WGBF, owned by W. N. Parker and H. H. Metcalf, Glens Falls, N. Y., 50 w., 1,370 kc.

KBTM, Paragould, Ark., 500 w, requested change in frequency from 1,190 kc to 990 kc.

WPTF, Raleigh, N. C., asked increase to 5,000 watts. It is now licensed at 1,000 watts.

The following have applied for construction permits for new stations:

600 kc

Sherman D. Bracken, 212 Colorado St., Portales, N. Mex., 10 kc.

1320 kc

Alfred J. Pote, Springfield, Mass., 1 kw.

1420 kc

Corner Drug Store, Inc., 20w. Fox and Canyon Streets, Carlsbad, N. Mex. (Daytime operation only).

TEACHERS BALK AT SPONSORED AIR EDUCATION

Washington.

Strenuous efforts are being made to make radio more important in the dissemination of scientific, political and economic information, but the educational aspect is hindered by commerciailsm. At present advertisers that use the air prefer to present musical programs, although once in a while an educational talk is introduced, sometimes even having no connection with the product of the advertiser.

Many educators feel that the microphone and education do not mix well, for the commercial reason, and object to sponsored programs carrying educational appeal, because the aim of the buyer of time on the air is to create sales, while the educator is interested in disseminating information, and has no sympathy with money-making projects.

Educators Fear Harm

Hence it is believed that any attempt to pair the two divergent interests could result in only harm to both, particularly to the educational aim.

Armstrong Perry, specialist in education, attached to the Office of Education, Department of the Interior, pointed out that broadcasting stations classed as commercial, as distinguished from those conducted by colleges and churches, usually devote about 15 per cent of their time to educational programs.

More Optimistic in California

In some states, according to "The United States Daily," little anxiety is felt about the danger of commercialization of education, the specialist explained. The Superintendent of Education in California was said to have shown a liberal attitude toward the subject, viewing the radio and its equipment and the circumstances surrounding broadcasts in the same way he views other commercial enterprises necessary for the promotion of education.

The superintendent regards the equipment in the same way he regards any other equipment of the public schools, and has accepted with appreciation educational broadcasts by commercial interests, it was explained.

Forum

Custom-Built Auto Set O. K.

REGARDING the letter in Forum, from Irving Wenig, concerning auto receivers, I believe that Mr. Wenig never heard a good portable receiver, and that he is no custom builder. No sincere custom builder will let himself get knocked over the head with the statement that auto sets don't amount to much. I have a diagram of a receiver that is working in the designer's car, which is picking up DX better than many factory-made home receivers. Of course it is a custom-built receiver and nobody can show me a better one.

So why give the radio trade over to the automobile trade?

H. Thurnsheer
191 Kingston Avenue,
Floral Park, N. Y.

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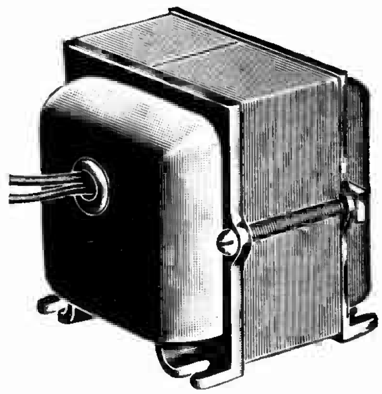
New Polo Power Transformers and Chokes

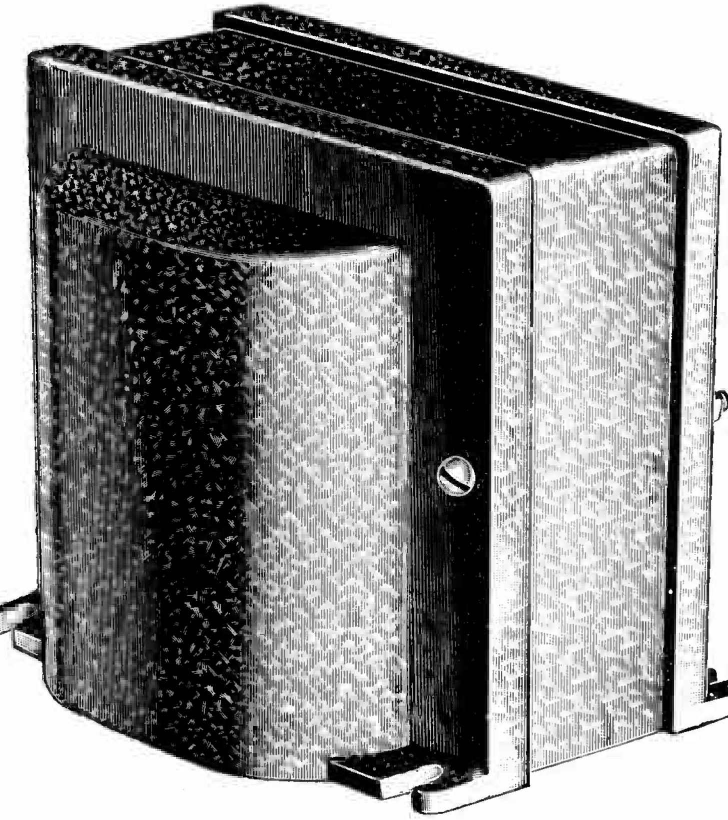


Shielded single choke, 200 ohms D.C. resistance, non-saturable at 100 milliamperes, with two black outleads, each 6 inches long. For filtration of B supplies. Inductance, 30 henrys.
Cat. SH-S-CH, price..............................$5.00

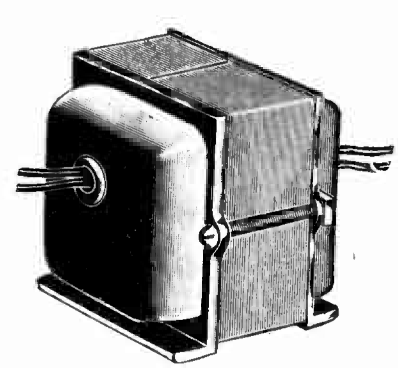
The shielded single choke will pass 100 ma. One will suffice if the current is 100 ma. or less, for filtration of B supplies, provided the capacity at the filter output is 8 mfd. or more. Use two such shielded chokes if less than 8 mfd. is used at the filter output. Also, the shielded single choke may be used as in the power tube circuit for an output filter. In this connection use at least 2 mfd. for the capacity section of the filtered speaker output. Order Cat. SH-S-CH @ $5.00

The shielded double choke may be used for filtration where the B current is 60 ma. or less, with relatively small filter capacities, no less than 4 mfd. at the output, however. This choke consists of one winding, center-tapped. Its use is especially recommended for 171, 171A, 245 or 210 push-pull output. Connect the black leads (extremes of windings) to plates of the push-pull tubes, **red center tap to B plus, and the speaker may be connected** directly to plates without any direct current, but only signal current, flowing through the speaker. This system is applicable only to push-pull. Order Cat. SH-D-CH @ $6.00

In the same type of case a 20-volt secondary filament transformer, for 110 volts, 50-133 cycle, may be obtained for use in conjunction with dry rectifiers, such as Kuprox, Westinghouse, Benwood-Linze and Elkon, in dynamic speakers or A battery eliminators. Not made for 25 or 40 cycles. Order Cat. SH-F-20 @....................$2.50



245 Power Transformer for use with 280 rectifier, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, and supply filament voltages.
Cat. 245-PT price $8.50



Twenty-volt filament transformer, 110 v. 50-133 cycle input, for use in conjunction with dry rectifiers. It will pass 2.25 amperes.

In a different type case, square, of cadmium plated steel with four mounting screws built in, size 1½ inches wide by 8¾ inches high by 4 inches front to back, a 50-60 cycle filament transformer is obtainable with the same windings as the 245 power transformer, except that the high voltage secondary is omitted. Order Cat. 245-FIL, @ $4.50
For 40 cycles order Cat. 245-FIL-40 @.......... 7.00
For 25 cycles order Cat. 245-FIL-25 @............8.50

[Any of the above three in the same case as the 245 power transformer, © $1.00 extra. Add PTC after the Cat. number.]

A single choke, unshielded, 65 ma rating, 30 henrys inductance, for B filtration or single output filter of speaker, is our Cat. US-S-CH @.................$1.25

Polo Engineering Laboratories, 143 West 45th St., New York, N. Y.

Enclosed please find $———— for which ship at once:

☐ Cat. 245-PT @...$8.50	☐ Cat. 245-FIL @..$4.50
☐ Cat. 245-PT-40 @ 9.50	☐ Cat. 245-FIL-40 @ 7.00
☐ Cat. 245-PT-25 @ 12.00	☐ Cat. 245-FIL-25 @ 8.50
☐ Cat. SH-S-CH @ 5.00	☐ Cat. SH-F-20 @. 2.50
☐ Cat. SH-D-CH- @ 6.00	☐ Cat. UN-S-CH @. 1.25
☐ F-2.5-D @ 3.75	

Note: Canadian remittance must be by post office or express money order.

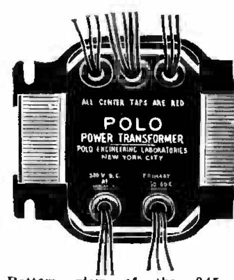
☐ If C.O.D. shipment is desired, put cross here. No C.O.D. on 25 and 40 cycle apparatus. For these full remittance must accompany order. The 25 and 40 cycle apparatus bears the 50-60-cycle label, but you will get actually what you order.

Name ....

Address ....

City.............................. **State**..............

The Polo 245 power transformer is expertly designed and constructed, wire, silicon grade A steel core and air gap large enough to stand the full rated load. The primary is for 110v A.C., 50-60 cycles, tapped for 82.5 volts in case a voltage regulator, such as a Clarostat or Amperite, is used. The black primary lead is common. If no voltage regulator is used, connect black lead to one side of the A.C. line, green lead to the other side of the line, and ignore red lead, except to tape the end. For use with a voltage regulator (82.5-volt primary) use red lead and ignore the green except to tape the end. The secondaries are: high voltage for 280 plates, with red center tap to ground; 2.5 volts, 3 amperes, red center tap to C plus, for 245 output, single or pushpull; 5 volts, 2 amperes, red center tap, as positive B lead, for filament of 280 tube; 2.5 volts, 16 amperes, red center tap to ground, for 224, 227 and pentode tubes, up to nine heater type tubes. **Hence there are** five windings.



Bottom view of the 245 power transformer. All leads are plainly marked on the nameplate, including the top row.

A special filament transformer, 110 v., 50-60 cycles, with two secondaries, one of 2.5 v. 3 amp. for 245s, single or push-pull, other 2.5 v. 12 amperes for 224, 227, etc., both secondaries center-tapped. Shielded case. 6 ft. AC cable, with plug. Order Cat. F-2.5-D @.......$3.75

The conservative rating of the Polo 245 power transformer insures superb results even at maximum rated draw, working up to twelve tubes, including rectifier, without saturation, or overheating due to any other cause. This ability to stand the gaff requires adequate size wire, core and air gap, all of which are carefully provided. At less than maximum draw the voltages will be slightly greater, including the filament voltages, hence the 16 ampere winding will give 2.25 volts at maximum draw, which is an entirely satisfactory operating voltage, increasing to 2.5 volts maximum as fewer than a total of nine RF, detector and preliminary audio tubes are used.

The avoidance of excessive heat aids in the efficient operation of the transformer and **in the maintenance of good** regulation, or excessive heat increases the resistance of the windings.

The transformer is equipped with four slotted mounting feet and a nameplate with all leads identified. **It is one of the** very finest instruments on the radio market.

Highest Capacity of Filament Secondary

SPECIAL pains were taken in the design and manufacture of the Polo 245 power transformer to meet the needs of experimenters. For instance, excellent regulation was provided, to effect minimum change of voltage with given change in current used. Also, the 2.5 volt winding for RF, detector and preliminary audio tubes, was specially designed for high current, to stand 16 amperes, the highest capacity of any 245 power transformer on the market. Hence you have the option of using nine heater type tubes. **The shielded case is crinkle brown finished steel, and the assembly is perfectly tight, preventing mechanical** vibration.

The power transformer weighs 11½ lbs., is 7 inches high, 4⅞ inches wide, and 4¼" front to back, overall.

Elevating washers may be used at the mounting feet to clear the outleads, or holes may be drilled in a chassis to pass these leads, and the transformer mounted flush.

Advice in Use of Chokes and Condensers in Filter

With the 245 power transformer either one or two single chokes should be used, or a shielded double choke, depending on the current drain and the capacity of filter condenser used. Where the capacity at the output is 8 mfd. or more for a drain of 65 to 100 ma., a single choke will suffice (Cat. SH-S-CH), but where smaller output capacity than 8 mfd. is used on such drain, two such chokes should be used in series. Next to the rectifier, in either instance, use a 1 or 2 mfd., 550 A.C. working voltage rating condenser (D.C. rating, 1,000 volts). You may use your choice of capacity at the midsection.

If the drain is to be 65 milliamperes or less, the double choke, Cat. SH-D-CH, may be used for filtration, instead of two single shielded chokes.

The Polo 245 power transformer may be obtained for 25 cycles or 40 cycles on special order, as these are not stocked regularly, and remittance must accompany order. The same guaranty attaches to them as to all other Polo apparatus—money back if not satisfied after trial of five days. In these the primary and secondary voltages and taps are the same, only the case is deeper (front to back) because of larger core and wire for lower frequency.
For 40 cycles order Cat. 245-PT-40..............................@ $9.50
For 25 cycles order Cat. 245-PT-25..............................@ $12.50

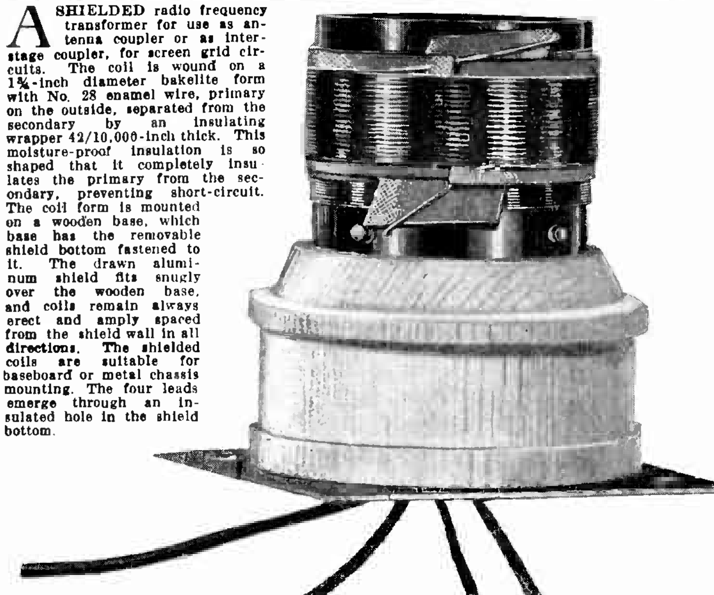
[Note: The filter for 40 cycles should consist of two shielded single chokes, Cat. SH-S-CH, with 2 mfd. next to the rectifier and 4 mfd. minimum at the joint of the two chokes and at the end of the filter. For 25 cycles the same holds true, except that the output capacity at end of chokes should be 8 mfd. minimum.]

We Make Special Transformers to Order

www.americanradiohistory.com

High-Gain Shielded Coils

A SHIELDED radio frequency transformer for use as antenna coupler or as interstage coupler, for screen grid circuits. The coil is wound on a 1¾-inch diameter bakelite form with No. 28 enamel wire, primary on the outside, separated from the secondary by an insulating wrapper 42/10,000-inch thick. This moisture-proof insulation is so shaped that it completely insulates the primary from the secondary, preventing short-circuit. The coil form is mounted on a wooden base, which base has the removable shield bottom fastened to it. The drawn aluminum shield fits snugly over the wooden base, and coils remain always erect and amply spaced from the shield wall in all directions. The shielded coils are suitable for baseboard or metal chassis mounting. The four leads emerge through an insulated hole in the shield bottom.

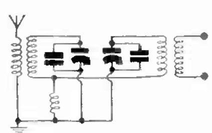


The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.

The external appearance of the shield, with four 6/32 machine screws and nuts, which are supplied with each coil assembly.

Precisely Matched for Gang Tuning

ONE primary lead-out wire from the coil, for antenna or plate connection, has a braided tinned alloy covering over the insulation. This alloy braid shields the lead against stray pick-up when the braid alone is soldered to a ground connection. The outleads are 6 inches long and are color identified. The wire terminals of the windings themselves, and the outleads, are soldered to copper rivets. Each coil comes completely assembled inside the shield, which is 2¾ inches square at bottom (size of shield bottom) and 3¾ inches high. High impedance primaries of 40 turns are used. Secondaries have 80 turns for .00035 mfd. and 70 turns for .0005 mfd.



BP-6 is the coil at bottom.

EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: shielded wire outlead is for antenna or plate; red is for ground or B plus. (These options are due to use of the same coil for antenna coupling or interstage coupling.) Blue is for grid and yellow is for grid return. For .00035 mfd. the Cat. No. is A-40-80-S. For .0005 mfd. the Cat. No. is A-40-70-S.

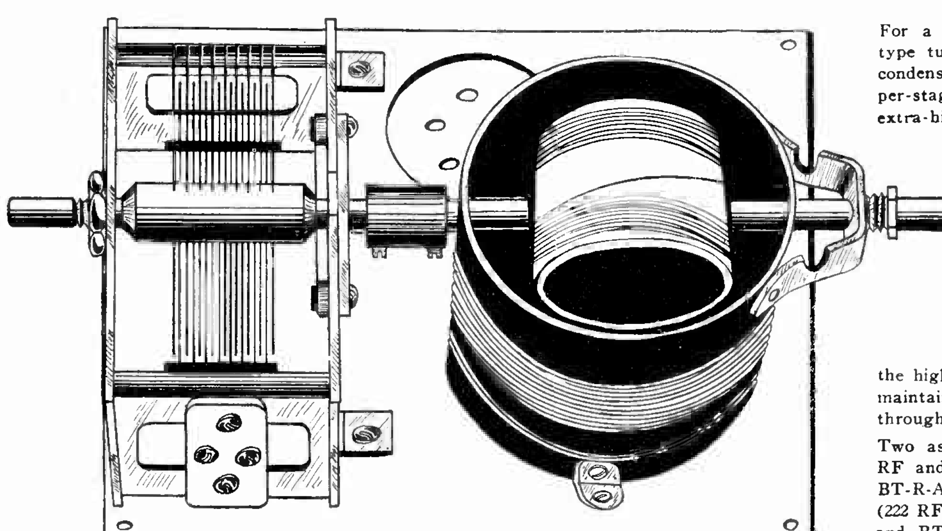
Where a band pass filter circuit is used the small coupling coil to unite circuits is Cat. BP-6. The connection is illustrated herewith.

Junior Model Inductances

The Series B coils have the same inductance and the same shields as the series A coils, but the primary, instead of being wound over the secondary, with special insulation between, is wound adjoining the secondary, on the form, with ¼-inch separation, resulting in looser coupling. No wooden base is provided, as the bakelite coil form is longer, and is fastened to the shield bottom piece by means of two brackets. No outleads. Wire terminals are not soldered. Order Cat. B-SH-3 for .00035 mfd. and Cat. B-SH-5 for .0005 mfd.

Coils for Six-Circuit Tuner

Series C coils for use with six tuned circuits, as in Herman Bernard's six-circuit tuner, are wound the same as type A shielded coils, but the shields are a little larger (3 1/16-inch diameter, 3¾ inches high), and there are no shield bottoms, as a metal chassis must be used with such highly sensitive circuits. Fasten the brackets to the shield and then, from underneath the chassis, fasten the other arm of the two brackets to the chassis. Order Cat. C-6-CT-5 for .0005 mfd. and Cat. C-6-CT-5 for .00035 mfd. Five needed for Bernard's circuit. If band pass filter coupling coil is desired order Cat. BP-6 extra.



For a stage of screen grid RF, either for battery type tube, 222, or AC, 224, followed by a grid-leak-condenser detector, no shielding is needed, and higher per-stage amplification is attainable and useful. This extra-high per-stage gain, not practical where more than one RF stage is used, is easily obtained by using dynamic tuners. Two assemblies are needed. These are furnished with condensers erected on a socketed aluminum base. Each coil has its tuned winding divided into a fixed and a moving segment. The moving coil, actuated by the condenser shaft itself, acts as a variometer, which bucks the fixed winding at the low wavelengths and aids it at the high wavelengths, thus being self-neutralizing and maintaining an even degree of extra-high amplification throughout the broadcast scale.

Two assemblies are needed. For AC operation (224 RF and 224 or 227 detector), use Cat. BT-L-AC and BT-R-AC. For battery or A eliminator operation (222 RF and any tube as detector), use Cat. BT-L-DC and BT-R-DC.

BT-L for the antenna stage and BT-R for the detector input. BT-L consists of a small primary, with suitable secondary for the .00035 mfd. condenser supplied. BT-R has two effective coils: the tuned combination winding in the RF plate circuit, the inside fixed winding in the detector grid circuit.

The moving coils must be "matched." This is done as follows: Turn the condensers until plates are fully enmeshed, and have the moving coils parallel with the fixed winding. Tune in the highest wavelength station receivable—above 450 meters surely. Now turn the moving coils half way round and retune to bring in the station. The setting that represents the use of lesser capacity of the condenser to bring in that station is the correct one. If gang tuning is used, put a 20-100 mmfd. equalizing condenser across the secondary in the antenna circuit and adjust the equalizer for a low wavelength (300 meters or less).

Screen Grid Coil Co., 143 West 45th Street, New York (Just East of Broadway):

Enclosed please find $............ (Canadian must be express or P. O. Money Order), for which send me prepaid the following:

☐ A-40-80-S, each $2.25
☐ Matched set, 4 A-40-80-S, $1 matching 10.00
☐ A-40-70-S, each 2.25
☐ Matched set of four A-40-70-S........ 10.00
☐ B-SH-3, each $1.00
☐ Matched set of four B-SH-3........... 4.00
☐ B-SH-5, each 1.00
☐ Matched set of four B-SH-5........... 4.00
☐ BT-L-AC and BT-R-AC, assembled, with condenser, link, socket and base, per pair....... 6.00
☐ BT-L-DC and BT-R-DC, assembled, with condenser, link, socket, base, per pair.......... 6.00
☐ C-6-CT-5, .0005 mfd. shielded coil for six-circuit tuner..........................each $2.25
☐ C-6-CT-3, .00035 mfd. shielded coil for six-circuit tuner..........................each $2.25
☐ BP-6 .... .25
☐ EQ-100, equalizer of 20-100 mfd. capacity, made by Hammarlund........................ .35

(Note: All coils come with shields, except BP-6 and BT-L.)

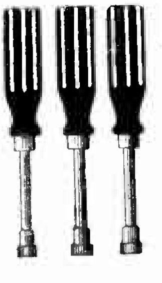
NAME.. ADDRESS..................................

CITY.. STATE..............................

☐ If ordering C.O.D. put cross here. Post office fee will be added to prices quoted.

www.americanradiohistory.com

Set of SOCKET WRENCHES *FREE*



FOR turning nuts down or up there is nothing as efficient and handy as a socket wrench. Here is a set of three wrenches for hexagonal nuts, enabling use with 5/32, 6/32, 8/32 and 10/32 nuts. Fit the nut into the proper socket and turn down or up. The three different size sockets, one size on each wrench, enables use of three different outside diameters of nuts, but at least ten different sizes of threads. Send 50 cents for four weeks subscription for RADIO WORLD and get this set of three wrenches FREE!

RADIO WORLD, 145 W. 45th St., New York, N.Y.

50 cents enclosed for 4 weeks' subscription for RADIO WORLD. Send socket wrenches free!

Name ....

Address ....

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

☐ Cross here if extending existing subscription.

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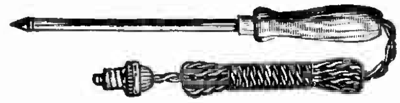
BOTH FOR ONE YEAR @ **$7.00**

You can obtain the two leading radio technical magazines that cater to experimenters, service men and students the first and only national radio weekly and the leading monthly, for one year each, at a saving of $1.50. The regular mail subscription rate for Radio World for one year, a new and fascinating copy each week for 52 weeks, is $6.00. Send in $1.00 extra, get "Radio News" also for a year—a new issue each month for twelve months. Total, 64 issues for $7.00.

☐ If renewing Radio World subscription, put cross in square.

RADIO WORLD, 145 West 45th Street, New York, N. Y

SOLDERING IRON FREE!



Works on 110-120 volts, AC or DC; power, 50 watts. A serviceable iron, 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

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DOUBLE RANGE POTENTIOMETER; made by Centralab, designed for volume control. In dust-proof bakelite case. Price, $1.05. Guaranty Radio Goods Co., 143 W. 45th St., New York.

FIDELITY HORN UNIT—Stands up to 450 volts without filtering. Can be used in the portable without horn attached. Price, $2.25. Guaranty Radio Goods Co., 143 W. 45th St., New York.

ERLA-DYNAMIC CHASSIS, WESTINGHOUSE RECTIFIER. Sensitive and efficient dynamic speaker chassis. List price, $25; our net price, $12.50. Guaranty Radio Goods Co., 143 W. 45th St., New York.

NEW DRAKE'S ENCYCLOPEDIA 1,680 Alphabetical Headings from A-battery to Zero Beat; 1,025 Illustrations, 920 Pages, 240 Combinations for Receiver Layouts. Price, $6.00. Radio World, 145 W. 45th St., N. Y C

"RADIO TROUBLE SHOOTING," E. R. Haan. 328 pages, 300 illustrations, $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**

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Room 504

1562 Broadway, N. Y. City

(Between 46th and 47th Streets)

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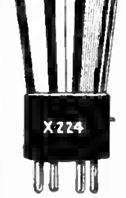

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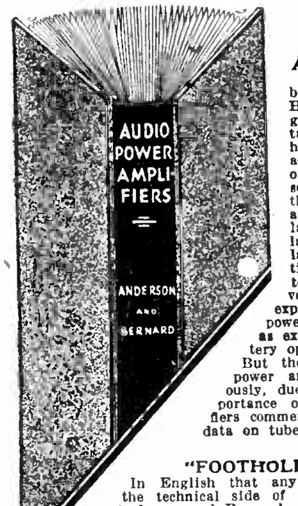

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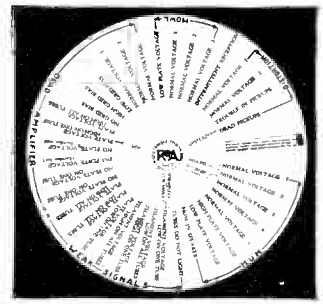

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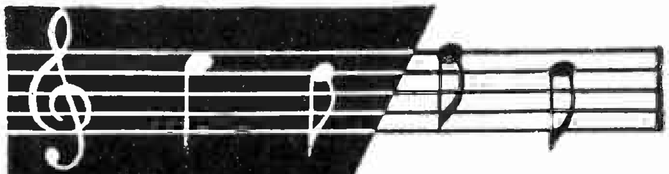

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