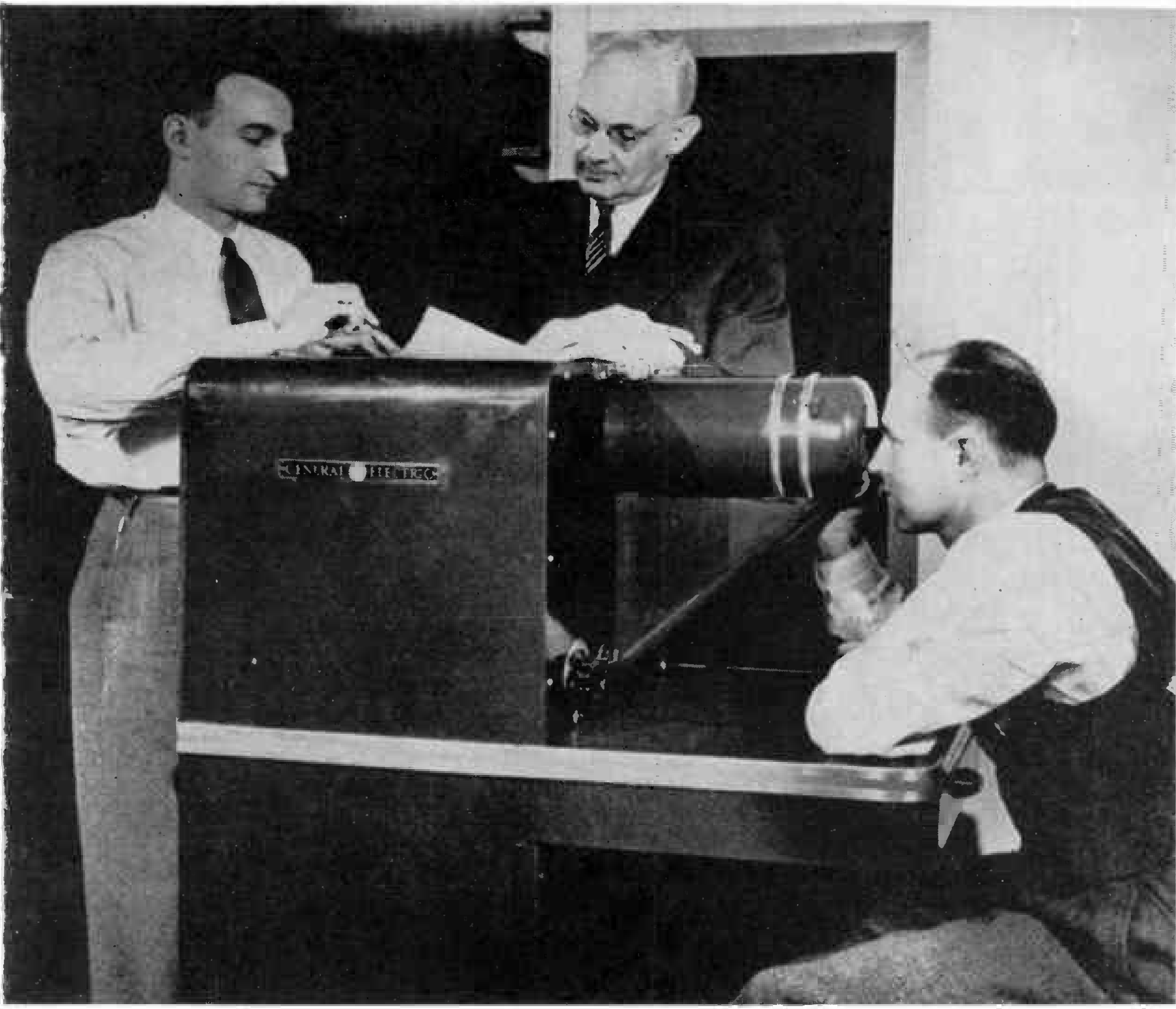
# NATIONAL RADIO NEWS




## IN THIS ISSUE




APR.-MAY 1943

VOL. 10 NO. 8

# *Control Yourself*

One reason some men never get anywhere is because they spend all their lives fighting difficulties of their own making.

For example, consider the man who is ready to argue at the drop of a hat, at any time and on any subject. He may out-talk other people and win his arguments, but in so doing he loses the friendship, respect and cooperation which are essentials of success. An argument won by noise and command merely shows that reason is weak.

Another example is a man who cannot recognize that anyone else could possibly be correct. Unwillingness to consider the other man's viewpoint is a serious handicap in any business where success depends on cooperation with others—and that covers just about every business in existence today.

Consider the words of the Roman philosopher Seneca: *"Most powerful is he who has himself in his own power."* And Milton had the same basic thought when he wrote, *"He who best governs himself is best fitted to govern others."*

In other words, if you let common-sense reason rule your own feelings, fears, desires and pride—*if you control yourself*—you'll soon find people fighting with you, not against you, for your success in Radio.

J. E. SMITH, *President.*

# Transformerless Power Packs

By J. B. STRAUGHN

N. R. I. Consultant

IN the last few years there has been an immense growth in the use of transformerless power packs. The original impetus came from a desire to eliminate the expensive power transformer, but other sound reasons for its use have since appeared. These are: 1. Freedom from induction hum, due to the strong magnetic field of the power transformer (of particular importance in many electronic measuring and test instruments). 2. Less weight, which is of great importance in all portable equipment. 3. The resultant saving in space.

In the transformer power pack, the various tube filaments are wired in parallel, using a pair of twisted wires, and are connected to a special low-voltage winding on the power transformer. Where tube design makes available only tubes of different filament voltage ratings, separate filament windings must be used. This, in some commercial receivers, calls for as many as four different filament windings including the rectifier.

In the transformerless power pack, use is made of the special tubes which are available, and which make the problem of supplying the filaments a simple one indeed. Figure 1 shows the basic arrangement used, in all transformerless supplies, to furnish the tube filaments with power. Here the tube filaments are simply wired in series and are connected across the power line. Resistor R serves to limit the filament current to the correct amount. The tubes do not have to be chosen with respect to filament voltage, but they must all require the same filament current. Since the same current flows through all of the tubes the total current is equal to that required to heat any one of the tube filaments. In a transformer power pack the total filament current is the sum of that drawn by the individual parallel filaments. The reduction in current drain, made possible by the series arrangement, reduces the magnetic field about the filament wiring, the possibility of hum induction into nearby circuits and the necessity for using twisted filament leads in any but exceptionally high gain circuits. Tubes commonly employed in transformerless systems have 6.3-volt, 7-volt, 12.6-volt, 25-volt, 35-volt and 50-volt filaments. The tubes are further divided into two types—those requiring .3 ampere and those requiring .15 ampere of filament current. In general no attempt is made to use .3-ampere tubes in the

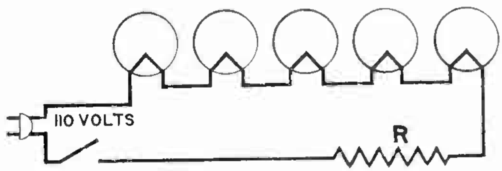



Fig 1. A string of tube filaments.

same filament string as .15-ampere tubes. If this was done the tube filaments requiring the least current would be shunted with a resistor. The shunt resistor would then carry the excess current around the low drain tubes. The resistance would be equal to the filament voltage of the tubes it shunts divided by the difference in amperes between the low drain and high drain tubes. This is a simple application of Ohm's Law.

In our filament string, we may for example, find 12.6-volt, 35-volt and 50-volt filaments all requiring .15 ampere.

In a transformer type supply we connect only tubes requiring the same filament voltage together. This is done regardless of the filament current requirement. We might have four 6.3-volt tubes connected to the same 6.3-volt winding on the power transformer and these tubes might require filament currents of 1 ampere, .3 ampere, .15 ampere and ,25 ampere. We seldom think about the filament current other than to make sure that the transformer when we install it is capable of furnishing enough current without overheating. The technician instinctively knows that if the right filament voltage is applied the correct current will flow. This is true because the filament of a tube has resistance and like any other resistor works in accordance with Ohm's Law. The current will be equal to the voltage divided by the resistance and naturally if the resistance and voltage are correct the right current will flow.

Now in a transformerless system we work from the current viewpoint rather than voltage. If the correct current is caused to flow through a filament the right voltage drop appears across it since voltage is equal to current multiplied by resistance. If we have three .15 ampere tubes as shown in Fig. 2 and the correct current flows

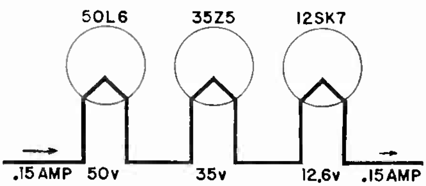



Fig. 2. If the correct current flows through a tube filament the voltage drop across the filament will be correct.

through their filaments the correct voltages as shown will appear across each tube filament. These voltages add up, 50 + 35 + 12.6, to 97.6 volts and if we connect 98 volts which is close enough, across the string, the desired .15 ampere will flow.

However we have a 110 volt power line and if the three filaments are connected across it too much current will flow. The difference between 110 volts and 98 volts is 12 volts so we need an additional voltage dropping device which will handle 12 volts at .15 ampere. An ordinary resistor may be used for this purpose. Ohm's Law ($R = V \div I$) tells us that an 80-ohm resistor will do the job and the complete circuit is shown in Fig. 3.

Filament voltage dropping resistors are made in a number of different forms. We may have a metal clad wire wound resistor of the candohm type. Such a resistor will be counted under the receiver chassis usually near the back wall which may be perforated to allow the escape of heat. Excess heat in a chassis is damaging to many of the parts, particularly electrolytic condensers.

To get the heat out of the chassis a long resistance wire is often built into the line cord and serves as the voltage dropping resistor. Such devices are known to technicians by the name cordohm and are available in various popular values.

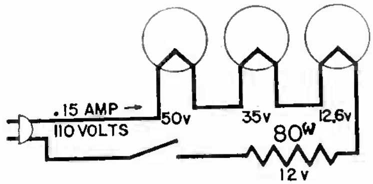



Fig. 3.

Finally we have the resistor tube where the resistance wire is wound on a mica form and is placed inside a metal envelope. This is terminated in a regular tube base and is plugged into the socket provided for this purpose on the chassis. These tubes come in the necessary values and for replacement purposes servicemen ask for them by the name, resistor tube, ballast or line ballast. The model number is very important and will be found marked on the envelope of the defective tube.

These devices serve no useful purpose other than to waste excess voltage. Where we have an excess of 12 volts as in Fig. 3 we could substitute an extra 12.6 volt tube for the resistor but this would be worse than using a regular resistor since only the tube heater would be in the circuit. In many instances this extra voltage may be used to light a pilot lamp. The lamp is inserted in the circuit just like a tube filament. Any remaining excess voltage not used by the pilot lamp is taken care of by a resistor as previously described.

For transformerless power supplies 6.3 volt lamps are used. These are often marked 6-8 volts meaning that they can stand any voltage between 6 and 8 volts without burning out. When installing a replacement lamp be sure it has the same color of glass bead supporting the filament wires inside its envelope as the original. These lamps are made with different current ratings distinguished by the color of the bead. A brown bead is for .15 ampere, a white bead .2 ampere and a blue bead for .25 ampere.

There is a precaution which must be observed when using pilot lamps in series with tube filaments. The filament of a pilot lamp is nowhere near as rugged as that of a tube. Due to the design of a tube heater its resistance is quite low when cold and when voltage is first applied the current will be higher than normal. As the filament becomes hot its resistance increases and the current comes down to its rated value. A pilot lamp filament being much thinner reaches full heat almost at once and the excess current drawn by the tube filaments will burn it out. To prevent this a resistor shunt is always placed across the

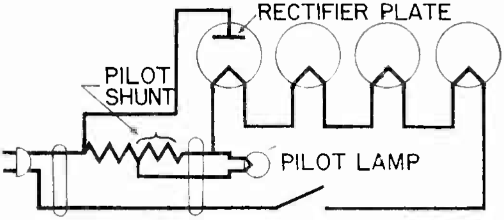



Fig. 3A. Cordohm with 4 leads.

pilot lamp and at normal current values we arrange the circuit so the lamp has a drop of about 4 volts across it. This causes the lamp to operate at less than full brilliancy but prolongs its life. Since the tube filament current will divide and flow through both the shunt and lamp the current through the lamp will always be less than the filament current and within safe values.

Where .3 ampere tubes are employed a blue bead .25 ampere lamp is commonly used. The difference in current is .05 ampere, the value which is to flow through the shunt. In adding up the circuit voltage drops preparatory to figuring the line cord resistance the pilot lamp is given a value of 4 volts. This same voltage will be across the pilot lamp shunt resistor and 4 volts divided by .05 ampere will give the shunt resistance in ohms. In some cases a tap is provided on the cordohm for the pilot lamp, making part of the resistor serve as a shunt. Fig. 3A shows this. Fig. 3B shows a tapped ballast tube of the type commonly employed. Later we will see how special rectifier tubes are used to limit the pilot lamp current to a safe value. This method is used with tubes of the .15 volt series.

## Half-Wave Line Rectifiers

For the B supply, the simplest solution is to use a single diode tube for half-wave rectification of the power line. The circuit is shown in Fig. 4. When the upper side of the line is positive, electrons flow through the switch which is closed, from —B and through the receiver which is shown as a resistor between —B and +B, through the filter choke and from the cathode to the positive plate of the rectifier tube. When the upper side of the line becomes negative, the tube blocks the flow of electrons and the receiver depends on the current which was stored in the input filter condenser. Before the input filter condenser is completely drained by the receiver load, the line voltage again reverses, and when the rectified voltage has risen above the voltage charge remaining in the condenser, it is again charged up. If only a small amount of current is drawn by the load (the receiver B supply circuits), the input condenser will be charged to the line voltage x 1.41, less the small drop in the tube. Thus like all input condenser filters, we have a device which delivers peak line voltage instead of the 110-volt r.m.s. value we measure with our a.c. voltmeter. Since the receiver as a load acts on the supply like a resistor the degree of discharge is determined by the time constant of the condenser and resistance of the load. The length of time it takes to discharge the condenser is equal to the capacity multiplied by the load resistance. The charging current does not pass through the load but through the low resistance path afforded by the plate-cathode of the rectifier tube. Hence the input condenser charges far more rapidly than it discharges.

While Fig. 4 is the basic half-wave transformerless power supply circuit, there are variations which rate study. In most cases a double-diode tube such as the 25Z6 is used. The plates and cathodes are tied together at the tube socket to give the circuit shown in Fig. 5. The circuit is exactly the same in operation as Fig. 4, but the parallel diodes can rectify greater currents.

In half-wave transformerless power packs the filter inductance may be a choke coil or a speaker field. It must have a low value of not more than

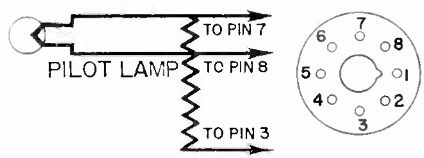



Fig. 3B. Resistor tube element and base, showing how element connects to tube pins. Pilot lamp connects to pins 7 and 8.

350 ohms to avoid poor regulation. Often the field will have a resistance of 3000 ohms or more and then one of the cathodes may be disconnected from the B supply filter and used to furnish field current only. Figure 6 shows this arrangement. At other times, the cathodes remain tied together, the field is shunted across the

input of the filter, and both cathodes supply the receiver and field currents. In either case the field is not a part of the filter and adds nothing to the filter action.

In Fig. 4 you will note that the choke is sometimes replaced by a resistor. This resistor gen-

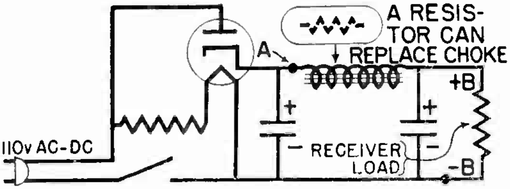



Fig. 4. Half-wave rectifier as used in a.c.-d.c. receivers. The rectifier filament only is shown here but it could be one of the filament string shown in Fig. 1.

erally has a value of 3000 ohms if it is to be effective in reducing the ripple. Even so, high capacity electrolytic filter condensors will be required.

By replacing a 200 ohm or 300 ohm choke with a 3000 ohm resistor the voltage drop across the resistor will increase leaving less voltage for

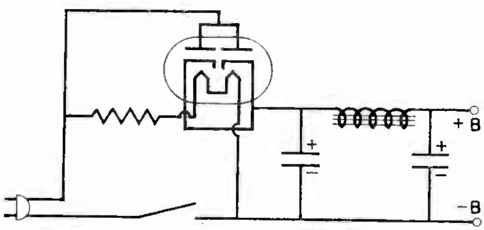



Fig. 5. Duo-diode tube with plates and cathodes tied together for half-wave rectification.

the operation of the receiver. To avoid such a loss in voltage the current through the filter resistor is decreased, thus reducing the voltage drop across it and increasing the voltage available for the receiver circuits. The necessary reduction in current through the filter resistor is accomplished by connecting the +B plate supply lead of the output tube to point A in the circle shown at Fig. 4 rather than the output of the filter. By doing this, considerable a.c. ripple voltage is fed the power output tube plate, but as the tube plate current is unaffected by small changes in plate voltage, little a.c. hum is transferred through the output transformer to the loudspeaker. Also in equipment which uses this scheme, low audio frequency signals are not reproduced very well so the effect of hum is further reduced. If for example the screen of the power output tube (a pentode of some type is generally employed) is connected to point A rather than the normal +B connection, hum will be heard since the plate current is decidedly affected by changes in screen grid voltage. The current reduction due to the plate supply lead change is sufficient and the screen current receives the usual filtering as it remains connected to +B.

The usual method of biasing a power tube is shown in Fig. 7. Here the 15 volts or so across R is subtracted from the voltage available for application between the plate and cathode thus lowering the plate-cathode voltage of the out-

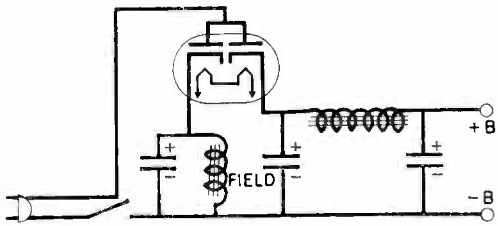



Fig. 6. Separate cathode field for field excitation. For simplicity the rectifier filament circuit has not been completed.

put tube. In some cases the filter choke is placed in the negative side of the circuit. The coil may be tapped to furnish bias for the output tube, as shown in Fig. 8. Then the full voltage between +B and —B may be applied between the cathode and plate supply lead of the power output tube. In this case the arrangement in Fig. 8 conserves the B supply voltage since the cathode connects directly to —B. This is important where we only have a limited voltage to start with.

Since half-wave rectification is used in all of these circuits, the ripple frequency is 60 cycles, the same as the line frequency.

A 60-cycle ripple is harder to eliminate than the 120-cycle ripple obtained with full-wave rectification. The fact that the low frequency response in the usual a.c.-d.c. receiver is low makes the amount of output ripple less important and by using larger filter condensers and a high choke inductance passable results are obtained.

The filter chokes commonly used in these power packs have small dimensions but still have a fairly high inductance. This is possible because the current through the chokes is relatively low and does not reduce the inductance by saturating the core.

The filter condensers may be in a block or separate individual condensers may be used. The highest voltage which will be applied to the condensers is approximately 140 volts, the line voltage × 1.41 less the drop in the tube. Because of this condensers for these circuits are rated at 150 volts d.c. or more. The capacity values in general use may run from 8 mfd. per section to 40 mfd. When replacing such a condenser be guided by the capacity of the original as marked on the case or on the schematic diagram.

A high-capacity input filter condenser introduces another problem, however. When the rectifier

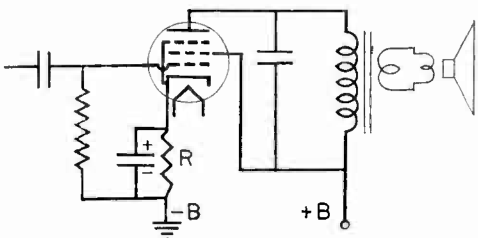



Fig. 7. Power output stage in an a.c.-d.c. set showing cathode bias resistor R.

tube is not passing current on the negative power line alternation, the input condenser is almost drained of its charge by the receiver load. When the rectifier again passes current on the positive line alternation, the surge current (in recharging the input condenser) may rise to such a high value as to burn out the cathode lead inside of the tube. This lead is purposely made so it will act as a fuse and burn out before the tube shorts and starts a fire or blows the line fuse. To limit the peak current to safe values a small resistor is often inserted in the plate supply lead of the rectifier. This resistor will generally have a value of about 25 to 50 ohms, and will not have a great effect on the output voltage of the power pack.

To avoid the necessity of using such a resistor, a rectifier with a tapped filament has been devised, and the plate is connected to the tap as shown in Fig. 9. Here the B supply electrons after passing through the receiver load and the filter system leave the rectifier cathode and flow to its plate. At the plate they divide, part passing through the pilot lamp and part through the rectifier filament. They join again at point A. Thus you see the tap is also used as a pilot lamp shunt. Like all filaments, the rectifier heater has regulating properties. When it is cold, its resistance is high. As it heats up, its resistance decreases. Therefore, if you come across an a.c.-d.c. receiver whose pilot lights up brightly when first turned on, dies down and then slowly lights up as the tubes start drawing plate current, you will know

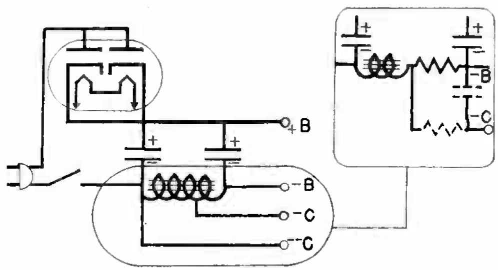



Fig. 8. Methods of obtaining semifixed C bias. The B filter action is no different with choke in negative side of line. Sometimes an extra R-C filter (shown by dotted lines) is required to keep hum voltages out of the C supply circuit.

that the pilot lamp is shunted across a tapped section of the rectifier filament.

When the power packs we have discussed are used on a d.c. power line the line plug must be inserted in the wall socket in such a way that the rectifier plate connects to the positive side of the line. If the line plug is reversed the rectifier plate

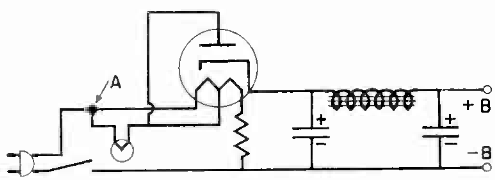



Fig. 9. Plate connects to tap on rectifier filament and pilot lamp shunts tapped section of filament.

will be negative and no B voltage will be supplied. On d.c. the B supply voltage will equal the line voltage less the drop in the tube.

Editor's Note: Part 2 on Voltage Doublers will appear in a future issue of the News.

# Advice on Remodeling Radio Equipment

RADIO servicemen eventually learn from sad experience that it is by far the better policy to stick to their own work, and avoid remodeling sets. Merely because a radio receiver does not use the latest types of tubes, does not have the approved standard i.f. value, or uses battery-type tubes which consume more power than newer tubes, is no reason for redesigning the receiver to incorporate these latest parts.

The average set owner who has paid a considerable amount of money for his receiver has the idea that it can be brought up to date for a few dollars, and inexperienced servicemen who are not warned beforehand might be inclined to agree. This is why we want to point out some of the pitfalls which await those who attempt to remodel a receiver.

First of all, remodeling involves redesigning the receiver. The average radio serviceman is definitely not a designer, for modern radio design is a far more intricate problem than might be imagined. It would seem to be a simple matter to change from 2-volt tubes to 1.4-volt tubes in a battery-operated receiver, for this apparently requires only a change in sockets. The real trouble with a remodeling of this type starts, however, when you begin trying to get the same sensitivity from the remodeled unit. It is true that the newer tubes may be capable of even better performance than the 2-volt tubes, but the r.f. and audio circuits must usually be redesigned to utilize this superior capability.

It is true, also, that a receiver having an i.f. value of 456 kc. will give reception freer from interference than one having an i.f. value of 175 kc. Changing to 456 kc., i.f. transformers will not by any means constitute a complete remodeling, however, for the entire range of tuning dial values depends upon the i.f. value of the receiver as well as upon the oscillator coil. Even if you are willing to change the oscillator coil also, you still have the problems of getting the same gain and selectivity at the new i.f. value, and making the oscillator and preselector track at dial scale readings.

The customer will quickly recognize any deficiency in performance in a remodeled set because of his familiarity with the performance of the original receiver. In attempting to improve the original performance, you run the very serious risk of having a dissatisfied customer in the end, even though you eventually do get satisfactory performance.

The cost of the material required, plus a fair rate for the time spent in remodeling, will usually total up to so much that you could not possibly charge the customer for the whole job. This means that you take a loss on the remodeling job.

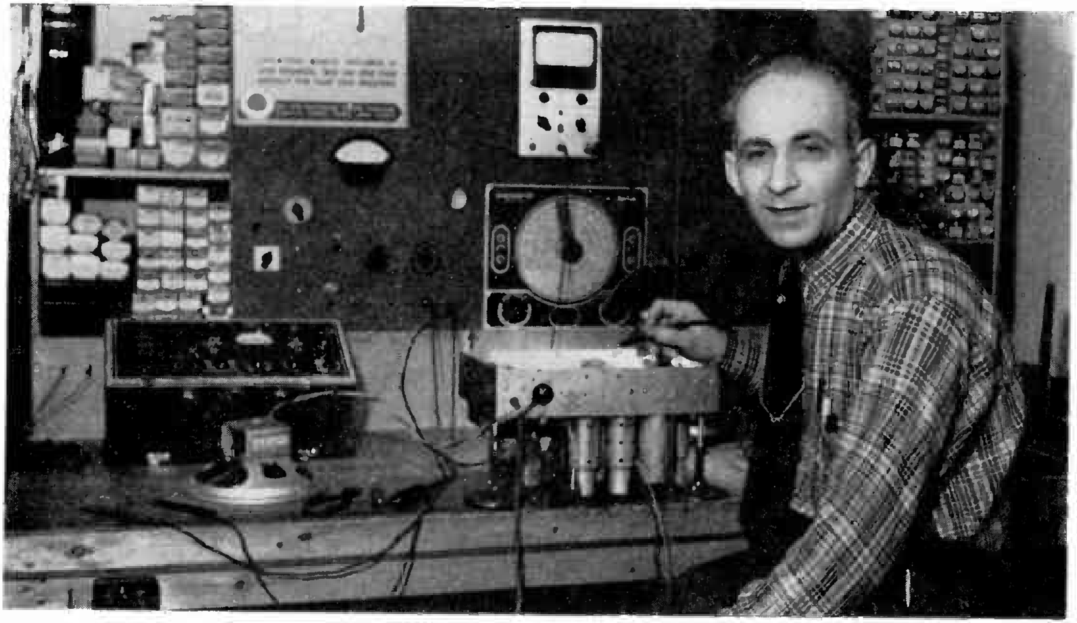
It is the job of a Radiotrician to recognize, isolate and repair defects in radio equipment, to align receivers, and to do such other things as are necessary to restore the original performance of the receiver. It is the job of the radio factory to design the receiver.

Another thought—you cannot expect to make a ten-year-old receiver have all the qualities and performance features of a modern unit unless you replace practically all of the parts and redesign the unit completely. Still another thought—even though you do redesign a receiver successfully, you will very likely be expected to keep that receiver operating satisfactorily for the rest of its life. In other words, you become "married" to that receiver, and will be blamed for all normal troubles which develop in it through no fault of your own.

Although remodeling is not recommended as a general policy, occasions do arise when a change in a circuit or part can be done in the interests of good servicing technique. For example, a serviceman who encounters symptoms of noise and oscillation in an auto radio or in a vibrator-powered receiver having a type 0Z4 gaseous rectifier will often replace this tube with a type 6X5GT tube, which is a vacuum-type rectifier having none of the troubles inherent in gaseous rectifiers.

Another example—when a defective loudspeaker is encountered in a universal a.c.-d.c. receiver and the field coil is not a part of the filter system in the power pack supply circuit, it is possible to change over to a p.m. dynamic loudspeaker.

Such changes in circuit design as are necessary to connect a phonograph pick-up, add a tuning eye, connect a pair of headphones or connect an extra loudspeaker are legitimate changes because they do not alter the basic circuit design of the receiver. Stick to changes of this kind.



# From W.P.A. to Exceptional Earnings

## Patrizi Hits the Jack Pot in Radio Business. Now Makes $65 to $80 a Week.

J. E. Smith, President
National Radio Institute
Washington, D. C.

Dear Mr. Smith:

I am very much interested in my radio work. It is fun. What I paid the National Radio Institute for my course is, in my opinion, hardly one-fifth of what I think the course is worth.

Before I enrolled I was working on W. P. A. projects. This continued for two years. I did not know how to get out of that kind of work. One day, while reading a magazine, I saw an N. R. I. advertisement. At first I hesitated to write you because I had no schooling in this country—except some night school work. Finally I decided to "take a chance."

I put into the radio course every spare penny I could get and every spare minute of time in study. After the eighth lesson I started doing some radio servicing for my friends. This spare time work gave me some earnings and every penny of this I put into my equipment and radio parts until my shop was fully equipped.

I built my own bench and also built part of my radio equipment, thanks to the knowledge gained from N. R. I.

Today I am all set, making $65 to $80 a week, clear money. I refused two jobs in Rochester, one for $85 a week and the other for $70 a week. I was also offered a job here in town for $65 a week.

The population of our town is about 12000. We get work from three other towns from five to twenty-five miles from here.

My wife is a great help to me. She takes care of my telephone calls, does the bookkeeping and attends to sales in the store.

I have the reputation of being the best radio man they ever had in this town. For all of this I am very thankful to the National Radio Institute.

Sincerely yours.

John B. Patrizi
National Radio Service
115 W. Sherman Avenue
Newark, New York

# CIRCUIT ANALYSIS of an F-M RECEIVER

## The Pilot 300

By J. A. DOWIE

N. R. I. Chief Instructor

This receiver is an 8-tube superheterodyne, designed for a.c.-d.c. operation, 105-130 volts. It has a range of 535 to 1720 kc. for broadcast, 41.4 to 50.4 mc. for f.m.

A 14Q7 functions as a combined mixer-oscillator and is followed by a 7B7 first i.f. amplifier. A 14H7 is used as a second i.f. amplifier and works into the 7C7 stage. This stage is changed over from limiter to a.m. diode detection when bands are switched. The 7C7 works into the 7A6 discriminator on the f.m. band. The function of this tube is to change the frequency modulation signal into an audio frequency voltage which is applied to the 7C7 voltage amplifier. The output of this tube then feeds the 35A5 power amplifier. Plate voltage for the tubes is provided by the 35Y4 half-wave rectifier system.

Observe the unique arrangement with respect to the plate circuits of the 14Q7, 7B7 and 14H7. Ordinary i.f. transformers are not used.

In order to secure best reception on f.m., a doublet antenna is essential. Provision is made for connection of the doublet antenna's transmission line to terminals A and D. For broadcast reception, the transmission line should be connected to terminals D and G. A ground connection is unnecessary. By-passing to chassis ground is through $C_7$. Condenser $C_6$ resonates the high-resistance, broad-tuned primary at the middle of the broadcast band, tending to equalize sensitivity throughout the band.

*F-M Reception:* To simplify the tracing of the signal, let us first take the case for f.m. reception and then consider standard broadcast. The f.m. voltage fed into A-D sends a current through $L_1$, inducing voltage in $L_2$ which is applied to the grid-cathode of the 14Q7 through switch $S_1$ in the grid circuit and through chassis and the 400-mmfd. condenser marked $C_9$. Condenser $C_6$ serves as a shunt for the f.m. current, and no voltage is developed across $L_3$, which is the lower primary. Absence of secondary induced voltage thus prevents adverse tuning effects. The 14Q7 mixes the f.m. and local oscillator signals, and beat frequency (i.f.) current flows in the plate circuit, following a path from the plate through $L_5$-$C_{40}$, the switch marked $S_3$ and down through the 300-mfd. unit marked $C_{10}$. Resistor $R_{17}$ is a decoupling resistor, and signal current prefers the easier path through $C_{10}$ rather than passing through $R_{17}$. The .01 shunt marked $C_{11}$ has inductive reactance at f.m. ultra-high frequencies, hence the necessity for using $C_{10}$. From ground, the path is completed to the cathode of the 14Q7 through $C_9$.

Local oscillator voltage is supplied between the first grid and cathode of the 14Q7 and modulates the current between cathode and pentode plate. Acting simultaneously on the space current is the signal voltage on the third grid, with the two signals being electronically "mixed," providing by heterodyne action an i.f. signal in the plate circuit of the first detector.

Feed-back in the oscillator is the result of coupling between oscillator cathode and grid coils. On f.m. the oscillator voltage is developed across $C_3$. On a.m., it is developed across $C_4$.

The parallel resonant circuit in the plate system of the 14Q7. $L_5$-$C_{40}$, develops a resonant high voltage at the f.m. intermediate frequency. This i.f. is 4.3 mc. The resonant voltage is applied to the 1-meg. resistor $R_2$ through the 150-mmfd. condenser $C_{13}$ and condensers $C_{10}$ and $C_{14}$. This causes a signal current to flow through $R_2$ and the developed alternating voltage across this resistor is applied to the grid directly and to the cathode of the i.f. amplifier through $C_{14}$ and chassis.

The 7B7 then builds up this signal voltage and sends a signal current through the f.m. parallel resonant circuit $L_{10}$-$C_{41}$ (L-C circuit nearest to plate, and through the a.m. non-resonant L-C circuit, $C_{44}$-$L_{11}$, in series with the f.m. Because the a.m. circuit is non-resonant, f.m. voltage is not developed across it and the signal goes through the a.m. condenser and $C_{15}$ to chassis ground. From there, it returns to the 7B7 first i.f. cathode. $C_{35}$ keeps the 7B7 screen at zero signal potential.

The resonant voltage across the f.m. tuned section $L_{10}$-$C_{41}$ (L-C circuit nearest to 7B7 plate) is applied to the resistor $R_3$, through grid condenser $C_{16}$, $C_{44}$-$C_{39}$, condenser $C_{15}$, and through chassis to the 14H7 cathode. The f.m. signal current flowing in $R_3$ produces an alternating potential across this resistor and this voltage is applied to the 14H7 second i.f. amplifier, which further amplifies the voltage, causing a larger f.m. signal potential to appear between the 14H7 plate and cathode. $C_{36}$ keeps the 14H7 screen at zero signal potential. It is the plate potential (voltage) which sends the f.m. signal current through the first (f.m. resonant) L-C circuit, $L_{12}$-$C_{42}$, and through the non-resonant a.m. circuit $L_{13}$-$C_{43}$. An f.m. voltage is developed across the tuned circuit nearest the plate but no f.m. voltage appears across the a.m. circuit due to the low impedance of the latter at f.m. frequencies.

The path for the f.m. current then is down through $C_{17}$, back to cathode, through the chassis.

The f.m. resonant voltage of the L-C circuit nearest the 14H7 plate ($L_{12}$-$C_{42}$) is then applied to $R_5$ through $C_{18}$, $C_{43}$-$C_{48}$. $C_{17}$ and through chassis to the chassis grounded point of $R_5$. An f.m. signal current flowing through $R_5$ develops a signal voltage which is applied to the 7C7 grid cathode (this tube serving as limiter on f.m.). Beyond a certain input value, approximately 3 volts r.m.s., the tube cuts off and levels the signal, preventing surge voltages getting through to the 7A6 f.m. detector. This detector is supposed to respond only to changes in frequency—not amplitude.

Cut-off action of the limiter is determined not only by the average bias, but as well by plate and screen potentials which are at low levels and therefore allow early cathode current cut-off.

The signal passed by the 7C7 tube sends an f.m. current through the parallel resonant circuit ($L_{14}$-$C_{46}$) in the plate system of this tube and down through $C_{20}$ to chassis, with return path to 7C7 cathode through the chassis. The screen signal potential of the 7C7 limiter is kept at zero by $C_{49}$. Current in the primary of transformer 6 induces f.m. voltage in the secondary, and applies it to the diode detector plates. At resonance, the diode voltages are equal. Above or below resonance, one diode plate receives a greater voltage than its twin. Shift of voltage away from net voltage output across total diode load (between cathodes) occurs at an audio frequency rate, in accordance with sound frequencies at the microphone in the broadcasting studio.

Voltage output of the 7A6 appears across $R_6$ and $R_7$, the f.m. i.f. signal being shunted to ground through $C_{21}$. The a.f. voltage output sends audio current through $R_8$, $C_{22}$, and the audio amplifier's input circuit. The shunt effect of $C_{22}$ cuts out some of the "highs," due to its low reactance at the high end of the audio band and compensates for pre-emphasis of "highs" in the f.m. transmitter. This condenser allows a flat "over-all" response curve.

*Audio Amplifier.* The audio amplifier input terminals are the chassis end of $R_9$ and the point to which $C_{23}$ connects at switch $S_4$. Audio voltage in-put between these terminals sends a.f. current through $C_{23}$, $R_9$, down to chassis.

The shunt elements, $C_{24}$ $R_{10}$ and $C_{25}$, pass some of the current produced by the input voltage. Voltage drops proportional to current flow and impedance are developed in these elements. When the arm of $R_9$ is set at maximum volume, the "highs' readily get through to the arm and the shunting effect of $C_{25}$ is not appreciable. With lowered volume, "highs" do not become absent since $C_{24}$ provides an easy high-frequency route to the control arm. Simultaneously, bass compensation comes into play, with the effect of $C_{25}$ and its emphasis on "lows" becoming more noticeable.

Whatever a.f. potential exists between the arm of $R_9$ and ground is responsible for audio current flow in $R_{11}$, $C_{26}$, and $R_{12}$. The potential is also partly responsible for current flow in $C_{27}$ and that part of $R_{13}$ which is between the arm of the tone control and ground.

When the arm of $R_{13}$ is set nearer to ground, the voltage of the arm with respect to ground is reduced. As a result, the current flow in $C_{27}$ caused by this voltage is reduced. The current coming from and due to the voltage of $R_9$ is increased, since the resistance $R_{13}$ which was in series with $C_{27}$ has been reduced.

$R_{13}$ serves as a negative feed-back type tone control. The greater the current in $C_{27}$ due to this voltage, the greater is the negative feed-back and reduction of "highs." Because $C_{27}$ has small capacity, it favors transmission of high-frequency audio, and tends to reject low-frequency currents. Thus, for maximum treble response, we set $R_{13}$ to have zero resistance between its arm and ground.

The a.f. current flowing in $R_{12}$ produces an a.f. potential to be applied to the 7C7 voltage amplifier grid directly and to cathode through chassis and $R_{15}$. The tube amplifies the grid-cathode potential, and signal current flows through the plate and screen circuits. A.F. potential of the screen is kept at zero by $C_{29}$. The developed plate potential sends high frequency audio current through $C_{30}$, to cathode, through chassis and $R_{15}$. All current flowing through the unby-passed cathode resistor $R_{15}$ is out of phase with the signal and tends to cause degeneration, reducing stage gain but also cutting distortion.

Resistor $R_{14}$ has high impedance compared to the combination of $R_{16}$, $C_{28}$ and $R_{13}$, so signal current due to the 7C7 prefers the easier path through the latter elements rather than through resistor $R_{14}$. The reverse signal current through $R_{14}$, due to 35A5 plate signal potential, further tends to buck out current from the 7C7 and to produce a small amount of negative feed-back in this stage, improving fidelity.

The signal potential across $R_{16}$ sends a current through $C_{28}$ and $R_{13}$, with return path to $R_{16}$ through filter condenser $C_{32}$. The current flow in $R_{13}$ produces an a.f. potential which is directly applied to the grid, and through chassis, $C_{31}$, to the 35A5 cathode. The screen grid is kept at zero audio voltage by $C_{32}$. The plate signal potential, due to the gain of the tube, is quite large and sends a high-frequency audio current through $C_{34}$ to chassis. Condenser $C_{34}$ also compensates for the large inductive reactance of the transformer at high audio frequencies, preventing audio oscillation.

The signal current which flows in the transformer primary ($L_{16}$), induces a secondary potential in $L_{17}$ which is applied to the voice coil $L_{18}$. The coil then moves at an audio rate and its attached cone, moving in air, produces sound at the same frequencies as the applied voltages.

Power for operation of the set is obtained from the 100-130 volt line which may be a.c. or d.c. Hum frequency voltages are removed by $C_{32}$ and $C_{33}$, which provide low-impedance by-passing. Opposition to current flow of hum frequency is offered by the speaker field $L_{19}$, which serves as a filter inductance, and by hum-bucking coil $L_{20}$, which introduces an out-of-phase hum in the voice coil circuit, cancelling hum in the voice coil.

By-passing for r.f. is provided by $C_{37}$, $C_{35}$ and $C_{36}$ in the filament circuit. Condenser $C_{39}$ eliminates trouble due to tunable hum and stray leakage currents. A switch on the volume control allows the set to be turned on or off.

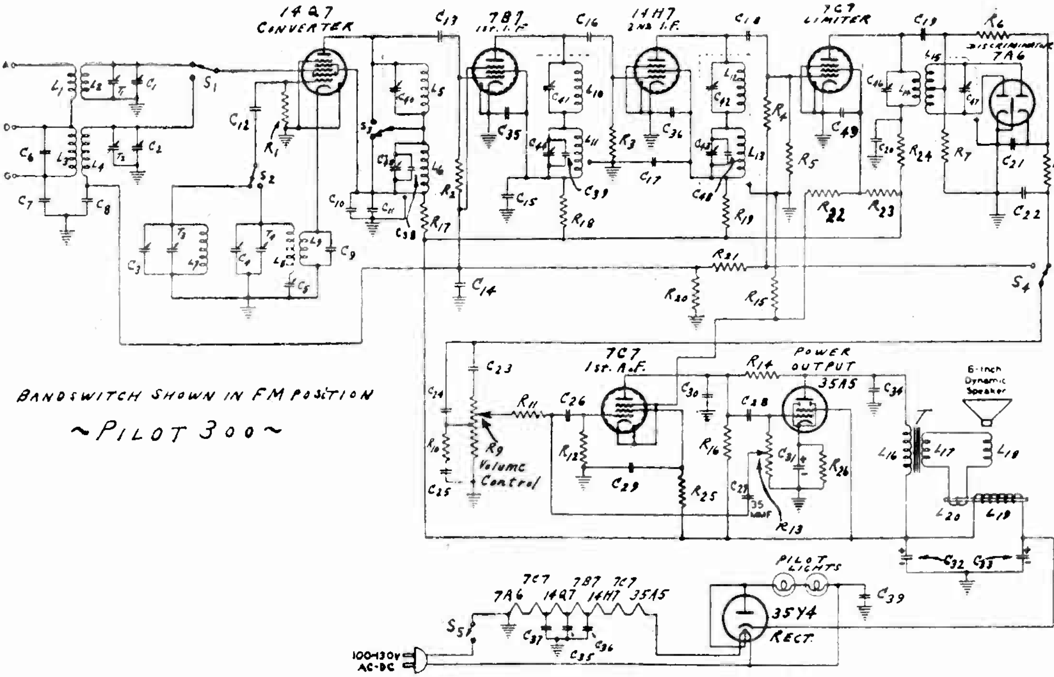
*Broadcast Reception*: The connections of band switch S shown in the schematic diagram are for f.m. and these connections are changed when the switch is thrown to the AM position.

Starting at the r.f. input, a.m. signal voltage is applied to terminals D and G, causing a current to flow in $C_6$ and $L_3$. Current also flows from G to chassis. The useful current flow is in $L_3$, which induces a voltage in $L_4$ and due to the resonant action of $L_4$, $T_2$, $C_2$ and $C_8$, the step-up voltage across $C_2$ is applied directly to the grid of the 14Q7, and to cathode through chassis. The result is that the plate and screen grids of this tube have currents at r.f. level. Condenser $C_{11}$ by-passes the screen r.f. current to ground. The plate r.f. current flows through switch $S_3$, condenser $C_{38}$ and down to chassis, through $C_{11}$. All these elements possess low impedance at r.f. and there is no effective r.f. voltage developed in the plate circuit.

The local oscillator voltage is developed across $C_4$ due to feed-back between $L_8$ and $L_9$. This voltage is applied to $R_1$ through $C_{12}$ and chassis. The plate and screen currents thus vary at the rate of the oscillator frequency. Like the r.f. voltages, the oscillator voltages are shunted from plate and screen to ground through low impedances. An important point is that the two signals flow at the same time in the plate and screen circuits. These circuits are non-linear, and, as a result, there is produced in them an i.f. beat frequency signal. The f.m. value was 4.3 mc. for the i.f. signal. The a.m. value is 456 kc.

The i.f. signal potential of the 14Q7 screen is kept at zero by $C_{11}$. The path of the i.f. plate current is through switch $S_3$ to AM parallel resonant circuit $L_6$-$C_{38}$-$C_{45}$ and down through $C_{11}$ to chassis. From there, the return to cathode is through $C_9$. I.F. current flowing through the parallel resonant circuit establishes a large voltage across its terminals. This voltage, across $L_6$, is applied to $R_2$ through $C_{13}$, $C_{14}$ and $C_{11}$. The potential across $R_2$ is applied to the 7B7 grid directly and to cathode through $C_{14}$ and chassis.

The plate and screen of this tube then have i.f. signal current larger than the current in $R_2$ by the amount of tube amplification. The screen current is by-passed to ground through $C_{35}$. The




BANDSWITCH SHOWN IN FM POSITION

~PILOT 300~

R1 oscillator grid leak
R2 1st i.f. grid resistor
R3 2nd i.f. grid resistor
R4 7C7 limiter grid resistor
R5 7C7 limiter grid resistor
R6 7C7 limiter discriminator resistor
R7 7A6 diode plate resistor
R8 7A6 cathode resistor
R9 volume control
R10 volume control tap resistor
R11 volume control series resistor
R12 1st a.f. grid resistor
R13 tone control
R14 35A5 plate resistor
R15 1st a.f. cathode resistor
R16 1st a.f. plate resistor
R17 14Q7 plate resistor
R18 7B7 1st i.f. plate resistor
R19 2nd i.f. plate resistor
R20 1st i.f. grid resistor
R21 a.v.c. resistor
R22 limiter screen resistor
R23 limiter screen resistor
R24 limiter plate resistor
R25 1st a.f. screen resistor
R26 35A5 cathode resistor
C1 r.f. tuning condenser on f.m.
C2 r.f. tuning condenser on a.m.
C3 oscillator tuning condenser on f.m.
C4 oscillator tuning condenser on a.m.
C5 oscillator series padder on a.m.
C6 L3 by-pass
C7 ground terminal by-pass
C8 14Q7 grid return condenser
C9 L9 by-pass
C10 14Q7 screen by-pass
C11 14Q7 screen by-pass
C12 oscillator grid condenser
C13 14Q7 plate condenser
C14 1st i.f. grid return condenser
C15 1st i.f. screen condenser
C16 1st i.f. plate condenser
C17 2nd i.f. screen condenser
C18 2nd i.f. plate condenser
C19 7C7 limiter plate condenser
C20 7C7 limiter plate return condenser
C21 diode cathode by-pass
C22 diode cathode filter condenser
C23 a.f. coupling condenser to R9
C24 a.f. shunt to R9
C25 a.f. shunt to R10-R9
C26 7C7 1st a.f. grid condenser
C27 negative feedback condenser to R13
C28 35A5 grid condenser
C29 1st a.f. 7C7 screen by-pass
C30 1st a.f. 7C7 plate by-pass
C31 35A5 cathode by-pass
C32 filter condenser 120-mfd. 150-V
C33 filter condenser 50-mfd. 150-V
C34 35A5 plate by-pass
C35 14Q7 filter by-pass
C36 7B7 filter by-pass
C37 filament by-pass
C38 fixed padder for a.m. coil L6
C39 fixed padder for L11
C40 f.m. i.f. trimmer for L5
C41 f.m. i.f. trimmer for L10
C42 f.m. i.f. trimmer for L12
C43 a.m. i.f. trimmer for L13
C44 a.m. i.f. trimmer for L11
C45 a.m. i.f. trimmer for L6
C46 f.m. trimmer for L14
C47 f.m. trimmer for L15, 7A6 stage
C48 a.m. fixed padder for L13
C49 7C7 limiter screen by-pass
L1 f.m. antenna coil primary
L2 f.m. antenna coil secondary
L3 a.m. antenna coil primary
L4 a.m. antenna coil secondary
L5 f.m. 14Q7 plate coil
L6 a.m. 14Q7 plate coil
L7 f.m. 14Q7 oscillator coil
L8 a.m. 14Q7 oscillator coil
L9 f.m. & a.m. oscillator coil primary
L10 7B7 1st i.f. plate coil for f.m.
L11 7B7 1st i.f. plate coil for a.m.
L12 14H7 2nd i.f. plate coil for f.m.
L13 14H7 2nd i.f. plate coil for a.m.
L14 7C7 limiter plate coil for f.m.
L15 diode plates coil
L16 output transformer primary
L17 output transformer secondary
L18 voice coil of loudspeaker
L19 field coil of loudspeaker
L20 hum bucking coil on loudspeaker
T output transformer
S1 band switch f.m.-a.m. r.f.
S2 band switch f.m.-a.m. oscillator
S3 band switch f.m.-a.m. 14Q7 plate circuit
S4 band switch f.m.-a.m. audio selector
S5 on-off line switch

i.f. plate current flows through $C_{41}$ and down through the parallel i.f. resonant circuit consisting of $L_{11}$-$C_{44}$-$C_{39}$. Across $L_{11}$, resonant voltage step-up occurs. The path for the i.f. plate circuit, after going through the resonant circuit, is down through $C_{15}$ and back to 7B7 cathode through chassis. $R_{18}$ and $C_{15}$ form an "R-C" filter, signal current preferring the easy route through $C_{15}$ rather than the harder route through $R_{18}$.

The voltage across $L_{11}$ is applied to $R_3$ through $C_{41}$, $C_{16}$ and $C_{15}$. The i.f. current in $R_3$ establishes a potential difference across its terminals, and this voltage is applied to the grid directly and to cathode through chassis.

The i.f. screen current is by-passed to ground through $C_{36}$ and $C_{17}$. The i.f. signal current flows through $C_{42}$ and the parallel resonant circuit, $L_{13}$-$C_{43}$. The path of the current is then down through $C_{17}$ and $C_{36}$ to chassis and 14H7 cathode.

$R_{19}$, $C_{36}$, $C_{17}$ form an R-C filter, signal current preferring the low-impedance path through the condensers.

Across $L_{13}$ the resonant i.f. voltage is developed. This potential sends signal current through $C_{42}$, $C_{18}$, $R_5$, $C_{36}$, and $C_{17}$. Due to current in $R_5$, a voltage is developed across the resistor terminals and is applied to the 7C7 grid-cathode. The screen current at signal frequencies is shunted to ground through $C_{49}$. The signal current is shunted to ground through $C_{46}$ and $C_{20}$.

During one-half the cycle of input signal voltage, the first grid nearest the cathode is positive in the 7C7 and rectified current flows in $R_5$, $R_4$, $R_{21}$ and $R_{20}$. The audio current in $R_{21}$ develops an audio output voltage. This voltage feeds the a.f. amplifier input, through switch $S_4$ to $C_{23}$, and through $C_8$ to chassis and the grounded terminal of $R_9$. Audio and i.f. voltages across $R_{20}$ are kept at negligibly low value by $C_8$ and $C_{14}$.

The audio amplifier then swings into action at this point. Significant, however, is the absence of $C_{22}$ on a.m., this condenser not being in shunt with the audio input. Thus, the a.f. amplifier has a flat a.f. curve for a.m. instead of the sloping curve at high audio frequencies. The slope is needed on f.m. to compensate for pre-emphasis of "highs" at the f.m. transmitter (would cut highs too much on a.m.). The rest of the a.f. then functions as described previously in connection with f.m. Power system is identical for a.m. or f.m.

*Help the Red Cross*

*THIS YEAR GIVE DOUBLE*

## Radio to Be Chore Boy After the War

RADIO, after the war, will perform such chores as sewing, de-activating vegetables, hardening metals and gluing things together, says David Sarnoff, Radio Corporation of America President —but that's not half of it.

"The useful services of radio," Mr. Sarnoff said in an Associated Press article, "will be broadened far beyond the communication sphere into such realms as the RCA electron microscope, radio frequency heating, supersonics and no end of applications made possible by the development of new radio tubes, especially those designed to send and receive micro waves—tiny waves measured in centimeters."

### Some Are Military Secrets

Mr. Sarnoff said that many of radio's scientific achievements of 1942 remained military secrets, but would make Americans proud when revealed.

He asserted that the application of "radio frequency heating to speed industrial processes and at the same time increase their efficiency is rapidly coming to the fore."

"Radio waves," he said, "may now be used to heat, dry, glue, stitch, anneal, weld, rivet and even to de-activate enzymes. This new field is known as thermal radio. It can laminate an airplane propeller in minutes, compared to hours required by ordinary heat and pressure methods.

### Possibilities Unlimited

"Radio high frequency 'furnaces' are a post-war prospect. In them, railroad ties will be seasoned quickly, and 'cakes' of textiles dried uniformly.

"Even rubber may be radio-cemented to wood or plastic; cloth stitched and seamed by radio heat; metals hardened; plywood glued, and fresh vegetables de-activated without loss of flavor or color.

"The possibilities in this new thermal realm of radio are unlimited, as indicated by remarkable advances in RCA laboratories during the year."

—n r i—

# Novel Radio Items

—BY W. R. MOODY—

**Radiation-proof receivers** which cannot betray the location of a vessel to the enemy are now used in merchant marine service. The specially-designed sets, known as Marine Model Low-Radiation Receiver SLR-12-A, are made under specifications of the F.C.C. by E. H. Scott Company of Chicago. These will allow seamen to keep abreast of world news and enjoy radio entertainment in their leisure hours.

—n r i—

**Electric eyes compensate** for stretching of steel cable in the highest-lift elevators in the world, those running to the sixty-fifth floor in Radio City, New York. These cables stretch almost an eighth of an inch each time a person enters the the car at the ground level. The electric eye notices this drop and starts the motor just enough to inch up the car each time another passenger steps in.

—n r i—

**A jam-proof method** of transmitting radio signals has been granted a U. S. patent recently. A specially-shaped key plate at the transmitter varies the carrier frequency of the transmitter in an irregular but definite manner according to the pattern on the plate. A similar key plate at the receiving end tunes the receiver to follow the variations in transmitter frequency. The frequency changes so fast that it cannot be followed by continuous manual tuning. Of course, the receiver must be synchronized exactly with the transmitter. Furthermore, the variation in frequency must be so great that receivers with automatic frequency control will not follow the variations, if secrecy of transmission is to be maintained. If an enemy should discover the pattern being used, the key plate can be changed. The program cannot be jammed in this system because the enemy would have to vary the frequency of his transmitter in precisely the same manner as that of the transmitter.

—n r i—

**Precious electroplated tin** on steel sheets is melted and fused by a high-power 200-kc. r.f. oscillator. This new radio treatment places a bright mirror-like finish on a strip of dull tin plate, and at the same time seals any small holes left during the electroplating process. As a result, only one-third as much tin is required as when the steel plates were dipped in molten tin. The new radio heating process eliminates cumbersome furnaces, and can keep up with any speed at which the steel strip is being plated. It is expected that electroplating lines can be speeded up to 1000 feet per minute, whereas former gas furnaces limited the speed to 150 feet per minute.

—n r i—

**An electronic clock** with no motor, wheels, hands or other moving parts has been installed in the new RCA laboratory in Princeton, New Jersey. More than 170 electronic tubes and lamps indicate the time in seconds, minutes and hours. Blinking lights tick off the seconds on a line numbered from 1 to 60, while other lights above these indicate minutes and hours. So far, however, this clock is merely an interesting experiment; its cost would be prohibitive for ordinary use.

—n r i—

**Wartime operation** for all broadcasting stations began on December 1, when stations reduced transmitter radiated power 1 db to conserve the life of tubes and other equipment. A change in sound level of 1 db is just barely noticeable by the human ear under ideal conditions, but actual observation of stations operating under this reduced power indicates that the change in transmitter power cannot be detected by the listener. A number of technical operating requirements were relaxed at the same time by the FCC, as a war measure.

—n r i—

**Atoms are pretty small.** If we could place a special identifying mark on every single atom in a glass of water—then pour that glass of water into the ocean and allow it to become thoroughly mixed with all the other water in all the lakes, rivers, seas, and oceans of the entire world—we could take up a glass of water anywhere in the world and find in it at least 5000 of our original marked atoms. In other words, a glass of water contains about 20 million million million million atoms.

—n r i—

**An entirely new kind** of transformer steel wherein the crystals line up like ten pins in a row, instead of in helter-skelter fashion as in an ordinary kind of steel has been developed as the result of nine years of intensive study and experiment by Westinghouse Research Engineers. This new grade of oriented steel called Hipersil has one-third more current carrying capacity than the best grade of ordinary transformer steel and because of its high permeability transformer weight may be reduced 25 to 30%, saving thousands of tons of critical steel and copper in building transformers as part of the war effort. A transformer of a given size, therefore, does more work and this is another way of saving steel and copper for more shells and tanks and ships.

# MEET THE ELECTRON!

This article originally appeared in Printers' Ink, the weekly magazine of Advertising, Management and Sales, under the heading "Advertisers! Meet the Electron!" The editor of Printers' Ink said there was some surprise up at General Electric when Printers' Ink expressed interest in a summary of developments to date in electronics. Such an article, said G-E, would necessarily be of a technical, rather than a merchandising nature at this stage. "So what?" said Printers' Ink. "Merchandisers ought to start thinking about developments in the field ahead of time." Which explains why the top magazine for advertising men made this article the leader in a recent issue.

The editor of NATIONAL RADIO NEWS is very grateful to Printers' Ink for permission to reproduce this article, which gives a broad picture of the impending electronic era and its amazing possibilities.

General Electric electronic equipment which duplicates man's five senses of sight, hearing, taste, touch and smell.

IN war plants from coast to coast today electron tubes, descendants of the radio tubes in every American home, are helping to speed the construction of planes, tanks and guns at a rate which would have seemed impossible even a few short years ago.

In hospitals and scientific laboratories similar tubes are performing new miracles of healing, opening healthier, happier worlds to mankind.

With the dawn of peace, these same tubes that have been tested and proved in a score of secret military applications will produce countless better products to raise a new and higher standard of living for John Citizen, his wife and his children.

Engineers at the General Electric Company, who have been living and working with these amazing tubes for years, now envision industry and science as standing at the open door of a period of revolutionary progress. They call it "The Electronic Era."

Electronics is the science of the electron, that tiny electrical particle, one or more of which revolve around the nucleus of each atom. With advance of the new science, the electron has been separated from the atom and put to work. The engineer has now actually harnessed the electron in vacuum tubes ranging from tiny globes to towering cylinders. For the first time, man can isolate and control pure electricity itself.

The first experiment in the development of today's science of electronics came when, in 1883, Thomas Edison observed a bothersome phenomenon in some of his lamps when they were first lighted. It was a glow between the filament terminals, accompanied by a rapid distintegration of the filament. Investigating, he found the glow was due to current passing through space between the terminals, and that a better exhaust eliminated the glow. There Edison—and the rest of the world—paused for several years, unimpressed by the fact that a phenomenon of electronics had been recorded for the first time. The "glow" was actually due to an electronic gaseous discharge . . . electrons isolated in space!

It remained for Richardson, Fleming, Thomson, DeForest, Langmuir, Coolidge, Hull, and other scientists to build on the phenomenon a new science. That science grew slowly at first, but today it is expanding at breathtaking speed, as one startling application inspires another. Already electron tubes have given us radio, sound pictures, television, electric surgery, and many other new developments in science, industry, medicine, and agriculture.

With electronics we now can "see" through the blackness of night, and the blanket of fog, or peer deeper into secrets locked in the invisible world of deadly germs. We can "smell" mercury vapor, an odorless, poisonous gas. We can help safeguard food products, assure the perfection of military weapons, and greatly speed war production.

Electronically controlled resistance welding helps make fabricated parts flow on schedule at Dodge, Boeing, Ford, and hundreds of other war plants. At Edward G. Budd Company, pioneer builder of all-welded stainless steel trains, workers now fabricate mammoth aircraft parts with special electronically controlled resistance welders—doing, in days, work that formerly took the riveter weeks. And doing it better!

Industrialists, scientists, and engineers from many industries, are turning to the new science of electronics to solve problems. Power engineers needed a device to "ride the line," so that emergency batteries used in case power fails would always be fully charged. Electronic engineers provided the electronic phanotron tube in a completely automatic, self-regulating battery charger.

Magazine and newspaper publishers needed an automatic self-regulating device to keep color printing plates in perfect register. The industrial electronic laboratories provided a device that does the job. Physicians sought ways to make incisions without excessive bleeding and the laboratory scientists obliged with tools for electric surgery.

Engineers in the rubber factories needed precise, continuous, automatic stepless control over a wide speed range which was made possible with electronically controlled d.c. motors—operating from a.c. power supply.

Once manufacturers of plywood had to keep sheets of finished material under pressure for days while glue dried. Today, West Coast assembly line builders of military plywood gliders and cargo planes wrap thin layers of wood around the mold. Heat induced by electronic oscillators dries the plastic cement in a few minutes!

On guard against the saboteur, fences of light rays and "electric eyes" are protecting important war factories. If the light beam is interrupted, signals sound and special police rush to the spot.

The science of electronics, prodigy of industry, has also found uses in the prevention, treatment, and control of diseases. For several days in the summer of 1927, two engineers in the G-E research laboratories at Schenectady complained of headaches and fever, while at work on a new high-frequency radio transmitter. Dr. Willis R. Whitney, then director of the G-E research laboratories, had the company physician make an examination. It was found that both engineers, immediately after working on the powerful transmitter, had temperatures of 102 degrees. Their pulse rates had jumped 50 to 75 per cent, and blood pressure had dropped 40 per cent. Yet within half an hour all fever symptoms disappeared!

"Why not harness this physiological reaction?" thought Whitney to himself. If high-frequency radio waves could create fever without harmful effects, wouldn't such artificial fever provide a controllable substitute for the sometimes dangerous malarial fever which has been used abroad to treat paresis? From this point research began: first with rabbits, then with human beings.

Treatment with G-E electronic Inductotherm Fever Cabinet. Patient is constantly attended.

Today, through electronically produced fever, hundreds of paretics who formerly would have died have been saved, and others who would have been crippled or insane have been restored to useful jobs. More than 2,220 American hospitals now own one or more machines, and physicians last year used them on more than 300,000 persons.

The industrial physician needs to know the chest condition of every worker exposed to dust hazards. In such jobs, the man with normal lungs may tolerate conditions dangerous to one whose lungs have been impaired. The doctor makes a diagnosis with the X-ray—one of the early electronic instruments. After X-ray examination, workers can be placed in jobs more suitable to their health; those suspected of having diseases or of being especially susceptible to infection can be spared disability and death.

Pennsylvania schools use electronic germicidal lamps to check the spread of contagious diseases. A special type of lamp is installed above eye level and directed upward. As the air in the room passes over the short wave light, virus and bacterium are killed. The schoolroom no longer need be a focal point for the spreading of childhood's ailments.

With another electronic instrument, the electron microscope, doctors and research scientists can view deadly types of virus magnified more than 30,000 times. (See cover photograph which shows Dr. S. Ramo, W. C. White, and Dr. C. H. Bachman with G-E electron microscope.) While no one knows what great secrets this new device will reveal in studies now in progress, it is probable that from its use will come the discovery and means of control of some of the most elusive enemies of health.

A portable electron microscope model, greatly simplified, recently was announced by Drs. C. H. Bachman and Simon Ramo of General Electric's electronics laboratory. Available now only to essential war laboratories, the new portable unit will find large-scale application in small laboratories throughout the nation in the post-war era.

A few years ago, Professor R. D. Evans of Massachusetts Institute of Technology found an electronic method to detect the presence of traces of radium in the human body. As a result, it is unlikely that we will again see in the headlines tales of radium workers suffering slow death years after painting dials on watches and instruments. Accompanying Professor Evans' discovery also came ways to prolong the lives of previous victims.

Industrial uses for the magic of electronics are seemingly without end. Makers of motion picture film and builders of delicate military instruments use high-voltage power to charge the dust particles in air in the ducts through which the air passes into a room. The electrically charged dust is attracted to a collector plate, and is removed.

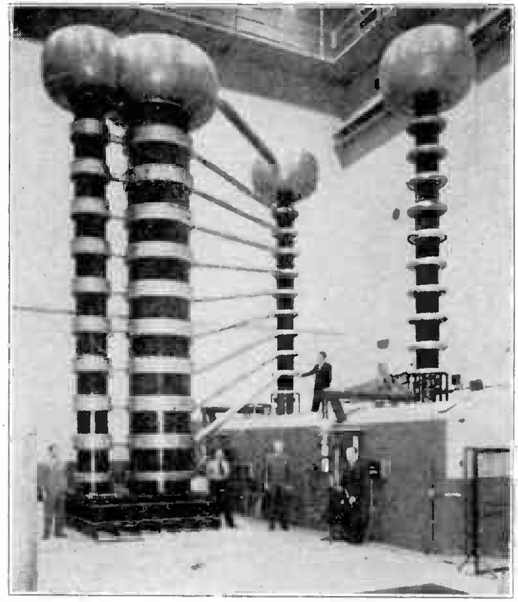
The National Noise Abatement Council uses electronic sound level meters to study particular noises that fray the nerves of industrial workers and thus reduce production.

Mercury is used in certain industrial plants. If poisonous vapor should escape, it then becomes a threat to health because it cannot be detected by human sight or smell. Workers are guarded by an ingenious electronic application—a tube that "smells" the vapor and sounds an alarm.

Electronic devices are sturdy, yet they do delicate, precise work.

In the recording spectrophotometer, utilizing an electronic tube to measure color wavelengths, more than 2,000,000 colors can be measured accurately. It is used by paint manufacturers, and by textile mills making material for military uniforms where accurate color matching is important.

In textile mills an electronic device automatically controls the tentering machines so that they can precisely square lengthwise and crosswise threads.



G-E 1,400,000-volt X-Ray machine, most powerful in the world. View from floor. In high-voltage laboratory of National Bureau of Standards, in Washington, D. C.

In schools, factories, offices, and on city streets in many parts of the country, electronic "eyes" accurately detect changes in natural daylight—then automatically turn on artificial light whenever clouds or darkness threaten safety or eye health. The same "eye" turns the lights off again when natural daylight is restored. Available now only to essential users, it may make its appearance in new homes, schools and offices after the war.

Luther Burbank himself would have been impressed by the methods used when scientists interested in genetic effects, bombarded seeds and young plants with X-rays, and were rewarded with new strains of flowers! After the war, research into the action of these rays on plants and food produce may yield many more useful varieties in horticulture and in agriculture.

Today the X-ray, vital aid to the physician, is another electronic device that research has turned to indispensable work in industry! In sprawling aircraft, tank, and other industrial plants, arsenals, steel mills, and shipyards the versatile X-ray now reveals the hidden bubble, crack or structural flaw before it spells death on the battle field or failures of precious machines.

Armed with an X-ray machine mounted on a service truck, a Detroit power company tracks down rotting electric poles. This ingenious examination, made without removing poles from the ground, is a big time saver and assures maximum service from each pole. Similarly, many automobile service stations are now equipped with X-ray machines that inspect a tire on the wheel for hidden fabric breaks . . . imbedded metal, or glass that would mean tire damage and impaired safety.

Textile mills direct a stream of X-rays on samples of cotton, wool, silk, and other fibres. The sample diffracts the rays and makes a pattern on photographic film for precise classification and analysis by the physicist.

This magic power of electronics is also applied to metal, paint, cement, and dozens of other materials to determine structural adaptability and service.

The new 1,000,000 volt X-ray can see through eight-inch plates of steel and inspects in sixteen minutes pieces of metal that previously required sixty hours.

In food industries, electronics untapped a few years ago, is playing an increasingly important role. Alert manufacturers pass bulk candy under a fluoroscopic screen to detect imperfections. Formerly the presence of balls of dirt and pebbles in finished peanut bars was a serious problem. Scientists recommended X-rays of raw peanuts to eliminate offenders. It worked.

In one record year, California fruit growers using the X-ray saved over $7,000,000 examining and sorting a bumper crop of oranges after a heavy frost. Salvaged were more than a million crates of perfectly good oranges that would have been marked for discard by former methods.

Today an electronic "eye" inspects the thin sheets of steel from which tin containers are made. Tiny pin holes, which if allowed to pass would spoil the can, are detected, automatically spotted and eliminated.

With the electro-cardiograph the physician can chart the faint voltages of heart action and use the record for observation and guidance.

A small group of American soldiers lost in a tropical jungle can be located and brought back to camp with the "walkie-talkie," a small two-way radio carried in a soldier's pack, and it can be used to direct operations on the field of battle. After the war, it may have wide usage as a mobile telephone communication on isolated ranches—forests—in automobiles, if radio frequencies can be made available for such wide use.

To scientists it seems natural to speak of electronics as a science of the future, for they are confident that what is to come will be more miraculous than what has already been accomplished. But the promise of exciting new vistas is based on the solid accomplishments of today. The electronic era is here!

*n r i*

It's the radio man. He says if Madame will phone him in sixty days he will try to arrange an appointment for her.

*n r i*

## We Have Dropped A Stitch

You probably have noticed that NATIONAL RADIO NEWS is now being stitched with one wire staple instead of the usual two. There is a good reason for this.

In order to conserve wire the War Production Board has requested all publishers to use one stitch instead of two, wherever possible. We are sure you are more than willing to approve this slight change in the interest of economy. If you will be careful not to subject NATIONAL RADIO NEWS to rough handling when turning the pages, one stitch should be sufficient to hold the pages together.

This explanation is made so you will understand the reason for the change. It is to save wire—to help Uncle Sam extend the available supply so that there will be some for all publishers.

# Sample Questions and Answers for Radio Operator License Examinations

By WM. FRANKLIN COOK

N. R. I. Technical Consultant

THIS is another installment of the questions taken from the "Study Guide and Reference Material for Commercial Radio Operator Examinations," together with typical answers. The questions give a general idea of the scope of the commercial radio operator examinations.

The basic theory for these questions has been covered elsewhere in your Course, but is being repeated here as answers to these questions. Remember, the following answers are far more detailed than would be required for an operator's license examination. The questions are theoretical, so the answers go more thoroughly into the basic theory, in order to permit similar questions to be answered.

Some of the material is advanced technical data, of course, which can be properly understood only by the advanced student or graduate. However, you will find this information valuable, whether or not you intend to take the operator's license examination.

## ELEMENT II

### Basic Theory and Practice

NOTE: A number of the following questions ask that you draw diagrams. However, in an actual examination, you probably will *not* be required to make such drawings. Instead, you will find that an actual examination will usually ask that you complete a drawing, or that you correct one. In other words, the greater portion of the drawing will be shown on your examination paper, and you will add to this drawing.

For example, in a question referring to neutralizing circuits, the entire circuit may be shown except for the neutralizing condensers and the necessary coil section needed for that purpose, if any. In other instances, a circuit may be shown which does not have one or two needed parts such as bypass condensers, a grid leak resistance, or some similar part. Therefore, don't worry greatly about having to draw diagrams, but do study them carefully.

**(2-100) Draw a diagram of a method of coupling a single radio frequency amplifier using a triode vacuum tube to a push-pull radio frequency amplifier using triode vacuum tubes, showing proper neutralization of the push-pull amplifier.**

*Ans.* See Fig. *2-100*. A complete circuit is shown here, in order to bring out several important points.

Triode-type tubes are required in the three stages. Although only neutralization of the push-pull stages is mentioned, the preceding tube must also be neutralized since it is a triode, unless it happens to be an oscillator or frequency multiplier.

Assuming that the single-tube is not the oscillator, as in Fig. *2-100*, signal voltage comes through coil *L1* and is fed into tuned circuit *L2-C1*. After being amplified by the tube, the signal is passed into tuned circuit *L3-C16*. By mutual inductance, the signal is introduced into tuned circuit *L4-C8-C9*. Usually the coupling between *L3* and *L4* would be made variable in a practical trans-

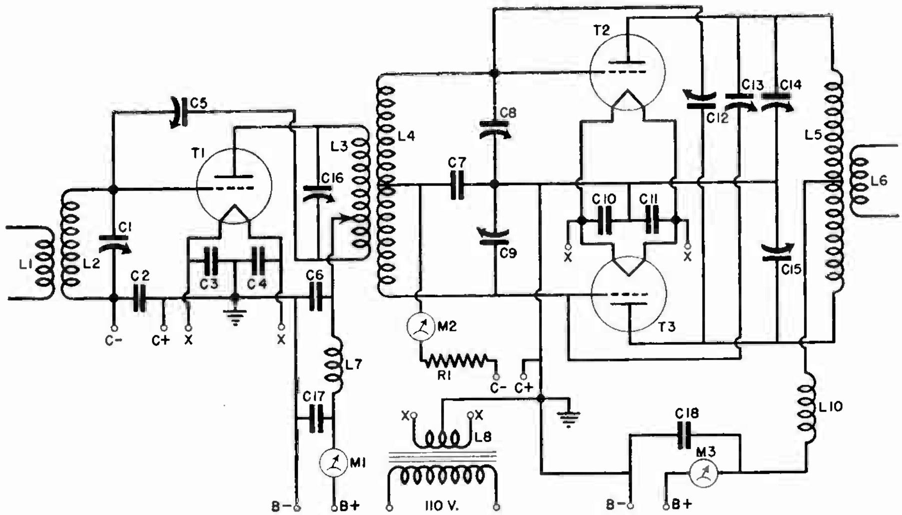



Fig. 2-100

mitting circuit, so that the proper excitation (r.f. voltage) can be fed to the push-pull tubes.

After amplification by the push-pull tubes, the signal is fed into output tank circuit *L5-C14-C15*. The signal is then passed on by mutual inductance to coil *L6*.

Filament-type triode tubes are shown in the drawing, because very few transmitting tubes have cathodes. The filaments are by-passed to ground for r.f. voltages through condensers *C3*, *C4*, *C10* and *C11*. It is necessary that the circuits be balanced to ground in this manner.

The first tube obtains its C bias from a separate source which is by-passed by condenser *C2*. The bias is adjusted to give proper operation. If modulation is not introduced in or ahead of this stage, it will usually be operated as a Class C amplifier. Bias is adjusted to twice the plate current cut off value for this condition.

Note that the plate supply is fed through choke coil *L7* and is by-passed by condenser *C6*. This combination is very necessary in transmitting circuits to prevent any possibility of stray radio frequency voltages getting into the power supply.

In the push-pull stage, bias is fed from a fixed C bias source into the center tap of coil *L4*. Resistor *R1* is used to provide additional bias, obtained by grid current flow through the resistor. Condenser *C7* serves as the grid condenser and also by-passes radio frequency voltages around the C supply. Again, class C operation is usual for unmodulated r.f. amplification.

Condensers *C8* and *C9* are double tuning condensers. These may be two separate condensers, but more commonly they are split stator condensers (two stator sections and a common rotor section). These condensers are adjusted together to give resonance with coil *L4*. This kind of condenser is used to give a more accurate balance to ground for the input circuit and thus divide the input voltage equally between the two push-pull tubes. It is, of course, possible to use a single tuning condenser and depend on the center tap of the coil for this purpose, but the split tuning condenser method is usually preferred in practice.

In a similar manner, condensers *C14* and *C15* are used to resonate with coil *L5*. Note that the plate voltage comes from the B voltage source through choke coil *L10*. The end of *L10* which connects to *L5* is not by-passed in this circuit. This allows a certain amount of radio frequency voltage to develop across *L10*. Since this voltage is in series with the plate supply to the two output tubes, it serves to balance coil *L5* with respect to its center tap, so that the center tap is more nearly at the exact electrical center of the coil.

It is assumed that the tube filament voltages will be similar, so that they can all connect to a single source of filament voltage (transformer winding *L8*). If they are different, separate windings would have to be shown here. The B— return is made here to the center tap of *L8*.

The first tube is neutralized through the use of condenser *C5* and the lower section coil *L3*. In other words, a part of the voltage developed in coil *L3* (that between the lower end and the tap) is fed back through neutralizing condenser *C5* to the grid circuit. Since this voltage comes from the lower end of *L3*, it will be out of phase with the plate end of this coil. Energy fed back through condenser *C5* will then neutralize or cancel the energy which is returned through the grid-plate capacity within the tube.

In the push-pull stage, cross-neutralization is employed. Neutralizing condenser *C12* is connected between one tube grid and the opposite tube plate, while *C13* is connected between the other grid and the remaining tube plate. The necessary shift in phase of the voltage is obtained in the output circuit for feed-back to cancel the effects of grid-plate capacity in these tubes.

Three meters are shown in the circuit: *M1*, *M2* and *M3*. *M1* will indicate the plate current of tube *T1*. It is by-passed to ground by condenser *C17*, which is necessary to prevent r.f. voltages from getting into the meter. In some diagrams, you will find this by-pass condenser connected right across the meter terminals.

Meter *M2* will give a measure of the grid current in the push-pull output stage, and is by-passed by condenser *C7*. Meter *M3* indicates the combined plate current of the output tubes, and is by-passed by condenser *C18*. These meters are necessary for making proper adjustments in transmitting circuits of this kind.

As mentioned in the beginning, the description of this circuit is made somewhat longer than would probably be necessary. The meters and other similar items might be eliminated in making a drawing for a question of this kind, although it is usually better to include these items.

**(2-101) Draw a simple schematic circuit diagram of a radio frequency amplifier employing a triode vacuum tube and making use of plate neutralization.**

*Ans.* Refer to the left-hand section of Fig. *2-100*. The circuit between coil *L1* and coil *L4* will answer the requirements of this question exactly. You have here a radio frequency amplifier using a triode tube, and it uses plate neutralization. It gets its name from the fact that the feed-back voltage for neutralization is obtained from the plate coil.

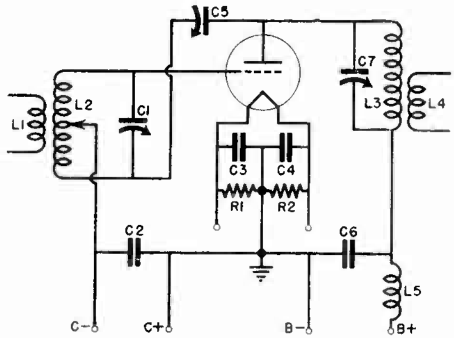



Fig. 2-102

**(2-102) Draw a simple schematic circuit diagram of a radio frequency amplifier employing a triode vacuum tube and making use of grid neutralization.**

*Ans.* Refer to Fig. *2-102*. Here you will note that the circuit is essentially very similar to the left portion of Fig. 2-100, except for the neutralizing connections. In this instance the grid coil is tapped. Energy comes back from the plate circuit through neutralizing condenser *C5* and is applied to the grid coil between the lower end and the tap. This voltage is out of phase with the voltage coming back through the grid-plate capacity due to the coil connections, so feed-back will be cancelled. In other words, the voltage coming back through the grid-plate capacity builds up a voltage of one phase across the upper section of *L2*, while the neutralizing voltage supplies a voltage of opposite phase at the lower end.

Resistors *R1* and *R2* are the means of connecting B— to the filament so d.c. plate current will flow. A transformer center-tap can also be used.

There may be a question as to the relative merits of grid and plate neutralization. Although these two methods appear just to be opposite to each other, there are certain fundamental differences.

In the grid method of neutralization, improper adjustment of the neutralizing condenser not only will fail to neutralize the circuit, but may even cause regeneration. Further, a certain amount of the driving power fed to the grid circuit is lost, as only a portion of the input energy is used to drive the

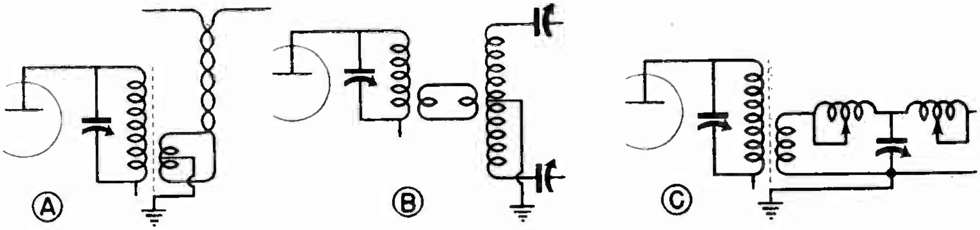



Fig. 2-103

neutralized tube. This is due to the use of a tap, so that there is a voltage division in the grid circuit.

In the plate neutralizing method, the same sort of voltage division occurs in the plate circuit, but here it is possible to stand greater losses as there is a greater amount of power here. Further, improper adjustment of the neutralizing condenser in a plate neutralizing method may result in a lack of neutralization, but regeneration is not ordinarily introduced.

For physical reasons, plate neutralization is commonly employed. In transmitter work, every effort is made to keep wiring down to a minimum. It happens that in practically all medium power tubes, the plate comes out the top of the tube. The plate tank circuit is then suspended between this top cap and some chassis point. The grid element, coming out the bottom or side of the tube, is then very close to the lower end of the plate tank circuit, and therefore a neutralizing condenser can be run directly between these two points.

Both neutralizing methods have the disadvantage of making the tuning condenser rotor plates hot with respect to ground, so that body capacity may affect tuning. This can be eliminated by using an additional winding for neutralizing purposes, or may be relatively unimportant where the tuning condensers are tuned through long nonmetallic rods.

**(2-103) Draw a simple schematic diagram showing the method of coupling the radio frequency output of the final power amplifier stage of a transmitter to an antenna.**

*Ans.* There are, of course, many ways of connecting an antenna to the final stage. Either inductive or capacitive coupling can be used.

This question does not say anything about harmonic suppression. It is quite possible that a question given in an examination would want you to give some method of harmonic suppression.

Fig. *2-103* shows several methods of connecting to the antenna. At *A*, ordinary inductive coupling is employed. The dotted line between the two coils indicates that there is a Faraday shield between the coils. This shield eliminates all capacity coupling, making the coupling entirely inductive, which helps to lower the amount of harmonics transferred. Also, the use of a tap on the output coil, so as to get a balance to ground, is helpful.

In *B*, link coupling is used. In this kind of connection, the antenna coupler is tuned, which helps to eliminate harmonics. Although a form of series tuning is shown here, a parallel resonant circuit may be employed to tune the antenna coupler. This circuit is used commonly with high-impedance or tuned transmission lines.

In *C*, the Faraday shield is again used. This time the circuit is again tuned by having variable inductances and a tuning condenser. It is possible to tune these items so that harmonics are suppressed and the fundamental frequency passed on.

The position of the coupling to the antenna is of importance. With a single-tube stage, the link or inductive coupling should be nearest the grounded end of the primary in each case. If the output stage is a push-pull stage, the link will be nearest the center of the primary winding, as this point is by-passed to ground instead of the end. Placing the coil near the point of ground potential reduces the potential difference between the coils, thus lowering the amount of current flow through the capacity between the coils.

**(2-104) Draw a simple schematic dia-**

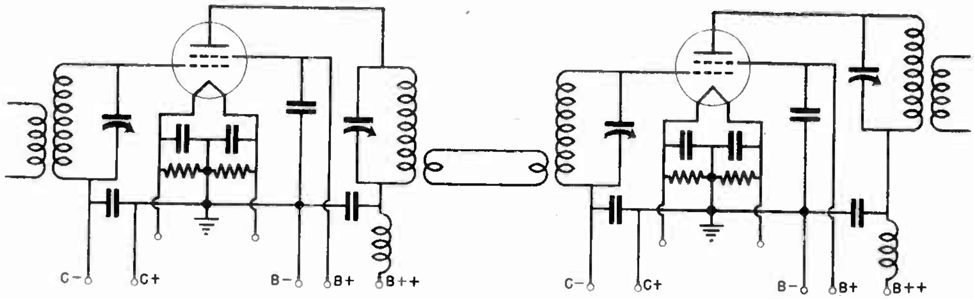



Fig. 2-104

**gram showing a method of coupling between two tetrode vacuum tubes in a tuned radio frequency amplifier.**

*Ans.* Refer to Fig. *2-104*. Note that tetrode (screen grid) tubes are requested this time.

The circuit consists of two ordinary screen grid circuits coupled together. Link coupling is shown between the plate tuned circuit of one and the grid tuned circuit of another, although the method of Fig. *2-100* could have been used.

Note that the screen grid circuit must be by-passed adequately. Furthermore, if these tubes are tetrode tubes designed for radio frequency work, no neutralization will be necessary. This is an important point, however. If the tubes are audio frequency tubes being used in r.f. stages, neutralization may still be necessary.

Again it is assumed that the first tube is a driver stage rather than an oscillator.

**(2-105) Draw a simple schematic diagram showing a method of coupling between two triode vacuum tubes in a tuned radio frequency amplifier, and a method of neutralizing to prevent oscillation.**

*Ans.* This question is essentially similar to several of the preceding questions. You can take the left-hand single stage from Fig. *2-100* and just repeat it, or you can use Fig. *2-102*, showing two stages instead of one. Be sure the method of neutralization indicated in one or the other of these figures is also copied, however.

**(2-106) Draw a simple schematic circuit diagram of a diode vacuum tube connected for diode detection, showing a method of coupling to an audio amplifier.**

*Ans.* Refer to Fig. *2-106*. A standard diode receiving detector is shown in this circuit. The signal comes from coil *L1* and is fed into tuned circuit *L2-C1*. It is then applied to the diode. As a result of rectification, there will exist across resistor *R2* a d.c. voltage plus a varying voltage, which in turn varies with the audio modulation on the signal.

Condensers *C2* and *C3*, together with *R1*, act as an r.f. filter. Condenser *C4* is a blocking condenser used to feed only the audio signal to the a.f. amplifier from diode load resistor *R2*.

**(2-107) Draw a simple schematic diagram of a triode vacuum tube connected for plate or "power" detection.**

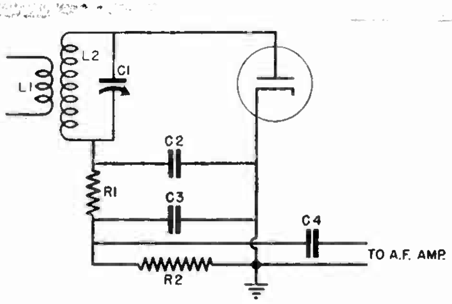



Fig. 2-106

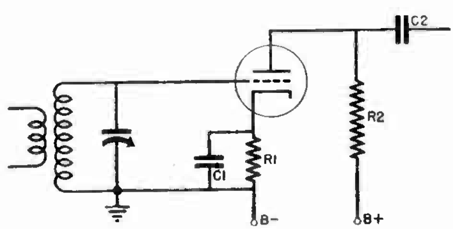



Fig. 2-107

*Ans.* See Fig. *2-107*. In this circuit, resistor *R1* furnishes a bias which practically cuts the plate current off. In other words, it has a rather high value of resistance. The tube acts as an r.f. amplifier, rectification occurring in the plate circuit itself, hence the name "plate" detector. Since the plate current is practically cut off by the bias, only changes in the signal voltage in one direction will appear across plate load resistor *R2*.

If any question is asked about power detection, just remember that the power detector is just like any other, except that it is adjusted to handle higher input voltages and deliver larger voltages. Hence, this is a plate power detector if the plate voltage is high enough and if resistors *R1* and *R2* are large enough.

**(2-108) Draw a simple schematic diagram of a triode vacuum tube connected for grid leak-condenser detection.**

*Ans.* Refer to Fig. *2-108*. In this circuit, resistor *R1* and condenser *C1* are the grid leak and grid condenser respectively.

Rectification occurs in the grid circuit in this case, due to grid current flow. In other words, on the positive peaks of the signal, a grid current flow exists through resistor

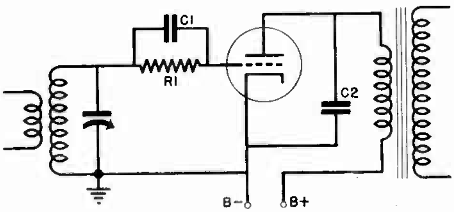



Fig. 2-108

*R1*. Condenser *C1* is chosen to have the proper time constant, so that a form of automatic bias is developed which will follow the modulation envelope.

Another way of looking at this circuit is to consider the grid and cathode as a diode rectifier. Then the audio voltage developed across resistor *R1* is applied to the grid of the tube, which acts as an amplifier. Note that the tube amplifies the audio frequency in this case.

As some radio frequency voltage is bound to get into the plate circuit, condenser *C2* is normally used with this circuit to by-pass the r.f. voltage, keeping it out of the audio transformer.

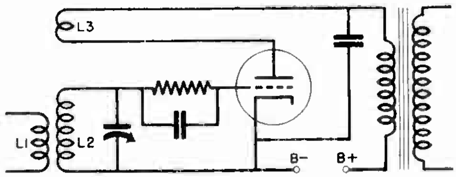



Fig. 2-109

**(2-109) Draw a simple schematic circuit of a regenerative detector.**

*Ans.* Refer to Fig. *2-109*. In this circuit, coil *L3* is added in the plate circuit. The radio frequency energy which gets into the plate circuit is fed back by this coil into *L2*. By properly arranging the phase of the windings, it is possible to make this energy reinforce the incoming signal.

Some means of controlling regeneration is necessary. Usually the coupling between *L2* and *L3* can be varied by moving *L3*. An ordinary grid leak-condenser detector circuit is shown in this example, with the addition of the regeneration feature.

**(2-110) Draw a simple schematic circuit of a radio frequency doubler stage, indicating any pertinent points which will distinguish the circuit as that of a frequency doubler.**

*Ans.* Refer to Fig. *2-110*. On paper, this looks like any other r.f. amplifying circuit. Therefore, you will have to indicate certain important points by writing a short description or by indicating certain items on the diagram.

First, just what is a doubler supposed to do? Essentially, this circuit is intended to double the frequency applied to the grid circuit. It is used in transmitters, where the crystal oscillator frequency is lower than the desired operating frequency.

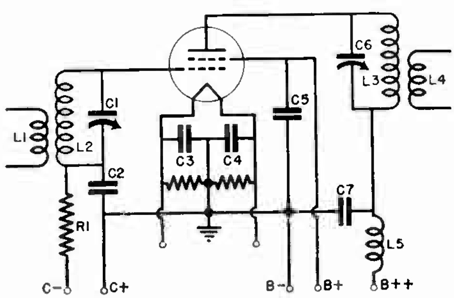



Fig. 2-110

As you know, any tube circuit will generate a certain amount of harmonics. By deliberately encouraging this stage to generate strong harmonics, it is possible to gain a second harmonic output with reasonable efficiency. To do this, the circuit is operated as a class C amplifier. Normal class C operation requires the grid bias to be about twice the cut-off bias. For better efficiency in a doubler, this bias is usually moved to four or five times the cut-off bias, then the excitation in the grid circuit is increased accordingly. For operation, therefore, this circuit requires a high grid bias and a high value of excitation. As a result of the bias and excitation requirements, you will usually find that a pentode, tetrode or very high gain triode tube will be used in a doubler, so that the bias and excitation can be held to reasonable levels.

As the excitation exceeds the cut-off bias, the plate current starts at zero and rises in a square-shaped pulse. This wave shape is rich in harmonics. By tuning the plate tank circuit *L3-C6* to the second harmonic, it will be passed on through coil *L4* to the next stage.

Neutralization is not usually necessary in a doubler, even when a triode tube is used, because the plate tank circuit is tuned to a different frequency than the grid tank circuit. However, it has been found that using a neutralizing circuit does tend to help, as this permits a certain amount of regeneration to be introduced without oscillation occurring.

From the foregoing, the identifying characteristics which you should mark on your diagram or should list would be:

1. The plate tank circuit is tuned to the second harmonic, while the grid circuit is tuned to the fundamental frequency of the oscillator or the preceding stage.

2. The bias voltage is much higher than normal for ordinary class C amplifiers. A high value of excitation voltage is therefore necessary.

3. The tube used will usually be a high-gain tube (one requiring a lower relative amount of bias and excitation voltage for the same purpose). The use of a high-gain tube is also necessary in order that a reasonable amount of second harmonic power can be obtained from the plate circuit. In other words, there is usually a loss of power or, at best, very little gain in a circuit of this kind. This is due entirely to the change in frequency from the fundamental to the second harmonic.

In case this question should be asked—a push-pull stage cannot be used as a frequency doubler. Push-pull stages cancel out even harmonics, so the second harmonic will be cancelled. However, push-pull stages can be used for odd harmonic multiplications, such as a frequency tripler, where the output frequency is three times the fundamental.

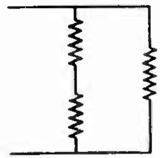


Fig. 2-111

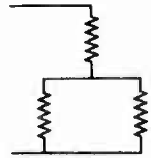


Fig. 2-112

**(2-111) Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be two-thirds the resistance of one unit.**

*Ans.* See Fig. *2-111*. Note that the resistors are equal and the total resistance is to be less than one of them. This immediately suggests that we must have a parallel circuit. However, three resistors in parallel of equal value will give a resistance one-third that of one, instead of two-thirds. Therefore, the only other possible parallel combination which will give a resistance less than one is to have one resistor in parallel with two.

For example, assume the resistors are 100 ohms each. Then two in series will equal 200 ohms, which in turn is in parallel with 100 ohms. Now using the parallel resistance formula, $R = \frac{R_1 \times R_2}{R_1 + R_2}$, we will find that our total resistance is about 66 ohms, which is two-thirds the value of one resistor. Incidentally, this method of assuming a value and then the use of the proper formula is one method of finding our when you have the proper connections.

**(2-112) Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one and one-half times the resistance of one unit.**

*Ans.* Refer to Fig. *2-112*. This time we must have a greater resistance than that of one unit, which means that we must have some kind of series circuit. Two equal resistors in parallel give one-half the resistance of a single resistor. Therefore, by placing two in parallel, in series with one resistor, we will have a total equal to one and one-half times the value of a single resistor.

N.R.I. ALUMNI NEWS



# OFFICERS OF THE N. R. I. ALUMNI ASSOCIATION

EARL A. MERRYMAN
Secretary

F. EARL OLIVER
President

LOUIS L. MENNE
Executive Sec'y.

EARL R. BENNETT
Vice President

LOUIS J. KUNERT
Vice President

PETER J. DUNN
Vice President

CHAS. J. FEHN
Vice President

# Here and There Among Alumni Members

Sgt. Thomas Jasiorkowski of Milwaukee, Wisconsin, and now somewhere in the Pacific has been decorated with the Purple Heart. Congratulations, Sergeant, from your N. R. I. friends.

——n r i——

*Secretary Earl Merryman is sailing the high seas as Chief Radio Man in the Navy. Earl has the best wishes of every Alumni member. By his valor in the doing of dangerous duty he typifies the patriotic spirit of our organization. Good luck and good going, Earl. Headquarters members will pinch hit for you while you are in the service.*

——n r i——

Harold D. Durham, who is Chief Engineer at Radio Station KOCY, Oklahoma City, Oklahoma has taken on the additional duties of Musical Director and Production Manager. Wonder what he does in his spare time.

——n r i——

*We regret to learn of the serious illness of the wife of former chairman Norman Kraft of Phila-Camden chapter. We hope Mrs. Kraft is now well on the road to recovery.*

——n r i——

Y. E. Yule of Faribault, Minn. is doing a fine spare time Radio business. Works as a service station attendant during the day.

——n r i——

*We are extremely sorry to learn that St. Sgt. Pilot Garry Frederick Hinton of Bartlesville, Oklahoma, lost his life in an airplane accident while in the service of our country. We extend sympathies to the members of his family.*

——n r i——

Harry C. Knapp has a nice position in a defense plant in Michigan. He is a Laboratory Technician.

——n r i——

*Sherman Greenlee of Water Valley, Miss. who has been confined to a wheel chair for 20 years owing to a rheumatic affliction writes that he is doing very well in his Radio servicing business and making a good living for his wife and two baby girls, thanks to N. R. I. Good boy, Greenlee, you deserve all the credit. Your alumni brothers rejoice in your success.*

——n r i——

Melvin E. Ruther is an instrument repair man in a Navy Yard Radio Laboratory in California. His work includes repairing of all kinds of meters. His supervisors regard him highly.

——n r i——

*Manuel Correia is doing radio work in the laboratory at Cornell-Dubilier Corporation, New Bedford, Massachusetts.*

Benny Tercyak of Norwich, Conn. had some hard luck. He lost his right hand while working in a defense plant.

——n r i——

*Howard Ridgway is broadcast engineer for Radio Station WIP, Philadelphia, Penna.*

——n r i——

L. C. Morris is teaching Radio in the Army. He is stationed at a camp in Florida.

——n r i——

*Mr. and Mrs. Fred Martin of Province of Ontario, Canada inform us that graduate Reino Martin is on duty in England looking after a Radio Station. Cheerio, Reino, and good luck.*

——n r i——

Nice letter from Harold H. McLean, a charter member of Toronto chapter. Is with the Railway and Power Engineering Corp., Ltd. Strong as ever for the Alumni Association.

——n r i——

*Paul H. Chauncey is secretary of Walker-Jimieson Co., 311 S. Western Ave., Chicago, Ill. He is much in demand as a speaker to Radio serviceman groups.*

——n r i——

Andrew Sloto is operator in a Coast Guard Radio station. Says N. R. I. helped him greatly while he attended a Coast Guard school. He finished with a high average.

——n r i——

*Said a Baltimore member, "Pete Dunn has Snew." "Snew!" we asked, "What's snew?" "Nothing," came the reply, "What's new with you?" These jokers will have their fun.*

——n r i——

R. J. Berry of Washington, D. C. recently received a Radiotelephone, second class, license and immediately was offered and accepted an essential job with a Maryland concern.

——n r i——

*Wallace G. Baptist, who had a swell Radio Laboratory before going with the Signal Corps writes to say two of his former employees, Ray E. Brubaker and Jack Carpenter, both N. R. I. men, are now attending Government Radar schools. As Radar is considered one of the top courses in the Army and Navy this speaks well for N. R. I.*

——n r i——

V. A. Winningham of Yreka, California informs us he has made as much as $55.00 a week in his spare time radio business. With so many men in the service good radio men are getting all the work they can take care of.

——n r i——

*Earl Cutting of St. Johnsbury, Vermont is doing a swell job teaching radio to the Senior boys in his local high school. The course is given in conjunction with requirements of the U. S. Board of Education.*

## Philadelphia-Camden Chapter

The first business is to report the retinue of 1943 Officers. The following completes the list:

Chairman—Bert Champ
Vice-Chairman—Harvey Morris
Rec. Secretary—Sydney Langendorf
Fin. Secretary—John McCaffrey
Treasurer—Charles J. Fehn
Librarian—James Sunday
Sgt. at Arms—Herman Doberstein

On account of war difficulties, rationing, etc., it was decided to hold only one meeting a month, same to be on first Thursday, with short business session and bang-up service discussion or demonstration afterwards.

After installation of officers at our first meeting following elections, Harvey Morris went to work with his usual demonstration of quick isolation, locating and repairing of trouble in three small sets and one large set brought to the meeting by others. After the meeting, although a number of us doubted him, Harvey promised to lead us to an elite eating place where he gave us to understand it was still possible to obtain Steak Sandwiches of quality equalled nowhere else in town. Of course, we bit, and on ordering were politely informed none were to be had. However, we did enjoy a few sandwiches of another variety. Harvey's alibi was that the owner joined the Army and a new owner has taken over.

On the night the Auditing committee was assembled in Harvey's home, the committee was just about ready to check the books, when bingo—another blackout. Thus, everyone had a half hour rest, and refreshments not yet under way, the best we could do was just chat in the dark. With the blackout over, the committee went to work with zest and Mrs. Morris busied herself preparing an appetizing repast.

Harvey is compiling notes on all tough jobs to pass along to those at meetings and is asking that others reciprocate. At present he is checking on a considerable number of radio phonographs, and is ready to pass his experience and tricks he has learned to anyone attending Chapter meetings.

Chairman Bert Champ as well as Norman Hafler are working at Boeing Aircraft Plant in Horsham, Penna. Secretary Langendorf is at present taking up a special defense course. However, we expect him to be on the job again regularly starting April.

Please remember—one meeting a month, on the first Thursday at Freas Shop, northeast corner of Atlantic and Emerald Streets, near Tioga Elevated station in Philadelphia.

CHARLES J. FEHN
National Vice-President.

## Chicago Chapter

We have been meeting at Kaplan's Hall, 3900 West 26th Street, on the second Wednesday of each month.

Chairman Andresen presides. After the business session was concluded he led the radio discussion at one meeting. Former Chairman Clarence Schultz took charge of another. The ever-faithful Art Miller took a leading part in still another meeting. Past Chairman Cada also has been giving aid whenever called upon.

For the most part we have been confining our meetings to actual practical Radio servicing. Some members bring in Radio sets while other members bring in test instruments. We then go through the complete process of locating the trouble and correcting it.

Chairman Andresen has been supplying us with a liberal portion of literature which he requests from various sources, on matters pertaining to Radio. Mr. Andresen believes in making it worthwhile for our members to attend meetings and he always tries to have something to place in our hands.

Refreshments usually follow the close of our meetings. New members and visitors are invited. Get in touch with Chairman Harry Andresen at 3317 North Albany Avenue, Chicago, Illinois, phone Juniper 2857.

CLARK ADAMSON, Secretary.

*n r i*

## New York Chapter

Our meetings have been going along nicely. Of course there has been an expected drop-off in our attendance because so many of our members have gone into the service or are working long hours which make it inconvenient to attend meetings regularly. Everything considered, however, our attendance has been unusually good.

Ralph Baer, who has helped us so much with his splendid Radio discussions, may leave us soon. Ralph says that Uncle Sam has been beckoning him to come to see him. If Ralph does go our loss will be the Army's gain. He will make a peach of a Radio man in the service. New York Chapter is proud of the many men it has given to the armed forces.

At our last meeting Mr. Baer gave us a talk on power packs after which we conducted our usual service forum. We are fortunate to have many good and experienced men to help those with less experience. The open forum is just the place to ask questions.

Meetings are held at our headquarters, Damanzek's Manor, 12 St. Mark's Place (between Second and Third Avenues) New York City, every first and third Thursday of the month.

L. J. KUNERT, National Vice-President.

## Baltimore Chapter

Mr. J. B. Straughn of headquarters came to Baltimore to talk to us on Power Supplies. His discussion was very interesting. After he had covered his subject thoroughly he answered some questions which were popped to him by members to clear up some points.

Mr. L. L. Menne also paid us a visit and inducted our own Pete Dunn into the office of National Vice President. Mr. Dunn has been a party to this ceremony so often he knows the Oath of Office by heart. We are told that Pete is scheduled to leave for California to take up a government assignment. We will miss him because he has always been one of our most active members. We will be glad to have him come back to us as soon as his job is done.

After each business meeting Vice Chairman Rathbun leads us in doing practical Radio servicing on sets the members bring in. There is nothing quite as beneficial as the actual work on a balky Radio set. It is this interesting work that has held up our attendance so well in spite of the loss of our full share of members to the armed forces.

No little credit for our productive meetings goes to our Chairman, Mr. E. W. Gosnell, who keeps things moving on regular schedule at all times. We also very much appreciate the help and consideration shown to all of our members by such regulars as Mr. Arthur, Mr. Ulrich, Mr. Phillips, the already mentioned Mr. Rathbun and others.

Our members have been exchanging parts with one another. This is a great help right now especially where Radio tubes are concerned.

We have been meeting regularly every second and fourth Tuesday at Red Men's Hall, 745 West Baltimore Street. Now, more than ever, we need the cooperation of others to help solve problems. We shall be glad to have any N. R. I. men in this area drop in on us any time. Just walk in and make yourself at home. You will be welcome.

P. E. Marsh, Secretary.

*n r i*

## Detroit Chapter

Officers elected for the current year as follows:

Chairman—John Stanish
Vice-Chairman—Harold Chase
Secretary—F. Earl Oliver
Assistant Secretary—Harry Stephens
Librarian—Floyd Buehler
Assistant Librarian—Fred C. Clow

Mr. J. A. Quinn and Bernard Hiller were elected as members of our Finance Committee.

We still meet at the home of some one of our members. This plan is working out very satisfactorily but it is necessary for members to attend meetings regularly or to keep in touch with the secretary in order to keep posted on our schedule. Our next meeting will be held at the home of Robert Briggs who will explain his equipment.

Assistant Secretary Stephens has prepared a map of the city showing all chapter members in certain areas—a sort of zoning system. Each zone contains the names and addresses of members living within that area. All of our members are making a copy of the zones on this map. Then when a member receives a call for Radio service too far out of the way for him to handle, he turns it over to the member within that zone. This plan enables us to conserve our gasoline and rubber as well as cooperate more closely with one another.

Mr. Robert Mains, one of our members, presided over our last meeting. The program was educational covering meters, multipliers and shunts.

Now is the time when we need one another more than ever. Come to our meetings. Get in touch with Secretary F. Earl Oliver at 3999 Bedford, or the undersigned at 5910 Grayton.

Harry Stephens, Assistant Secretary.

*n r i*

## F. Earl Oliver To Be Honored

Chairman John Stanish of Detroit Chapter is arranging a blow-out in honor of Alumni President F. Earl Oliver. Lou Menne of headquarters will formally induct Mr. Oliver into the President's chair. John Stanish will act as Master-of-Ceremonies. The date is still indefinite. All Detroit chapter members will be notified. It will be quite an affair.

*n r i*

Quick pal, lend me ten bucks! Pay you first time I see you.


## Broadcast Engineer

This letter is to heartily congratulate you upon the excellence of your NATIONAL RADIO NEWS. Believe me, it is much prized for its wealth of information, useful to me in my work as broadcast engineer for station WIP, on 610 kilocycles, 24 hours a day.

HOWARD RIDGWAY
Philadelphia, Penna.

n r i

## Got Job Through Tip in News

I am working for Spokane Radio Co., Inc. and find the work very interesting. We are building communications sets for the Forestry Service at present.

I got in touch with the company after reading your article in the Oct.-Nov. issue of NATIONAL RADIO NEWS for which I wish to thank you.

ARTHUR F. OSBURN
Spokane, Wash.

n r i

## On Overseas Duty

I look forward to NATIONAL RADIO NEWS and have read every word in the last issue. I really enjoyed reading the article "How Recordings Are Made." However, I especially enjoyed the article on Captain George J. Rohrich, now in the Signal Corps of the U. S. Army. We are proud of him. I have been appointed Radio Chief. I shall never regret the day I enrolled. Our location is a military secret.

S/SGT. MANUEL C. LOPES, JR.
U. S. Army

n r i

## Takes Out the Kinks

I certainly liked "Developing the Ability to Diagnose Receiver Troubles" by J. B. Straughn. It takes out a lot of kinks a fellow will run into.

GILES H. LATIMER
Streamstown, Alta., Canada

## Written So You Can Understand It

I wish to thank you for the help you have given me. I am now employed by the Ohio State Highway Patrol as radio operator.

I think the NATIONAL RADIO NEWS "Questions and Answers for Radio Operators" are fine. They explain it so you can understand it.

RUSSELL A. THATCHER
Cambridge, Ohio

n r i

## Another Job Through News

I recently received a letter from Air-Track Mfg. Corp., College Park, Md. offering me a job in the Engineering Dept. Perhaps you did not receive my letter informing N. R. I. of my job with Bliley Electric Co., Mfg. in Erie, Penna. I enjoy this work very much. Since N. R. I. is responsible for my having obtained this job, I want to thank you sincerely.

WILBUR G. MCCORMICK
Erie, Penna.

n r i

## Go On! We Like It!

Those "Questions and Answers" by Mr. William Franklin Cook are swell, those pieces by Mr. C. B. DeSoto on "Recordings" are great. "Radio Items" are—ah, what's the use. I'd never get through.

WILFRED LAVERGNE
Edmonton, Alta., Canada

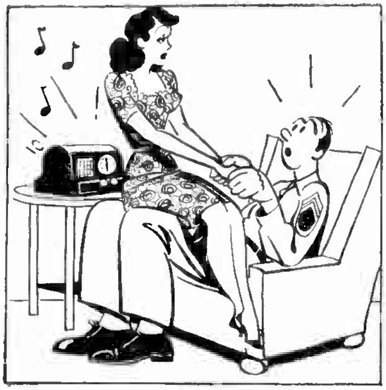
n r i

## From Puerto Rico

Congratulations for that splendid article "True Adventures of a Spare-Time Serviceman." It affords a means of checking our standards of service in this country.

Those circuit analyses by Mr. Dowie are fine too. There is no other radio paper like the NEWS. We are very proud of it.

EFRAIN CONDE
Humacao, Puerto Rico



I have always been fascinated by men in uniform. My husband is a policeman.

—n r i—

First draftee: I sure feel like punching that hard-boiled top sergeant in the nose again.
Second draftee: Again?
First draftee: Yes, I felt like it yesterday.
—*Pointer.*

—n r i—

Teacher: You don't know how much five and seven make? Suppose you had $5 in one pocket and $7 in the other. What would you have?
Freddy: I'd have on the wrong pants.
—*Lampoon.*

—n r i—

Diner (Rising unsteadily from a chair in a restaurant): Shay, waiter, find my hat.
Waiter: It's on your head, sir.
Diner: Well, don't bother, then, I'll look for it myself.

—n r i—

"Give me your tired, your poor,
Your huddled masses, yearning to breathe free,
The wretched refuse of your teeming shores,
Send these, the homeless, the tempest-tossed to me:
I lift my lamp beside the golden door."

—*Inscription on the base of the Statue of Liberty.*



# NATIONAL RADIO NEWS

**FROM N.R.I. TRAINING HEADQUARTERS**


Vol. 10 — No. 8

April-May, 1943

**Published every other month in the interest of the students and Alumni Association of the**

**NATIONAL RADIO INSTITUTE**
**Washington, D. C.**

**The Official Organ of the N. R. I. Alumni Association**
**Editorial and Business Office, 16th & You Sts., N. W., Washington, D. C.**

**L. L. MENNE, EDITOR**
**J. B. STRAUGHN, TECHNICAL EDITOR**




## Index