

101

RADIO — ELECTRONICS

S-40

Circuits

45 Watt
Amp.
Pg 37
807

1949

RADCRAFT PUBLICATIONS, INC.
New York, N. Y.

(ke) to meters (m) or meters
(Columns are interchangeable)

101

**RADIO —
ELECTRONICS**

Circuits

Compiled and Edited by

Fred Shunaman

and

Angie Pascale

**Radcraft Publications, Inc.
25 West Broadway • New York 7, N. Y.**

Copyright 1949
by
HUGO GERNSBACK

Litho'd in U. S. A.

PREFACE

THE first book in this series, *101 Radio Hookups*, was published in the middle '20's. At that time, 101 circuits covered the whole field, and covered it exhaustively. Practically every useful circuit of the day was printed in that book. But when the editors of this *101 Circuits* started work, they found that 1,001, not 101, circuits would have been necessary for the same complete coverage. So the work has been necessarily one of selection.

In making the selections, we have been guided by four main considerations. First, the book must show the evolution of the radio circuit—from the simplest crystal set to the modern multi-tube. Second, the non-radio electronic circuits—such as intruder alarms and phototube controls—should be represented in such numbers as their importance justifies. Third, as many as possible of the circuits should be reproducible by the practical constructor; they should be selected for their utility as well as for their interest to the student. Fourth, the experimenter should find circuits which may serve as a starting point for further research and development. Some of the old circuits which attracted a great deal of attention at various periods of radio's history should be included, even though they have later dropped out of sight. Many of them still offer promise to the diligent experimenter. Look for example at the superregenerator, which hibernated for many years till very-high and ultra-high frequencies brought it into the light again. New tubes and new components may make many other circuits far more effective than when they were first introduced. Who knows what the history of the Flewelling circuit might have been had good 1-5 megohm potentiometers been available when it was first popular?

No attempt could be made to be exhaustive. Limitation to 101 circuits prevented that. The student may look in vain for many circuits which were famous in their time. Some of the omitted ones depended on special factors or components which would make their inclusion impractical today. For example, the famous Cockaday, or four-circuit tuner, produced remarkable results, but only when connected to an extremely large antenna—up to 200 feet long. Another fundamental circuit, the Ultraudion, is omitted because it reappears in the v.h.f. circuits—as a superregenerator instead of a standard regenerator, it is true. On the other hand, the three-circuit tuner is included in spite of its dependence on an obsolete component. Such an important historical circuit could hardly have been omitted, so it is printed and instructions for constructing the now unobtainable variocoupler are given for the experimenter who might like to re-create the set.

No apology is made for the lesser attention given to modern standard broadcast receivers. Just enough of this type of circuit is included to complete the coverage of the various types of circuits. Current broadcast receiver circuits are available in profusion from a number of sources, and there is little difficulty in obtaining as many as may be needful.

The constructor has been especially considered in the introductory article. With its help, we trust that he will be able to make the fullest use of the book. We hope also that the student may find a reasonably representative collection of circuits from various phases of the radio-electronic art and that the experimenter will discover a large number of intriguing circuits to engage his activity and interest.

CONTENTS

Introduction—How to Use Electronic Diagrams.....	5
Crystal Circuits	7
One-Tube Circuits	8
Two-Tube Circuits	14
Three-Tube Circuits	17
Four-Tube Circuits	21
Four-to-Five Tube Circuits	23
Multiple-Tube Circuits	26
Special Circuits	32
Audio	37
V. H. F.	39
FM	40
Test Instruments	42
Audio Filter Nomogram.....	45
RADIO-CRAFT INDEX, (Volume XIX Oct. 1947—Sept. 1948)	46

INTRODUCTION

How to Use Electronic Diagrams

THE skilled constructor needs only a schematic diagram to create a radio circuit. Indeed, many an experimenter uses the schematic merely as a starting point, adding his own variations to meet his special needs, or possibly just to express his individuality.

The same schematic diagram often seems sadly wanting to the less skilled experimenter. He wonders why diagrams which omit so much important information are printed. Complete receivers may be shown with no power supply, and with no indication as to what the voltage and current ratings of a suitable supply might be. Wattage of resistors and voltage ratings of capacitors are also almost invariably omitted. Yet the experimenter must know these ratings before he can even purchase the components, much less put them together.

The not-too-skilled experimenter buys his material on blind faith and the advice of a radio-store clerk, or orders it from the mail-order catalog on the basis of pure chance, hooks his components together with what help he can get from the schematic, puts on his phones and hears—nothing! Naturally he is at loss as to whether incorrect components, mistakes in wiring, or a defective part is the cause of his trouble. Usually he blames the diagram and its lack of detail.

But the information is all there! What he needs is to know how to interpret it. This is easy, with the help of three tools: common sense, a couple of simple manuals, and a knowledge of Ohm's Law.

No one should be permitted to attempt radio construction without a tube manual. Almost all schematics presuppose that the constructor has one on hand. That is why tube pin numbers are seldom found on a diagram. The tube manual gives the voltages and currents for the various tube elements—a necessity in selecting correct parts.

These voltage and current values solve many problems. If the plate of a tube is to have 100 volts, the bypass capacitor to ground can obviously be a 200-volt type (which a 100% safety allowance). The voltage ratings tell other things. Everybody knows Ohm's Law (at least in theory) but many who know that E/R equals I never realize that if the screen-grid is to receive one milliamperere at 100 volts from a 250-volt supply, the dropping resistor must be 150 volts divided by .001 ampere, or 150,000 ohms.

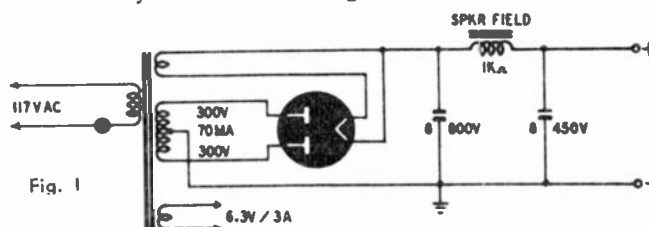
The neophyte would profit by using common sense alone in many cases, if he could see just where and how to use it. For example, how often is a builder puzzled about the voltage rating of the electrolytics in a diagram of an a.c.-d.c. receiver? Common sense would immediately point out that there cannot be more than the peak value of 117 volts a.c. (or about 165 volts) on the capacitors. Therefore any rating above that would be sufficient.

But we may have a schematic with a power supply transformer, with no voltages marked. How do we know what the voltage is to be—or even how to buy the transformer? The problem is simple. We simply have to *design* our equipment for the tubes given. Common sense and Ohm's Law are all that is needed.

Let us take the 3-tube receiver of Circuit 39 and design a power supply for it.

We have a little help. The high voltage is 250, according to the diagram. The tube manual says that the total current of the 6K8 is 16, that of the 6B8 7.5, and of the 6F6 45 milliamperes. Thus our total current is (roughly) 60 ma. So 250 volts at 60 ma (and 6.3 volts a.c. at 1.2 ma for the filaments) is what our power supply will have to deliver.

Next step is to draw a schematic for our power supply. A little study will show that Fig. 1 is almost universal. We



are now ready to make up a bill of material from the schematic and collect our parts. But not quite! The important question of *ratings* is now to be solved.

Ratings are of two kinds—voltage and current. There is one important rule in selecting components. Never be afraid of using higher ratings than those required. A 600-volt capacitor will work perfectly in a 200-volt circuit, where a 200-volt capacitor might blow out immediately if 600 volts is applied to it. *The exception is a transformer.* It must give the exact voltage required. If a transformer with a 700-volt secondary is chosen where 600 volts is needed, all voltages in the circuit may rise accordingly, with possible damage to tubes and other components.

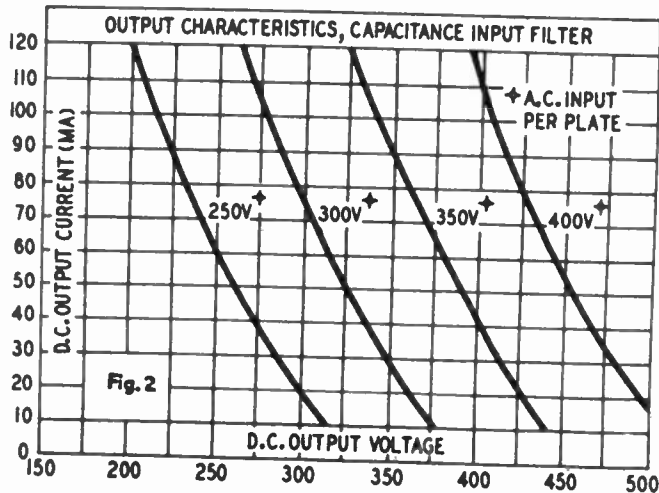
Amperage ratings are different. If voltages and resistances remain the same, the same amperage will flow (see Ohm's Law again) regardless of the amperage rating of the transformer winding or choke coil (or wattage rating of the resistor) through which it flows. Thus for our 60 ma, a transformer with a 75-ma current rating is even better than one designed to deliver 60 ma, for the wire will be bigger and resistance lower, making it less likely to heat.

But what should be the voltage rating of the transformer? To find that, we must find the *drop* in the tube and that in the filter choke. Fig. 2 shows the drop across the tube. Startingly enough, we find that a 250-volt input can produce an output of *more* than 250 volts (if the

current is small and the filter has a capacitor input). Apparently a low-voltage transformer with a center-tapped secondary between 500 and 600 volts would be correct. The catalog consulted offers nothing less than 600 volts at 70 ma. Maybe this will do. The voltage will drop in the filter choke.

Fig. 2 shows that with 300 volts per plate, the output d.c. at 60 ma is about 315 volts. We have 60 ma and want to drop it from 315 volts to about 250. The filter choke will preferably be the field coil of the speaker. Ohm's Law (again) tells us that to drop the voltage 65 volts at 60 ma, a resistance of 1,080 ohms is required. The catalog offers numerous speakers with 1,000-ohm fields, and this problem is solved.

Our transformer has a 6.3-volt winding rated at 3 amperes (an excellent rating for our 1.2-ampere filament drain) and a 5-volt, 2-ampere winding for the 5Y3 or 80.



A pair of filter capacitors are needed also. Standard practice (engineer's language for "what the other fellow does") indicates 8 μ f to be a good value. Each time the set is turned on, the input capacitor will have to stand the peak voltage of the 300-volt winding until the tubes start to draw current. This is 300 times 1.41, or 420 volts. Capacitors may be rated at 450 volts working, though a 600-volt input capacitor would give a better safety factor. Our power supply has been designed—painlessly.

The budding engineer will be surprised at the disregard for accuracy in these calculations. The truth is that radio equipment is *not* critical. The tubes, which are rated at 250 volts, will probably give fair results with anything from 180 to 300 volts on their plates, and a change from 240 to 260 might not produce any perceptible results.

Other components are even less critical. If voltages are too high, tubes will wear out and components break down. But if other values are wide, often no difference can be observed. We have seen that a 200-ma transformer winding or choke will carry 100 ma *better* than one designed for 100 ma. The same is often true of bypass capacitors. More than one experimenter has scratched his head over the value of an unmarked capacitor, when *any* value between

.001 μ f and 100 μ f would have worked perfectly. A resistor is not so uncritical. If it is too high, it will drop the voltage too much—if too low, it will not drop it enough. Ohm's Law, once more, will tell you exactly what you need.

But what about the schematic with *no* values marked? The quick and easy way to handle such a diagram is to compare it with a somewhat similar one. If it is a 5-tube super, for example, anything that is used in another 5-tube super with nearly equivalent tubes (look up the tube manual again) will work well. It may be necessary to use *two* schematics for comparison, if part of the circuit resembles one more closely than the other. Resistor values can be checked by Ohm's Law, of course.

Coil data is another sticker to those who do not realize that a given coil and capacitor will resonate at a given frequency *no matter what receiver it is used on*. Some designers prefer to use single-silk covered wire on a 3-inch form, while others like enamel-covered on a 1½-inch form. Others specify coil arrangements for special reasons. Thus the secret of the Oscillodyne is in the extra-large tickler. But in the majority of cases substituting standard commercial coils for those specified by the designer makes no difference whatever. In this book, coil data is given where necessary, interesting or convenient. The table below will suffice for all other circuits. Note again that exact figures are often meaningless. A short antenna calls for a bigger primary than a longer one, and the size of the tickler coil often depends on the individual tube in the detector socket. It is always necessary to experiment, adding or taking off turns till the set regenerates smoothly.

COIL TABLE, 1½-INCH FORM
C = 140 μ f

Freq. (mc)	No. of turns	Wire size	Spaced to	Tickler (turns)
1-2	80	28	2 in.	20
2-4	40	24	2 in.	12
4-8	20	18	1½ in.	6
8-16	10	18	1 in.	4
16-32	5	18	1 in.	4

With a 365- μ f variable capacitor, maximum frequencies will remain much the same, and minimum will be about half of those given; thus 80 turns will tune from .5 to 2 mc.

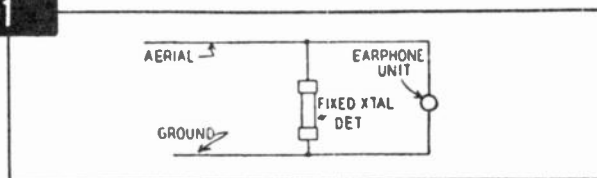
Standard commercial coils, or coils from old receivers, may be adapted to the constructor's uses. Know what you are using, though! If a high-impedance antenna coil primary (one with a large number of turns) is used as tickler in a regenerative circuit, the set will oscillate uncontrollably. The remedy is to use the primary as antenna coil and wind on a reasonable-sized tickler for the band (about 20 or 30 turns of fine wire for a broadcast coil).

There are numerous problems which have not been covered in this chapter. But the tool for solving all of them has been revealed. Common sense, plus use of information at hand, is the secret of interpreting all radio-electronic circuits.

The crystal receiver, if carefully constructed, may be a reasonably selective and fairly long-range radio set, and a real source of radio entertainment. Its quality has always been admitted to be better than that of any other type of receiver. It is probably easier to abuse than any other circuit, and that is the main reason for its lack of reputation.

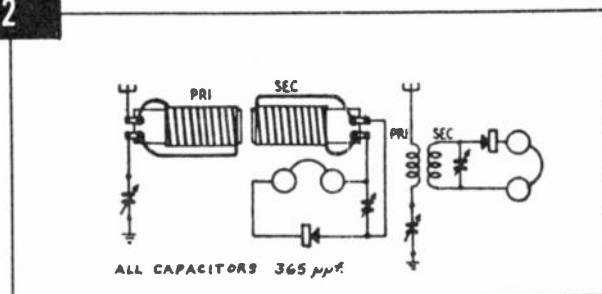
Crystal reception over distances up to 1,000 miles is not at all uncommon, and can be attained regularly under good conditions. If distance is to be sacrificed for selectivity, a two-circuit, loose-coupled set can be made which will compare well with some t.r.f.'s.

1



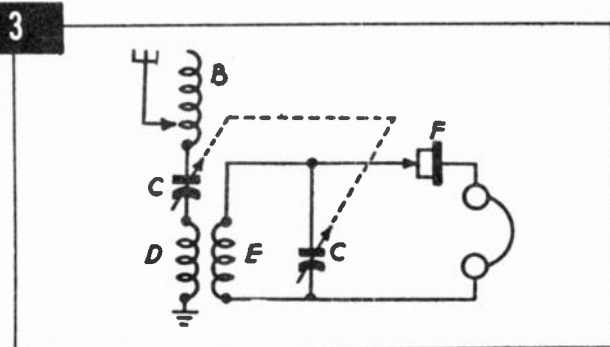
1. Simplest of all crystal receivers, this circuit is just a fixed crystal connected between the aerial and ground, with the phone or phones connected across it.

2



2. Pictorial and schematic of a two-circuit crystal receiver. Coils are two halves of a broadcast t.r.f. coil cut apart and mounted so the coupling is variable.

3

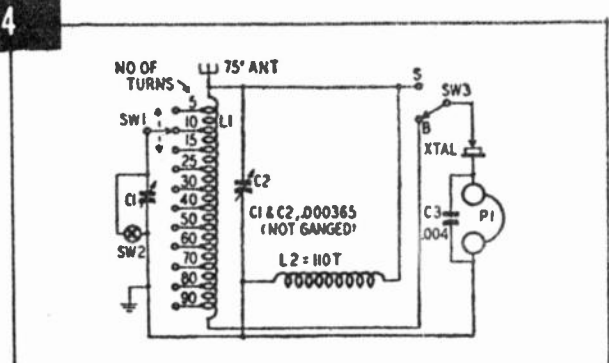


3. The "Loud" crystal radio. Coil B is 60 turns of No. 24 d.c.c. wire, tapped every fifth turn. Capacitor C is a 2-gang 365 μf unit (insulated from the chassis). Coil D uses 15 turns of No. 24 d.c.c. wire, and coil E—separated from it one-eighth of an inch on the same form—is wound with 90 turns of the same size of wire.

The great secret of crystal-set sensitivity is: *good material*. Since the signals are very weak, only the finest headphones obtainable should be used. Stations quite inaudible with a poor type of phones come in with good volume when an excellent pair is substituted. *Range* depends more on the antenna. A high, long aerial is necessary for distance with a crystal receiver. Thousand-mile records are made with aerials 60 to 90 feet high and some hundreds of feet long, with perfect grounds in wells or the salt water of the sea. The crystal will work quite satisfactorily of course without such ambitious antenna systems, but the moral remains: *make your antenna as high and long as possible!*

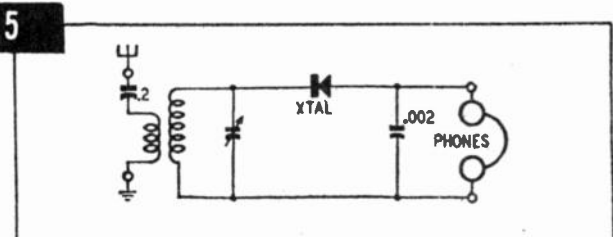
Selectivity depends on loose coupling and good, low-resistance coils. High-Q coils may be wound by using large, double-cotton-covered wire (or better, litzendraht) and by using low-loss coil forms or no forms at all. Coupling may be reduced by winding coils further apart on the same form, or by mounting them so one can be swung close to or away from the other. Circuit 2, made of the two halves of a broadcast coil, can easily be so constructed, and in its original form, had the coils mounted only on their own connecting wires, which were heavy. By bending the wires, the coupling could be varied as desired.

4

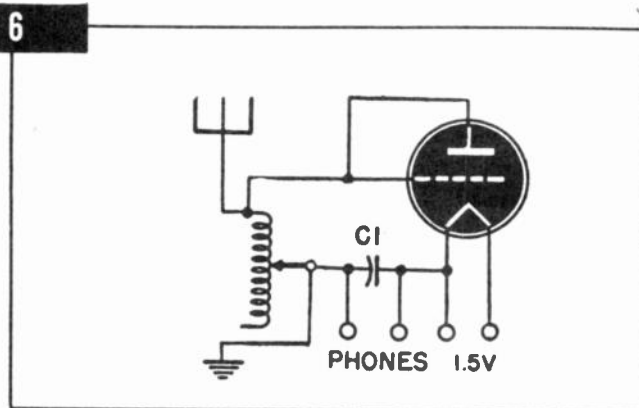


4. The Modern crystal receiver uses a 1N23 crystal. Coil is wound with No. 22 d.c.c. wire on a 2-inch form, tapped as shown. L2 is No. 34 d.c.c. on a 2-inch form.

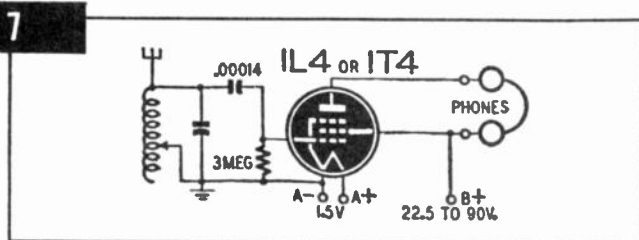
5



5. A very standard crystal circuit, which can be used for any frequency by inserting coils for the given wave-band as recommended in the introductory article. This circuit may be converted easily into a 1-tube receiver.

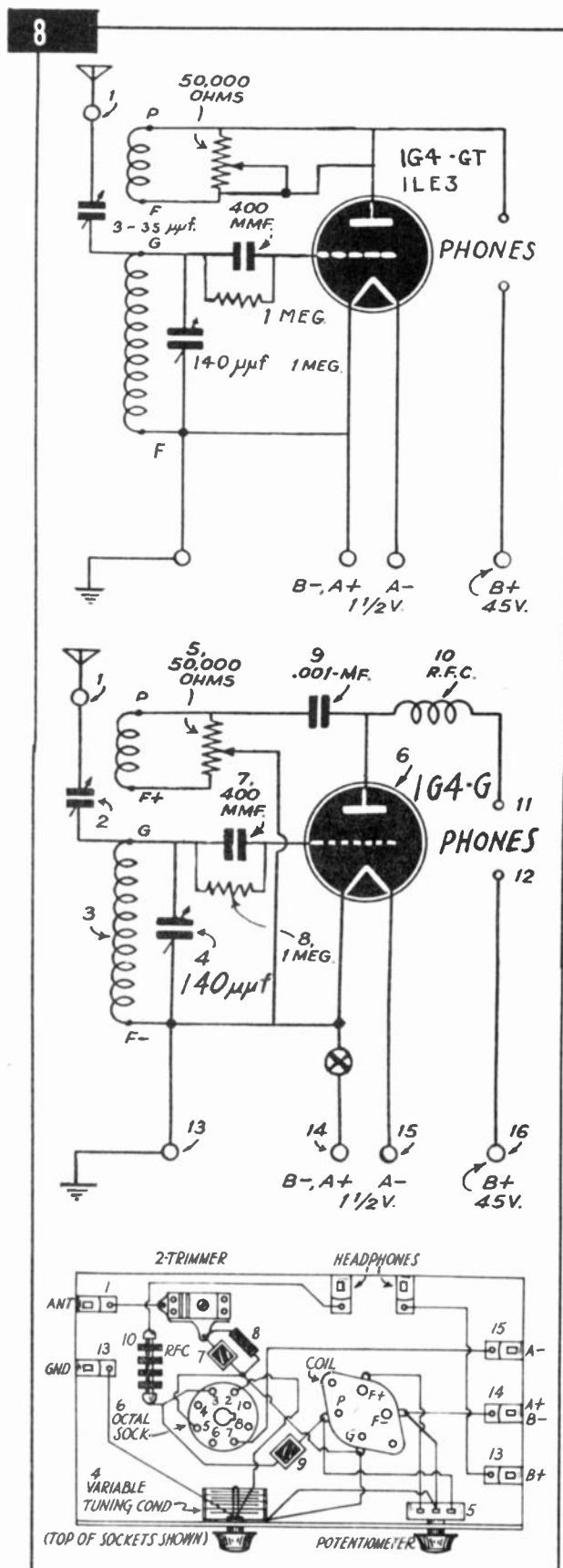


6. This is the simplest of all tube circuits, using only a diode-connected 1G4 and a tapped coil. A 6H6 may be used in this circuit if there is a.c. available for the filament. The capacitor C1 is not critical—may be .001 or .002 microfarad.

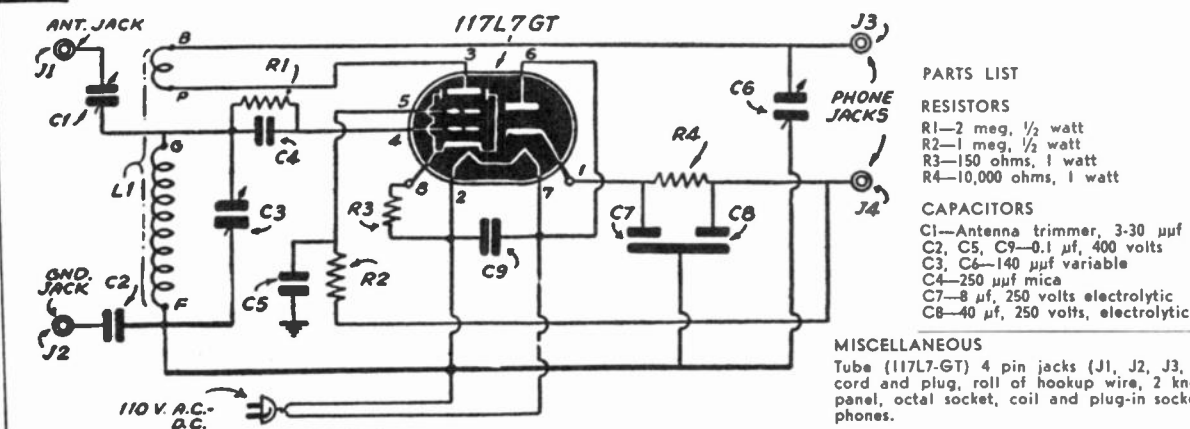


7. The simplest detector using a tube with a grid. The tube shown is a pentode, but a triode may be used with good results, simply by omitting the lead between the lower phone connection across to the screen of the tube. The fixed capacitor across the coil may have a value of 250 μf . The coil itself may be a tapped or slider type. A permeability-tuned coil should give excellent results. The fixed capacitor should then be adjusted, making tuning range coincide with the desired band. Tuning may be very broad on this little set if the antenna is made large enough for long-distance reception. This difficulty may be overcome by the use of a regenerative receiver. As an alternative a small trimmer capacitor may be inserted in series with the antenna and its capacitance reduced to increase selectivity.

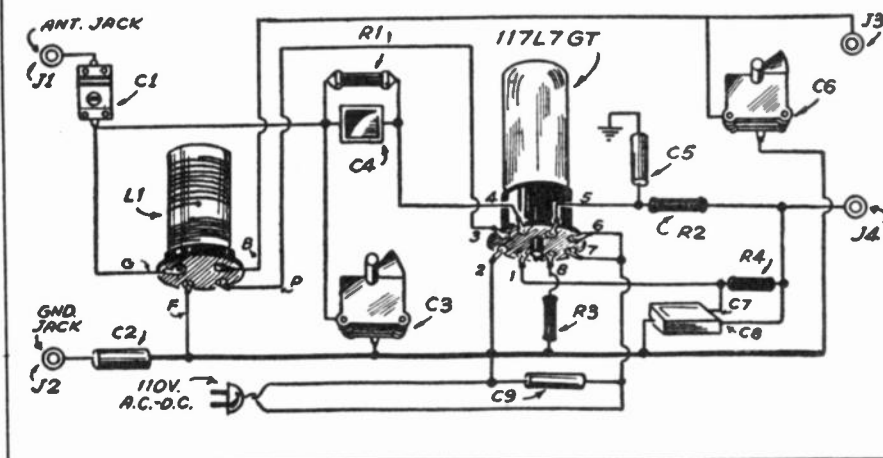
8. One of the simplest types of regenerative receiver. Two forms (series fed in the top figure and shunt fed in the bottom one) are shown. In the series fed circuit B-current passes through the tickler; in the shunt type it is supplied through an r.f. choke, the r.f. passing through the .001- μf capacitor and tickler coil, then to ground. Coils PF, GF, may be a standard shortwave plug-in coil, or a broadcast type, or may be wound with the help of the coil information given in the introductory chapter. The variable capacitor should be a 365- μf unit if the set is to be used chiefly for broadcast listening. Well built and used with an excellent antenna, this 1-tuber can receive from great distances. The layout (of the shunt-fed set) may help the beginner who is not sure how the parts should be laid out. It can be varied to almost any extent, of course. Base and panel should be bakelite, hard rubber, polystyrene or other good insulating material, which is likely to give less trouble to unskilled constructors than the more common metal chassis. Note well that the numbering system for the tube socket is opposite to that in the manuals, as it is a top rather than a bottom view of the tube socket.



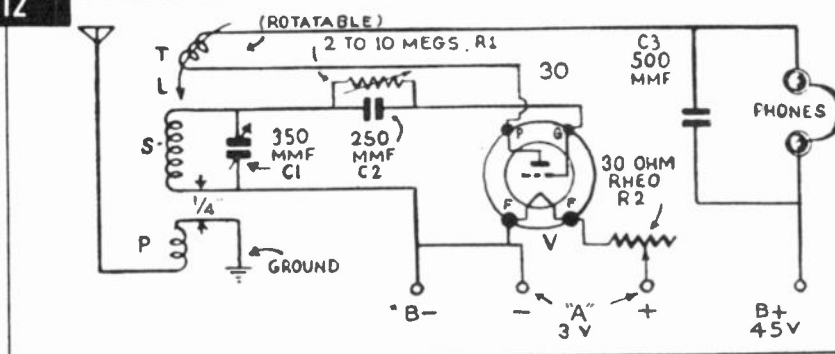
11



11. A Reinartz circuit for a.c. use. The 117L7 may be used as a pentode, as shown, or may be made a triode by tying the screen to the plate. The set was designed for use where a radio which can be carried in a suitcase and will stand hard knocks is desired. Using a regenerative circuit, it is very sensitive and will receive very well with very little antenna. It can be hooked up to a bedspring, short length of wire strung around the room, or any large metal object. In some places a ground will improve reception, in others it is unnecessary. One precaution is necessary with this or any other regenerative receiver—if the regeneration control is advanced too far the set will burst into oscillation. This ruins the program, giving it a mushy sound, and at the same time radiates a whistle which spoils reception on all nearby receivers tuned to the same station. The coil may be any standard broadcast-type coil with a low-impedance antenna winding, or may be wound on a 1½-inch form with 120 turns of No. 28 wire for the grid coil and 25 of No. 32 or 34 for the tickler, both enamel-covered wire. If the receiver is to be used on broadcast only, C3 may have a capacity of 365 μ f instead of 140 μ f as shown. By using miniature components the set may be made very compact. The original, known as the "Campanion" was put in a case about 6 x 3 x 2½ inches, and was built as a portable for vacation use.



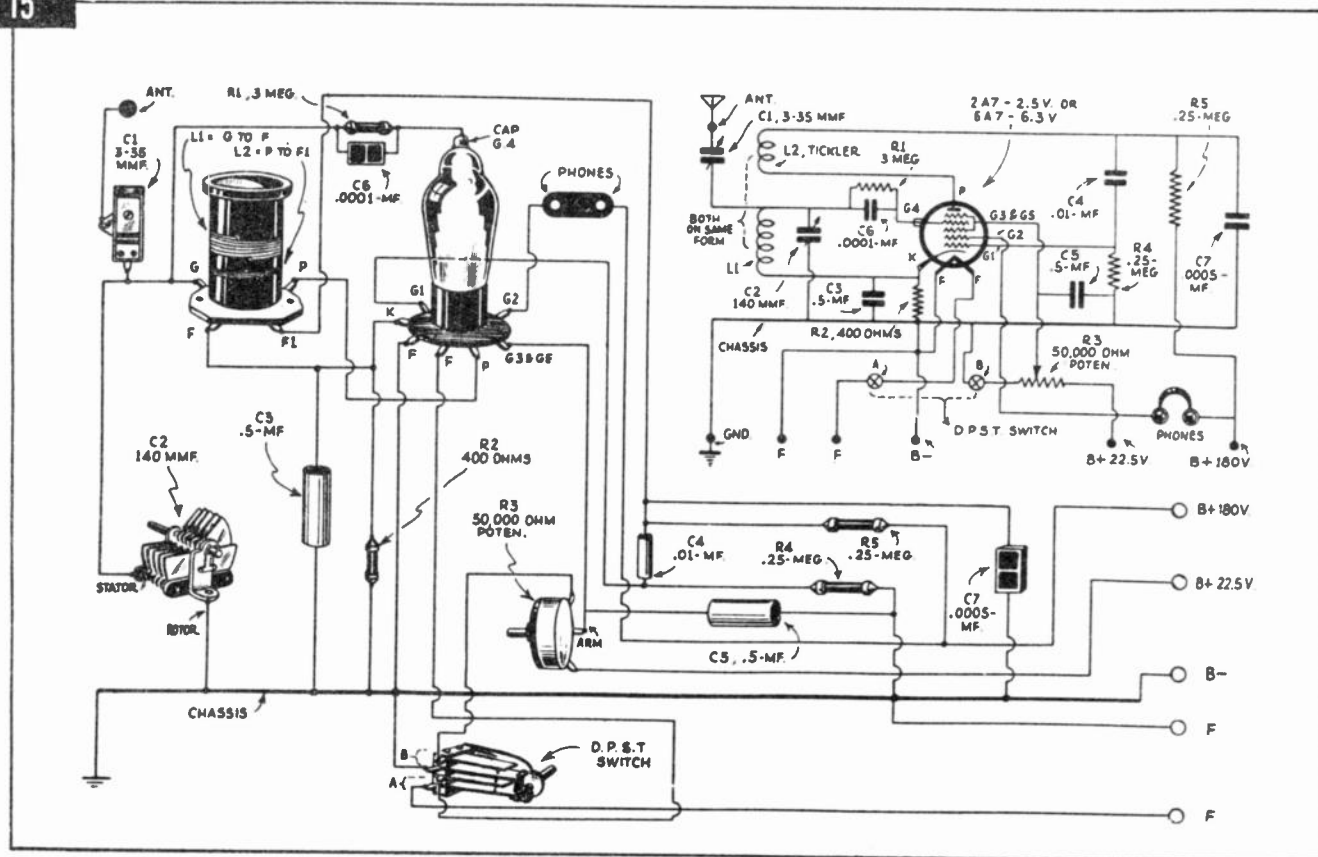
12



12. The original 3-circuit tuner, at one time as much the standard radio circuit as the superheterodyne is today. It used a variocoupler, a device no longer obtainable. One can be made from a 3-inch coil form about 3 inches long, and a smaller form, 2 inches in diameter and 1 inch long. The smaller form is wound with 20-30 turns of No. 28 wire, in two windings, to clear a shaft on which it rotates inside one end of the large form,

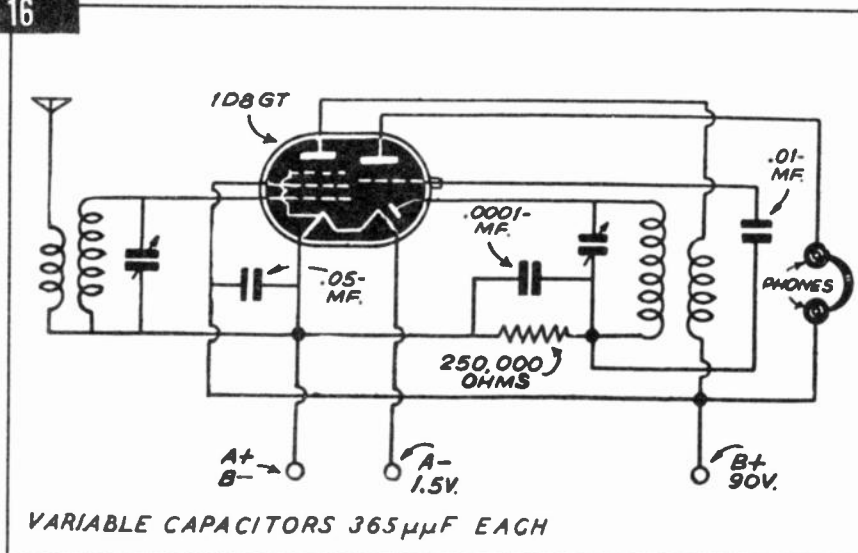
which has holes bored in it for the shaft. The large form is wound with about 40 turns of No. 24 wire. Enamel insulation may be used in all cases. The primary is a dozen turns of No. 28 wire wound about 1/8 inch away from the ground end of the grid winding. The tickler shaft should fit snugly enough that the tickler coil will stay put, but turn smoothly. This circuit, when used with a good antenna, combines good sensitivity and selectivity.

15



15. The Pentaflex, another of the two-in-one circuits. The signal is detected in the mixer circuit and amplified in the oscillator circuit of a standard converter tube. Though a 6A7 is shown, this hookup might work well with a 1R5. The signal comes in to grid 4 and is detected. Grids 3 and 5, acting as the screen in the detector circuit, are varied in voltage to control the regeneration. The audio signal now goes to grid 1 by way of C4, and is there amplified in the circuit which comprises grid 1 as grid and grid 2 as anode. Standard plug-in coils are used for broadcast and short waves. Switch shown in the pictorial may be any type of insulated d.p.s.t. switch. The Pentaflex is an old circuit and was very popular, but was apparently superseded by the more convenient dry-cell tube circuits, before the 1R5 appeared.

16



16. Three-in-One receiver—r.f. amplification, detection and a.f. amplification with a single 1D8-G. The coils are a broadcast antenna coil and r.f. transformer. The pentode section of the tube is used for r.f. amplification, as it is less likely to oscillate than the triode section. After amplification, the signal is passed through the r.f. transformer to the diode section and there rectified, the audio signal being taken off by the lead to the 0.1-μf capacitor and the grid of the triode section, and amplified at audio frequency. There should be a 1-megohm resistor between the triode grid and the negative side of the filament (omitted from the diagram). There have been many variations of this hookup, including reflexes and circuits which use the triode for radio and the pentode for audio amplification, but this circuit is more dependable if not quite as sensitive as its variants.

17. The Interflex, a crystal detector in the grid circuit of a 1-tube set, which then acts as an audio amplifier. Excellent reproduction is obtainable with this receiver, as the crystal detector is unsurpassed in fidelity. Sensitivity may be increased greatly by adding regeneration, which may be done by using a circuit with a tickler coil. Regeneration is slightly more easily controlled than in a grid-leak detector, as the circuit lacks the "stickiness" characteristic of the grid-leak. The crystal should be turned both ways in the circuit, as reception is much clearer with it in one direction than in the other.

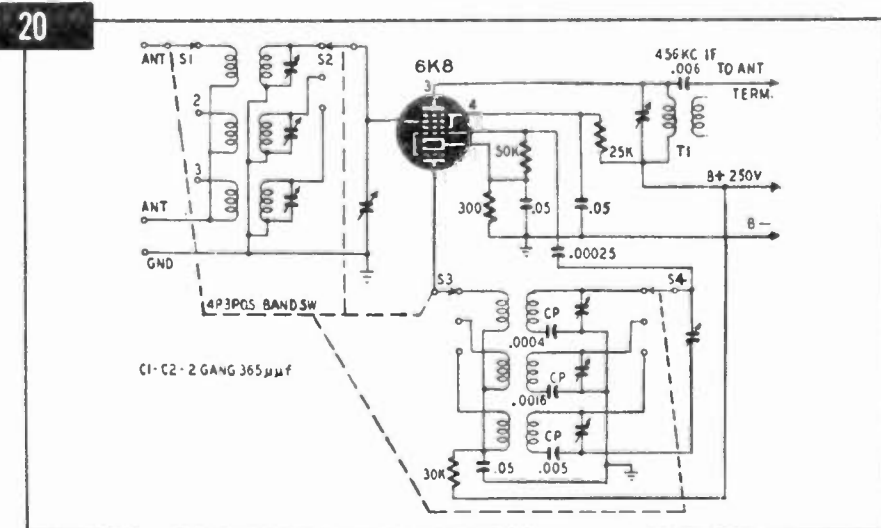
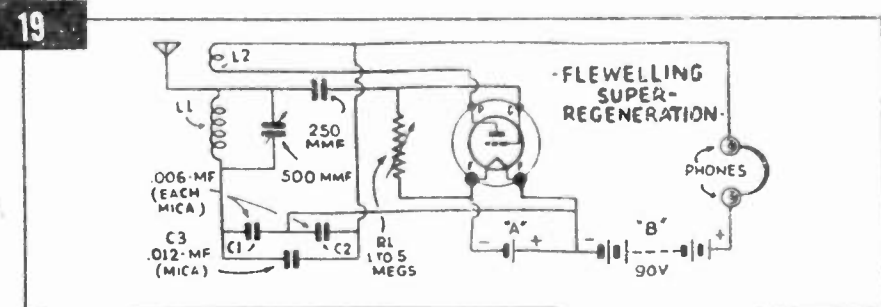
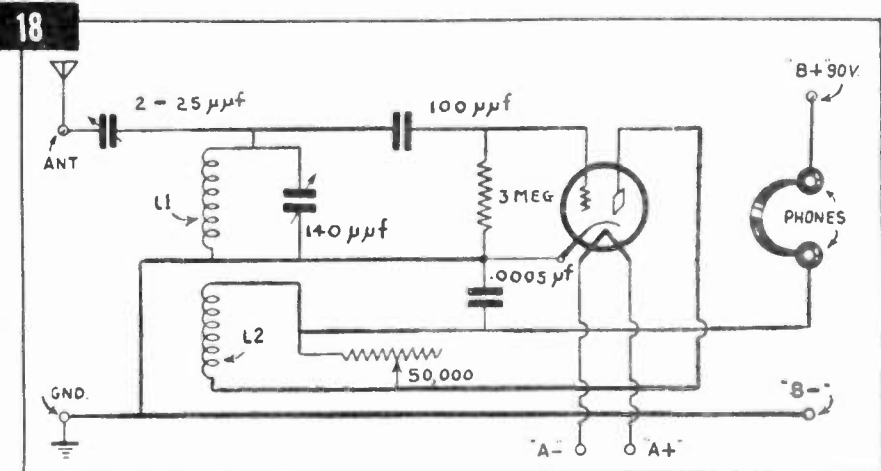
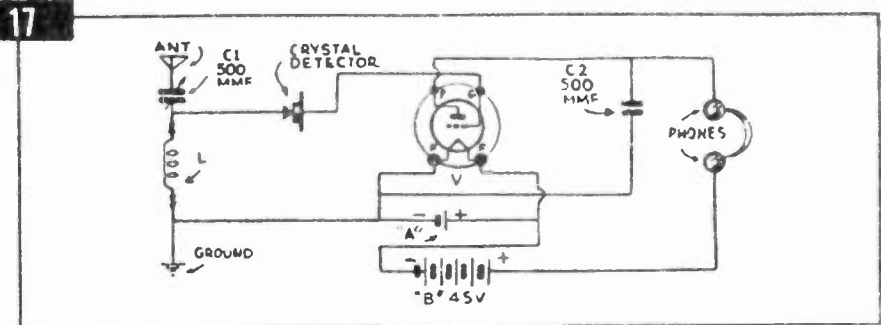
18. The Oscillodyne is a special type superregenerator. A large tickler coil is its secret. Coils are wound on $1\frac{1}{2}$ -inch diameter forms with No. 30 enamel wire, $\frac{1}{8}$ inch between the two windings, as follows:

FREQUENCY (mc)	L1	L2
1.5-3	36	36
2.5-4	24	24
3.5-8	14	12
7-14	7	9
13-28	4	6

Space the higher-frequency coils to cover the desired band. For the broadcast band, a high-impedance antenna coil may be used, with the primary winding for the tickler. This set has made numerous dx records.

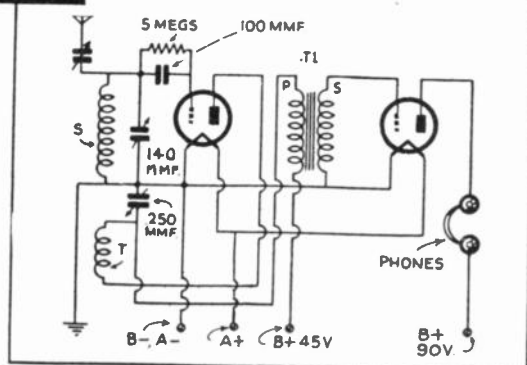
19. The Flewelling superregenerator, a set which depends on three large mica capacitors (C1, C2, C3) for the low-frequency oscillations that produce superregeneration. The tickler coil should be large; the data given for the Oscillodyne may be used for this receiver as well. This is one of the simplest superregenerative hookups, and with careful adjustment gives excellent results. While a dry-cell tube like the 1G4 gives good results, a power tube is much better, and it might be worth while to try a 1G6 with both sections tied together. A.c. tubes give even better results.

20. Shortwave converter for standard broadcast receivers. The 6K8 converts the shortwave signal to an intermediate frequency in the range of the broadcast set. Coils may be wound by hand with data given in the introductory chapter, but for a multiband job it will be found more satisfactory to use a factory-made set. The output transformer is a 455-kc i.f. transformer and must be one which the manufacturer specifies to be tunable up to about 600 kc. It is then adjusted to a frequency between 500 and 600 kc, the set tuned similarly, and the converter aligned.



14 Two-Tube Circuits

21

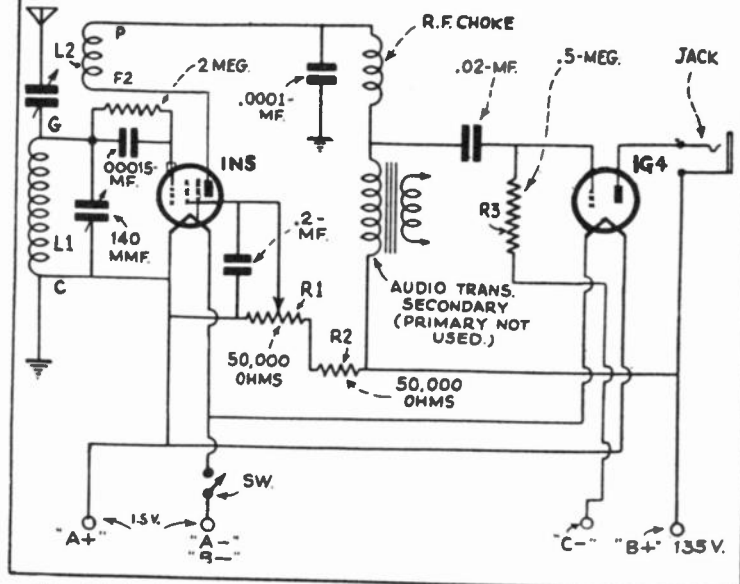


21. A regenerative triode with one stage of transformer-coupled amplification. This set is probably the easiest-constructed 2-tuber, and as the original Doerle receiver, had a reputation for distance-getting. Coil forms are UX tube bases on which the coils are wound with No. 24 enamelled copper wire, with no spacing between S and T.

Range (meters)	Turns (S)	Turns (T)
15-45	5	6
35-75	16	5
60-125	28	6

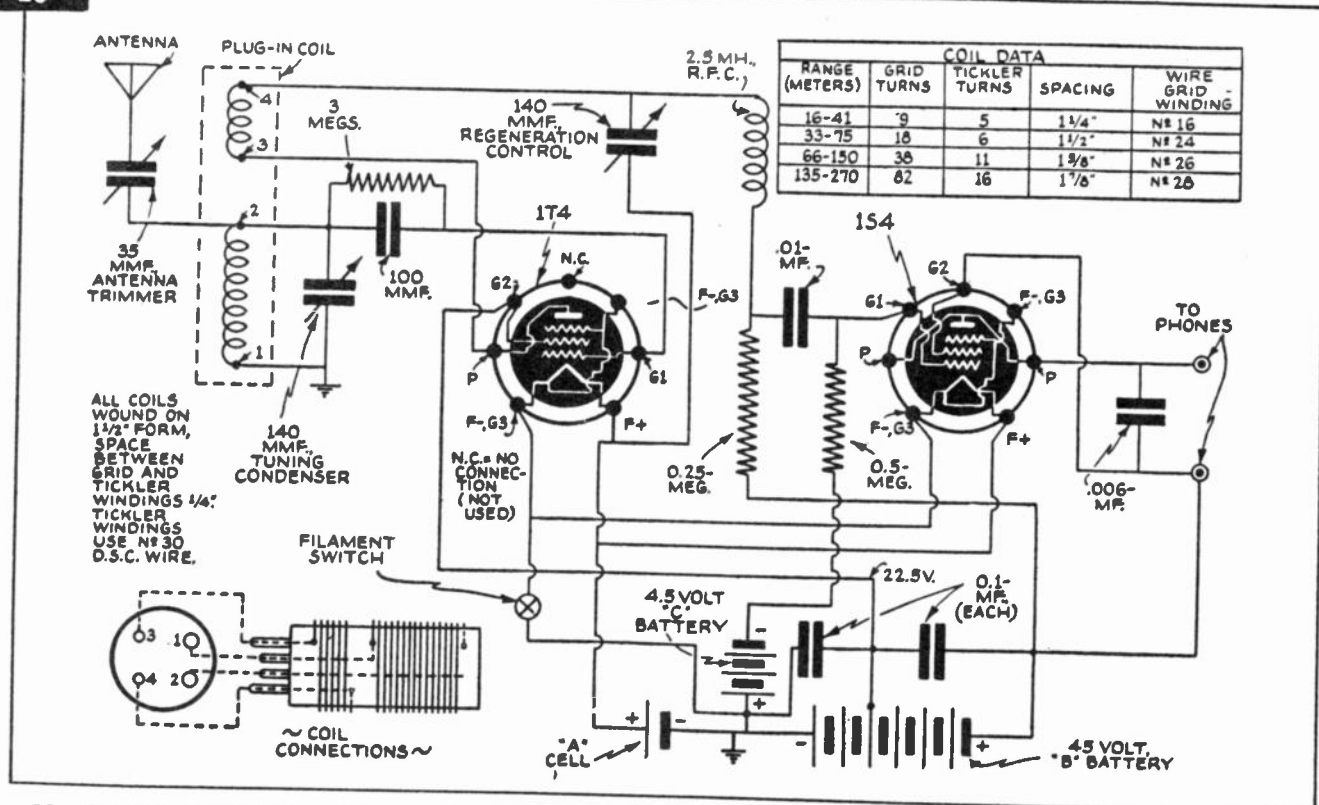
Standard plug-in coils may be used, of course.

22



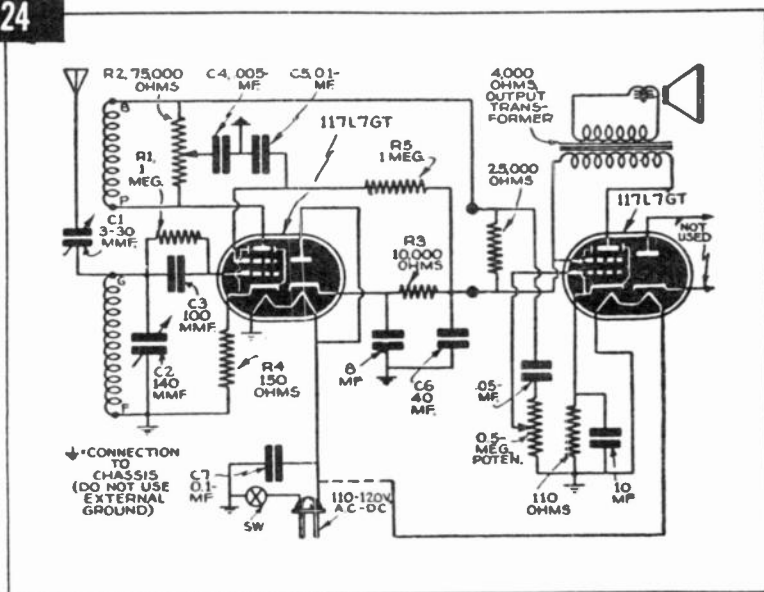
22. This circuit uses a screen-grid tube as detector. Regeneration is controlled by varying the screen potential. Impedance-coupling to the audio stage is used, any high-inductance choke such as the secondary of an audio transformer being suitable.

23



23. Another Reinartz-type detector, the Overseas DX-er may be made into a compact and sensitive portable. It uses two miniature tubes, the audio amplifier being a power tube capable of considerable output, and may operate a loud-speaker on strong local stations. The set was originally built into 4 x 6 inch card file. This set uses resistance coupled audio. An audio choke may be found to give better results than the 0.25-megohm plate resistor.

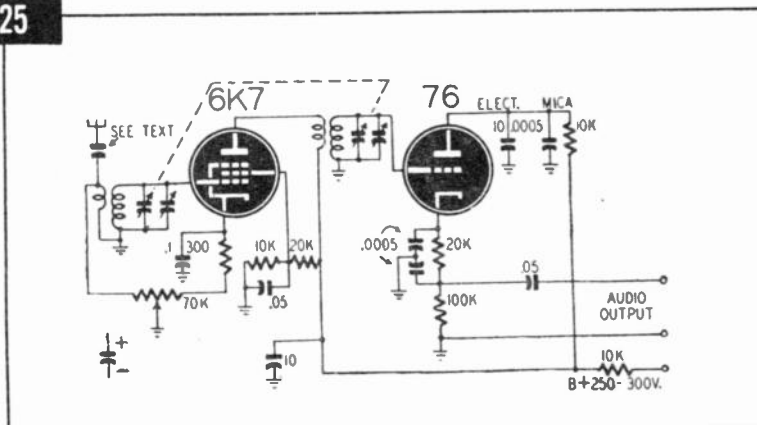
24



24. The Pygmy receiver of Circuit 9 has a stage of resistance-coupled amplification. This set can be built as a 1-tube by omitting all parts beyond the two heavy dots.

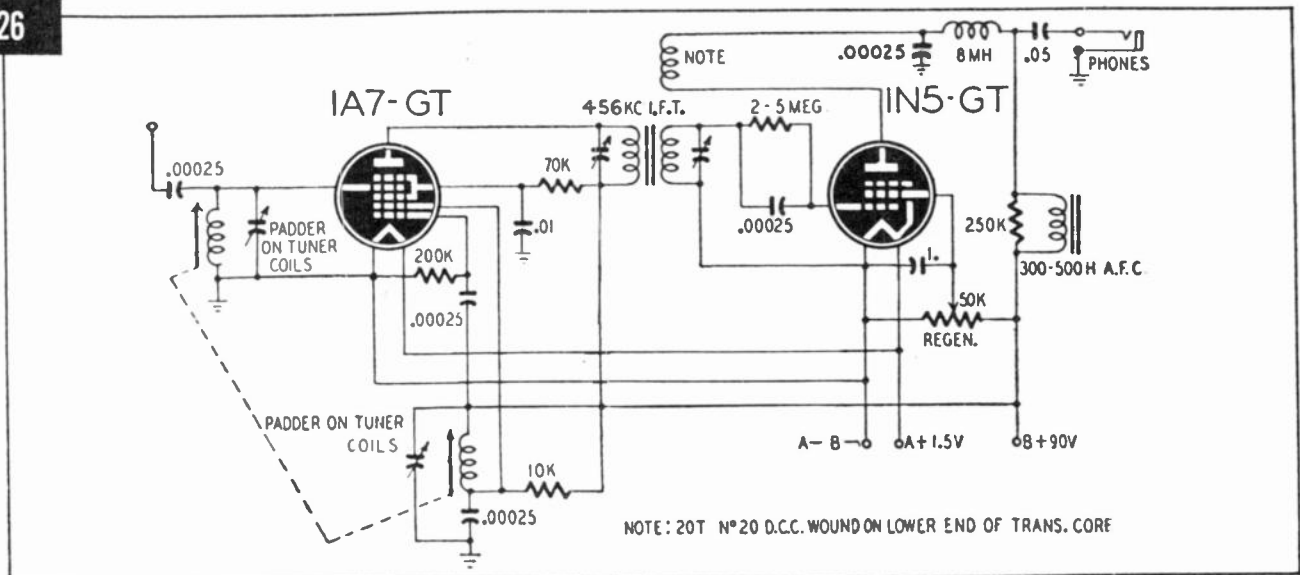
25. One stage of tuned r.f. followed by a plate detector with a cathode-follower output. This circuit was designed as a high-fidelity tuner to feed into an audio amplifier, but will work equally well as a head-phone receiver, though for that purpose a stage of audio would help it greatly. As a high-fidelity tuner, 50,000-ohm resistors between grids and ground would broaden tuning for better reproduction of high notes, but would increase the danger of interference. The antenna capacitor may be large where there is little interference or if the antenna is very short. For congested areas and long antennas use a 3-30 trimmer. Any tubes of the same type as those shown may be used. For example a 6SK7 and a 6C5, or even a 1N5 and a 1G4. Power for the set may be taken from the amplifier or from a separate power supply.

25



26. A regenerative superheterodyne using only two tubes. While not greatly more sensitive than other 2-tube receivers, this radio is more selective and has the great advantage that once the regeneration is set, it may be left undisturbed while tuning in nearby stations. This feature is particularly valuable if the receiver is used for amateur reception where the set may be tuned to numerous stations within a small band of frequencies. The regeneration control may be turned up to the oscillation point to receive radiotelegraph (c.w.) stations without radiating interfering signals, as the detector is tuned to the intermediate frequency. For short waves, the permeability-tuned broadcast coils shown would be replaced by plug-ins and variable-capacitor tuning employed.

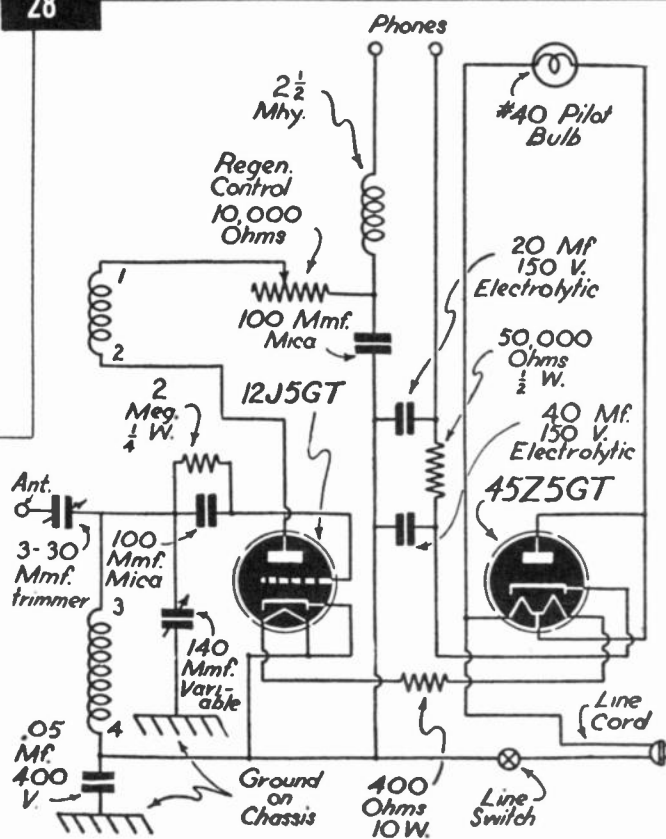
26



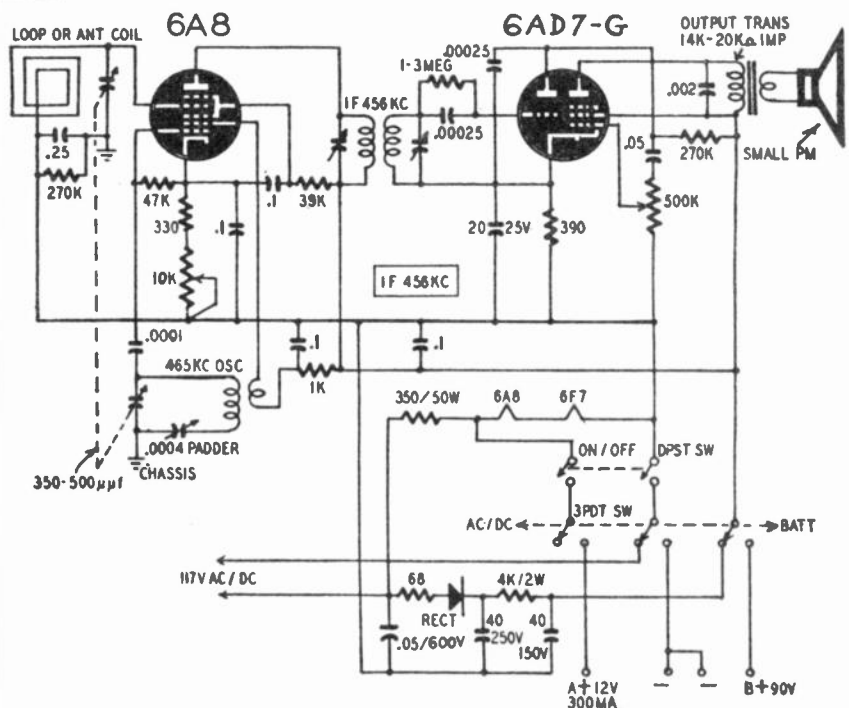
The schematic diagram shows a two-stage vacuum tube amplifier. The first stage is a 7F8 tube configured as a tuned circuit, with its grid connected to a B+117V supply through a 47K resistor and a .002 capacitor. The plate is connected to a 33K resistor and a .002 capacitor to ground, and to an RFC (Radio Frequency Choke) and a 2.5-10MH inductor. The second stage is a 7F8 TO POWER AMP tube, with its grid connected to the plate of the first stage through a 10K resistor and a .002 capacitor to ground. The plate is connected to a 220K resistor and a .002 capacitor to ground, and to a 50V transformer. The transformer has a primary winding of 50V and a secondary winding of 50V. The secondary is connected to a 500K resistor and a .25 capacitor to ground, and to a 47K resistor and a .002 capacitor to ground. The circuit is powered by a B+117V supply.

28. First half of the Progressive receiver, a set which can be expanded from a 2- to a 4-tube, as is shown in Circuit 41. The 2-tube is a 1-tube in effect, as the other tube is a rectifier, used only to supply power to the receiver. Regeneration is controlled with a 10,000-ohm variable resistor in the detector plate lead. This has the disadvantage that the plate current flows through the regeneration control, which may become noisy. If desired, a 50,000-ohm resistor can be used across the tickler.

28



29



34

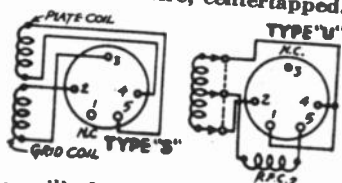


IG6-GT

IA5-G

All windings wound in same direction.
All "S" series coils on 1½-inch forms.

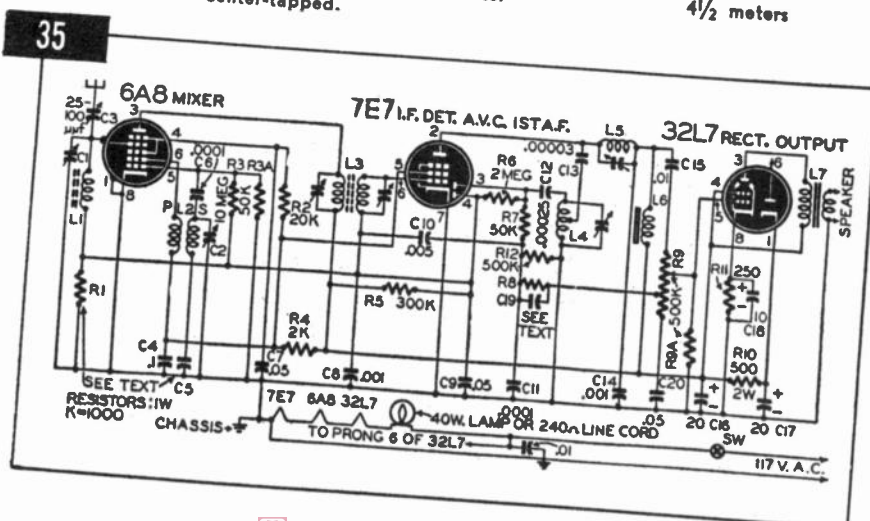
COIL	All series coils on 1 1/2-inch forms.		
	PLATE WINDING	GRID WINDING	
S-D-7	60 turns No. 28 3-layer winding	250 turns No. 28 4-layer winding	Approximate Wavelength 665-425 meters (451-700 kc)
S-C-6	40 turns No. 28 3-layer winding	140 turns No. 28 3-layer winding	
S-B-5	6 turns No. 28 2-layer winding	60 turns No. 28 2-layer-winding	500-275 meters (600-1100 kc)
S-A-4	10 turns No. 28 close wound	29 turns No. 26 close wound	300-140 meters (1000-2200 kc)
S-A-3	8 3/4 turns No. 26 close wound	13 turns No. 26 close wound	150-80 meters
S-A-2	3 3/4 turns No. 28 close wound	6 1/4 turns No. 26 spaced 1 turn	80-40 meters
S-A-1	4 3/4 turns No. 28 close wound	2 1/4 turns No. 26 spaced 1 turn	45-19 meters
U-U-8	10 turns, 1/2 inch inside diam. Self-supporting coil, center-tapped		20-10 meters
U-V-6	2 1/2 turns, 1 1/2 inch diam. Self-supporting coil, center-tapped		8 meters
U-V-5	3/4 turn, 2 inches diameter center-tapped.		6. meters
U-V-4 1/2	1/2 turn, 1 1/4 inch semi-diameter center-tapped.		5 meters
			4 1/2 meters



As will be seen from the coil diagram, the *U* circuit is super-regenerative, the coil being connected in ultraudion fashion, with the B-voltage led in through a center-tap.

35. The Super-Reflex, another Conatser circuit in which the 7E7 is i.f. and a.f. amplifier as well as detector. Coils L4 and L5 are i.f.t replacement windings, or may be taken from i.f. transformers on hand. L1 and L2 may be standard antenna and oscillator coils, though the designer used an antenna transformer without the primary, removing turns from the secondary till C1 would tune over the broadcast band. C1 and C2 are 365 μf each, and C5 is the value recommended by the manufacturer of the oscillator coil used. R1 should be as small as possible for circuit stability. Start with 2 megohms and reduce. Try 200 μf for C19 then vary for best results.

35

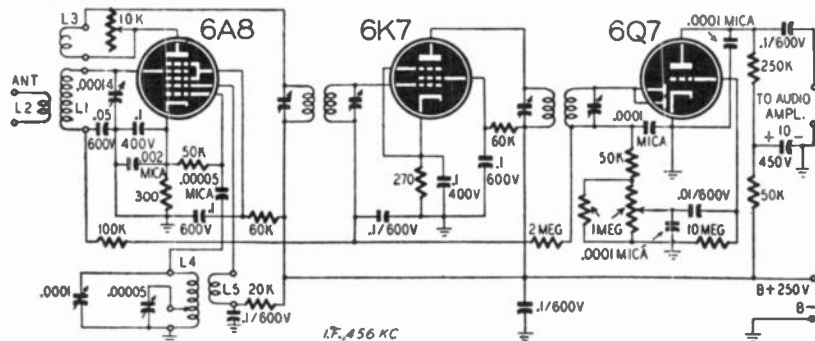


36. A 3-tube tuner (or headphone receiver) this radio is a regenerative superheterodyne. The circuit is somewhat unusual, since the regeneration is in the mixer and not the i.f. circuit, as is more common with regenerative supers. This should have the advantage of introducing greater selectivity and sensitivity early in the circuit and should make it an excellent hookup for weak dx signals. The circuit shows only one other unconventional feature—the special padding or adjusting capacitor across L4. It may be used as a band-spread capacitor on amateur bands or for exact tuning of foreign short wave broadcast stations. If used as a headphone receiver a pair of crystal phones may be used across the output circuit, or a 6R7 substituted for the 6Q7 and the headphones inserted directly in the plate circuit (or across the 250,000-ohm load).

NOTES ON COIL DATA

L3 is jumble-wound to 3/4-inch diameter and placed inside near bottom of L1. L2 and L5 are close-wound and spaced about 1/8-inch from bottom of L1 and L4. L1 and L4 are spaced to 1 1/2-inch on bands A, B, C, D, and 1 inch on band F.

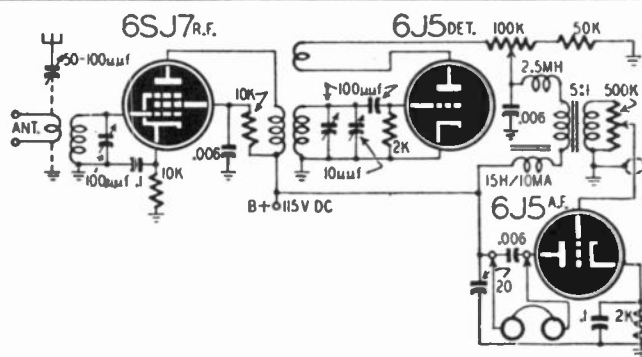
36



RANGE	L1		L2		L3		L4		L5		L4 TAP TURNS FROM BOTTOM TO TAP
	TURN	WIRE SIZE	TURN	WIRE SIZE	TURN	WIRE SIZE	TURN	WIRE SIZE	TURN	WIRE SIZE	
A—500 TO 1000 KC 300–600 METERS	195	N° 32 ENAM	40	N° 32 ENAM	40	N° 32 ENAM	127	N° 32 ENAM	33	N° 32 ENAM	TOP
B—900 TO 1800 KC 160–325 METERS	110	N° 28 ENAM	26	32	26	32	75	28	16	32	TOP
C—1700 TO 3300 KC 90–170 METERS	60	28	13	22	15	22	56	28	14	22	40
D—3. TO 6.4 MC 47–100 METERS	33	22	8	22	11	22	30	22	10	22	20
E—6. TO 12. MC 26–50 METERS	18	22	4	22	8	22	16	22	8	22	7
F—10. TO 25. MC 14–30 METERS	8.5	18	4	22	6	22	8	18	5	22	3

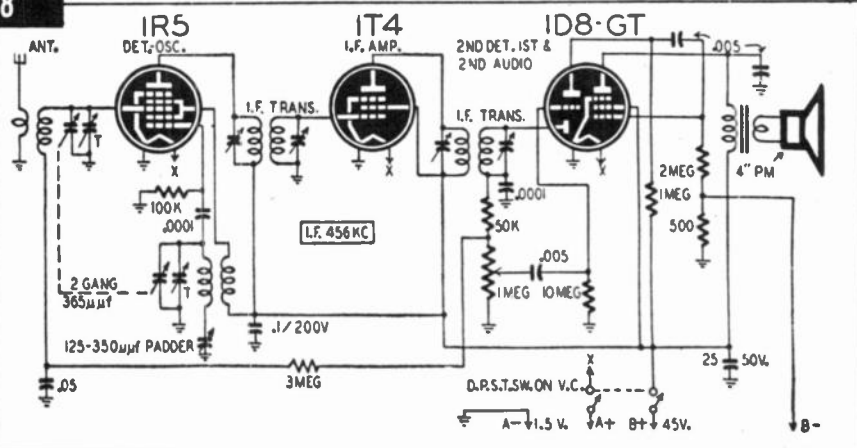
37. A 3-tube receiver for d.c. areas or 110-120-volt shipboard use. The filaments may be supplied from the line through a 280- to 300-ohm dropping resistor, or from a 6-volt battery. Either a single conductor to the wall receptacle (and a good ground on the receiver) or a double conductor with one wire connected to set ground, may be used. The former is safer, as there is no danger of a chassis being "hot".

37

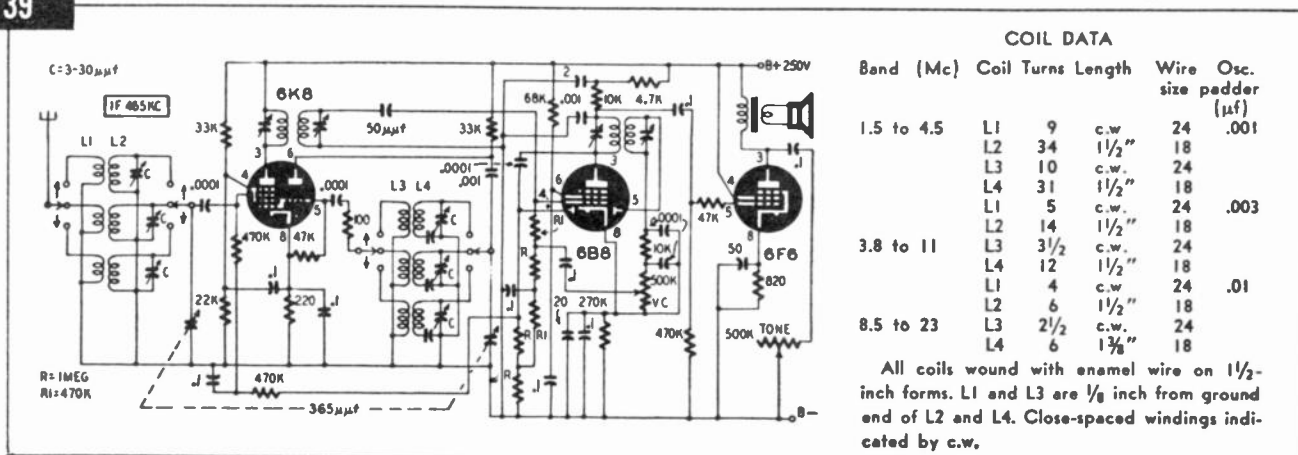


38. This 3-tube superhet actually has five stages, the 1D8 acting as detector and two stages of audio amplification. Since it will operate on 45 volts, it should be an excellent circuit for a super-compact portable for vacation use. For greater sensitivity the plate voltage may be increased to 90. The grid bias on the pentode section of the 1D8 is controlled automatically by the 500-ohm resistor between -B and ground for either B-voltage. The antenna coil may be replaced by a loop, though the antenna transformer with a short hank aerial will be more sensitive. A standard set of antenna, oscillator and i.f. coils are used. If a cut-plate capacitor and coils designed for it are used, the oscillator padding condenser may be omitted.

38

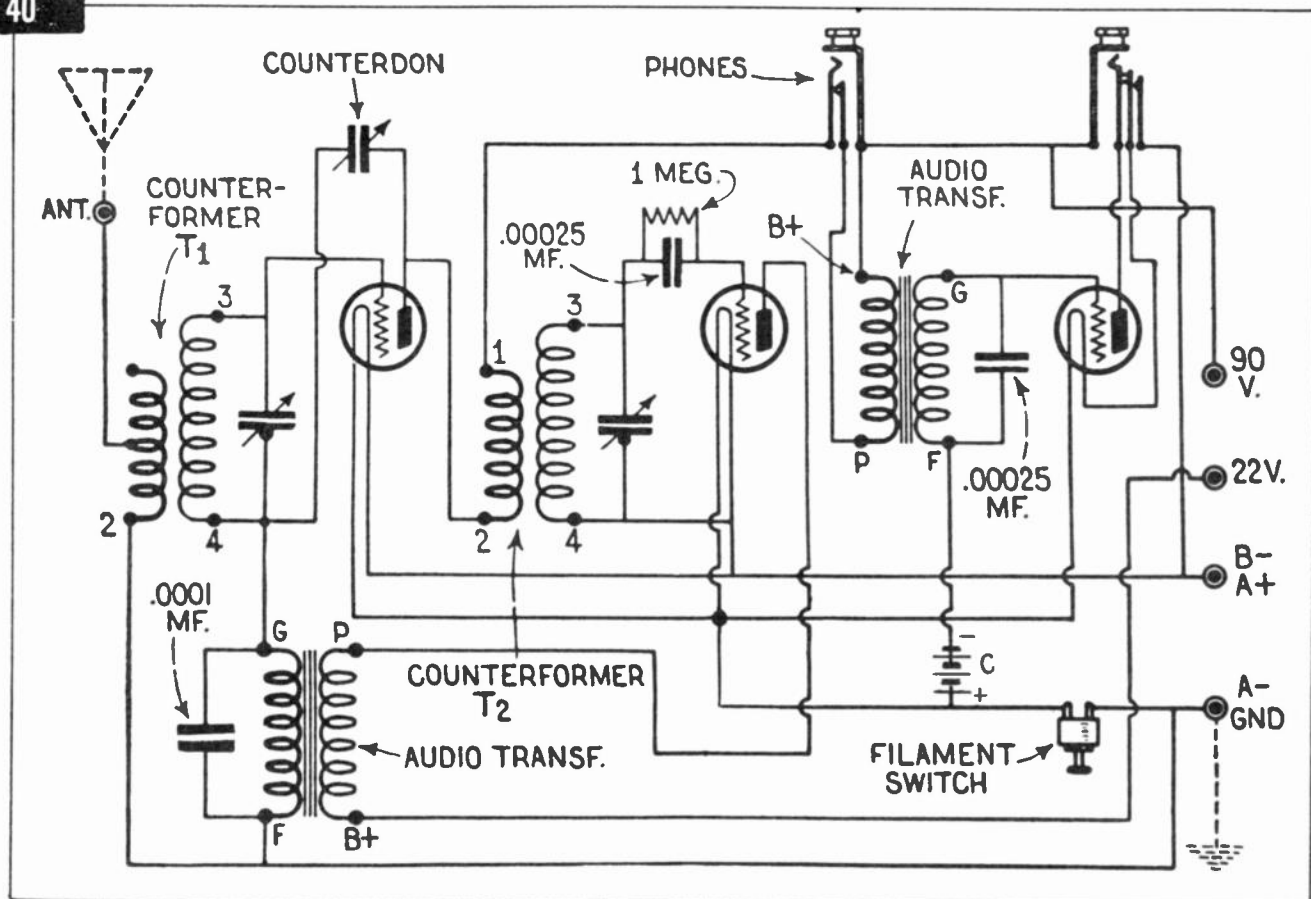


39



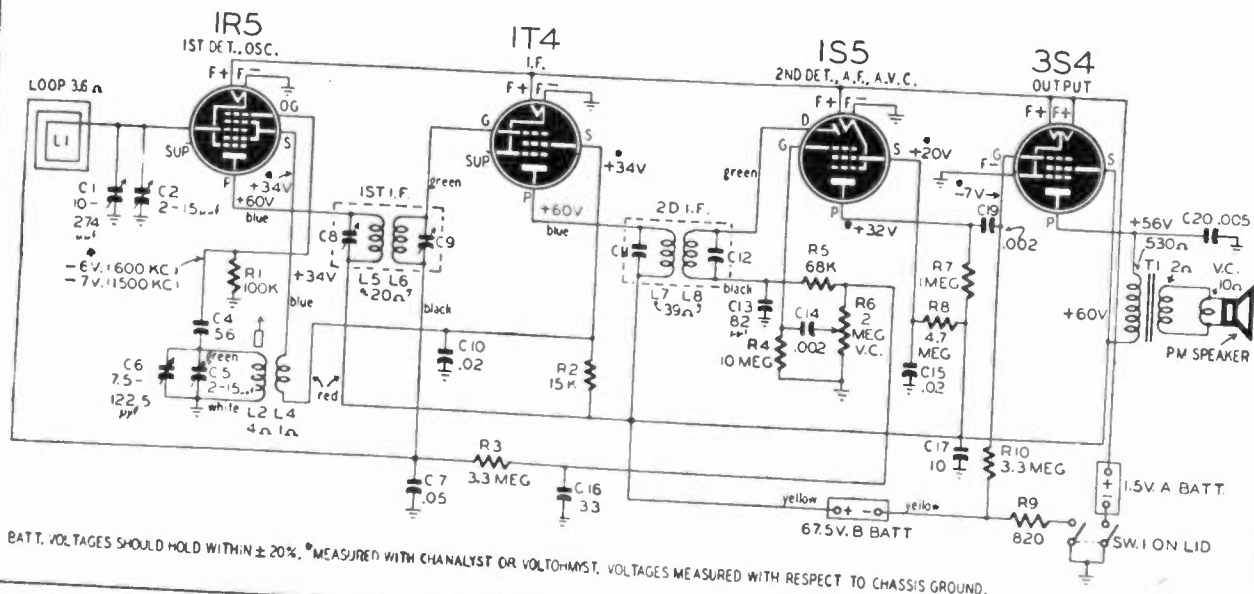
39. A 4-tube reflex superheterodyne with only three tubes, this English circuit is more sensitive than the standard 3-tube super. The signal is first converted to the intermediate frequency by the 6K8 converter, amplified at the i.f. by the pentode section of the 6B8, and detected by its diode section. A.v.c. is obtained from the other diode. The audio signal across the volume control is then applied to the grid of the pentode section and amplified again at audio frequency. Further audio amplification is provided by the 6F6 output tube. Standard commercial coil assemblies may be used, or the coils may be wound from the constants given in the table. Any well filtered power pack may be used. A good, high antenna is essential for dx reception with any of the smaller radio receivers.

40



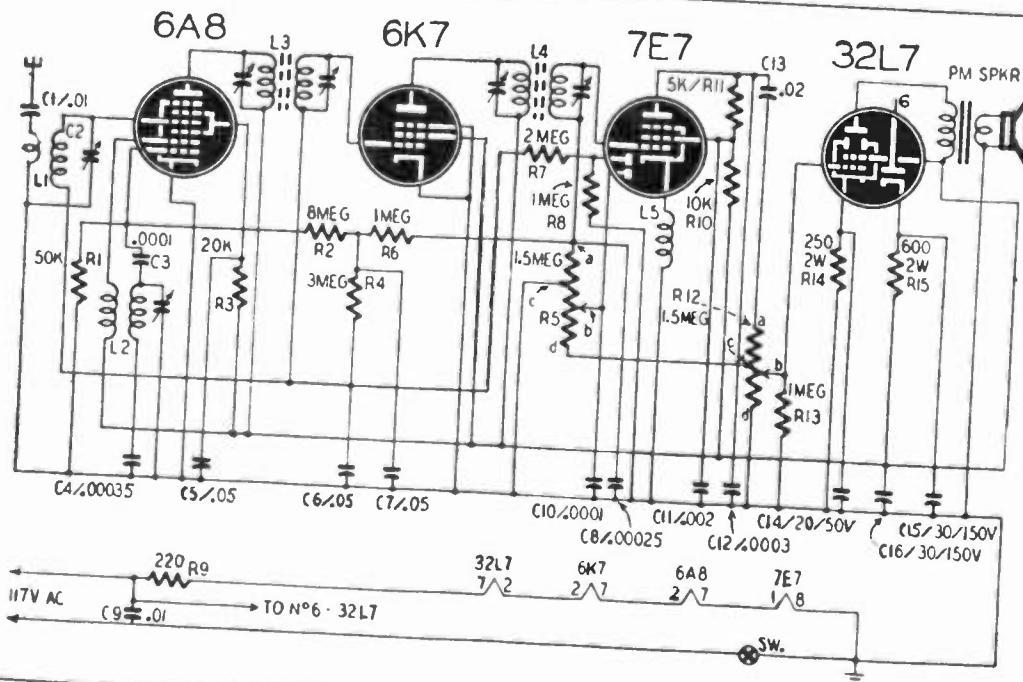
40. The Harkness Counterflex, one of the most famous reflex receivers. Tubes recommended for use in this circuit are 1G4's or 1LE3's. The two Counterformers are wound on 2 5/8-inch forms. The secondary of T1 is 65 turns of No. 28 s.s.c. enamel. Its primary is wound on top of the secondary at the ground end, with 15 turns tapped at the 10th turn. T2 has a 60-turn secondary and a 30-turn primary. The Counterdon is a midget variable with a maximum value of 30 or 40 μf. Variable capacitors are 365-μf single-gang units. Standard audio transformers are used.

43



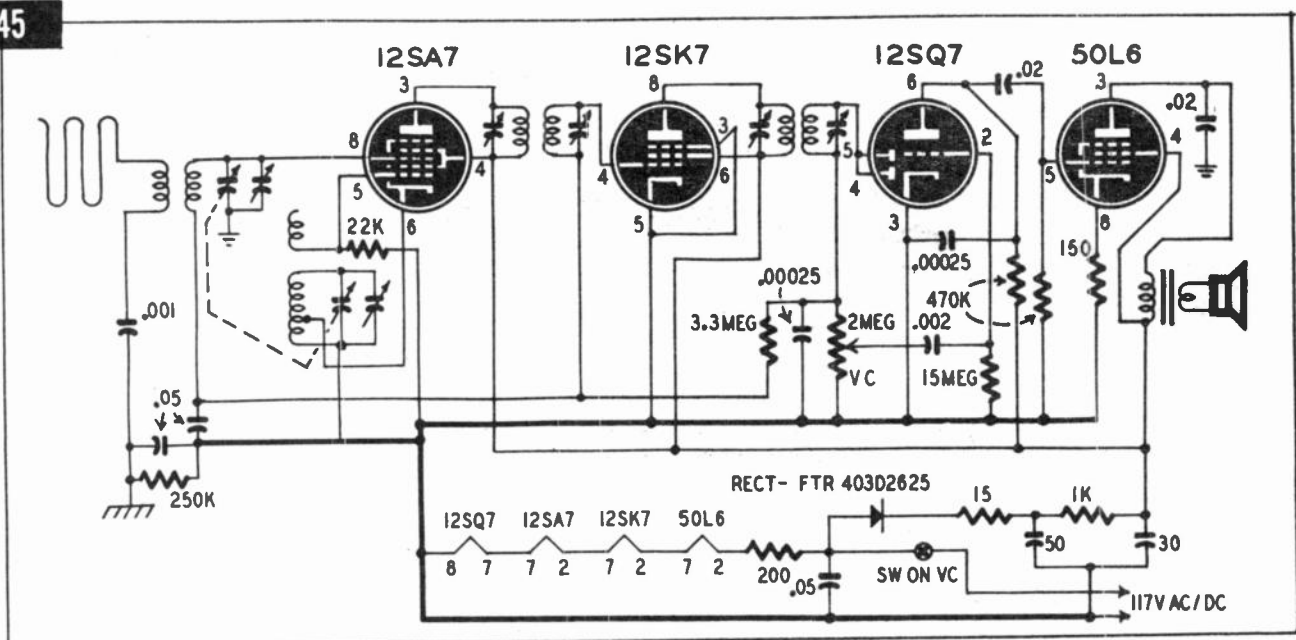
43. The RCA Victor 54B1 etc., one of the standard camera-type portables. A very simple and straightforward little superheterodyne, it is an excellent model for portable-radio builders to use as a basis for their designs. Components of the 54B series were specially-built midget types. The i.f. is the standard 455 kc. This circuit is a good guide for the constructor of any portable receiver, whether it be of the miniature camera or the standard portable type.

44



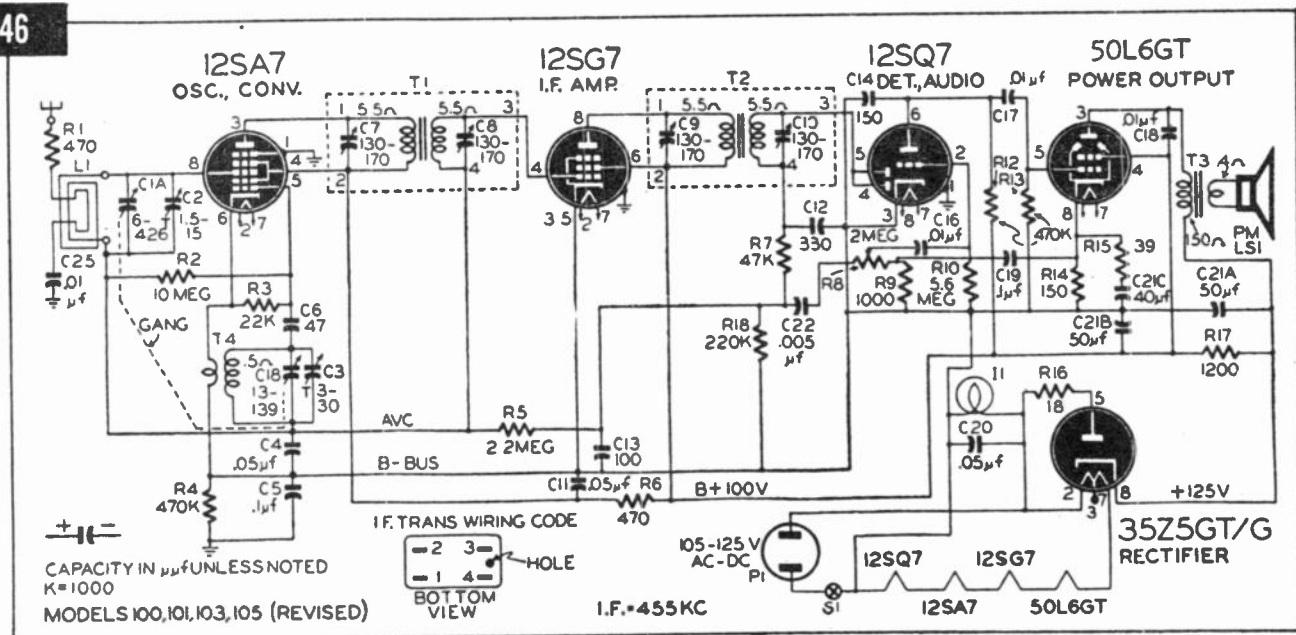
44. The Connatser reflexed 4-tuber. The unorthodox detector circuit is explained by the choke in the cathode of the 7E7, which causes its voltage to ground to vary with the signal, while that of the diodes remains essentially constant. The reflex circuit may be cut in and out at will with R5. With *b* on R5 between *a* and *c*, the circuit is a reflex—between *c* and *d*, a straight circuit. For reflex, set *b* on R12 toward *a*, for straight-through operation, toward *c*. The hookup is a development of the simpler 3-tube reflex of Circuit 35, though it operates on a different principle.

45



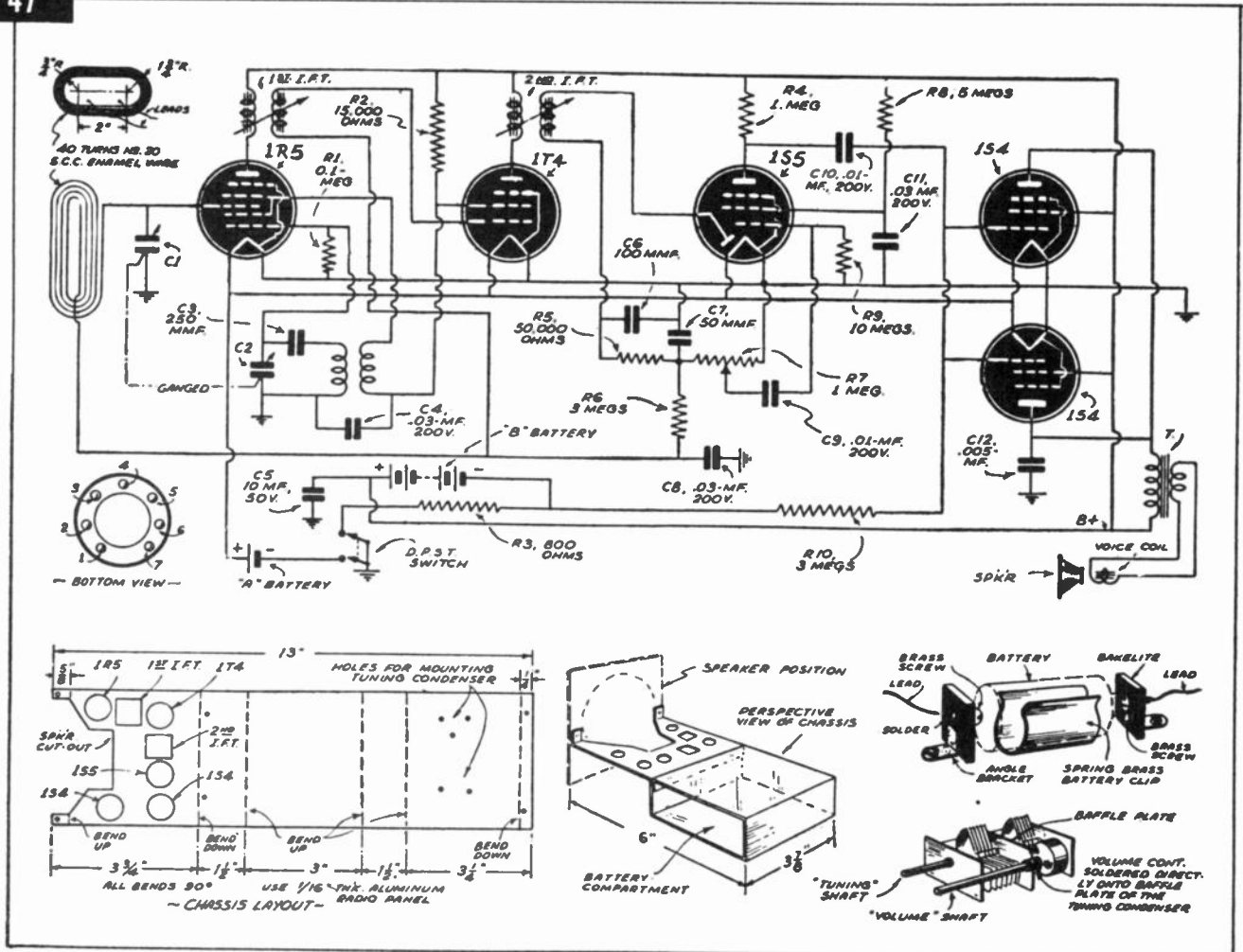
45. A modern commercial superheterodyne with a selenium rectifier and resistance-capacity filter. The 15-ohm resistor before the first filter capacitor prevents heavy surges from damaging it. In some receivers, the plate lead of the output tube is taken off before the 1,000-ohm filter resistor, which then may be increased to 3,000 ohms or more, improving filtering in the rest of the receiver. The oscillator grid condenser is simply a few turns of wire wound over the grid end of the oscillator coil. The arrangement looks strange, but is a standard circuit, as may be seen by substituting a grid condenser on the schematic. If high-quality parts are used, this is an excellent receiver.

46



46. Receivers of this type, in the past commonly called 5-tubers, now must be described as "4-tube and rectifier." The reasoning is logical, as otherwise the set might be considered by the non-technical to be a larger and more powerful radio than the 4-tuber above. This design is much the same, though a few differences show themselves immediately. In this set (the G-E Model 100) the oscillator coil has two windings, the tickler coil being in the cathode circuit. The audio circuit also shows some differences. In many or most small sets of this type the diode return is through a small filter resistor (usually about 47,000 ohms and bypassed by two small capacitors) through the volume control to ground. In this set, the volume control is isolated from the diode circuit and has a 1,000-ohm resistor between it and ground. A capacitor from the 50L6 cathode feeds back audio energy to the junction of the two resistors, supplying a certain amount of negative feedback. The diodes are returned to ground through a 220,000-ohm resistor.

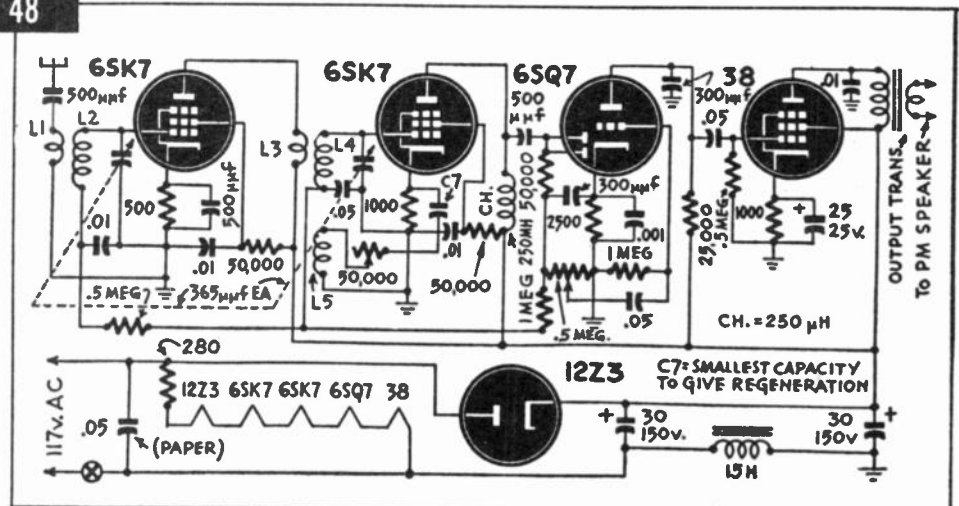
47



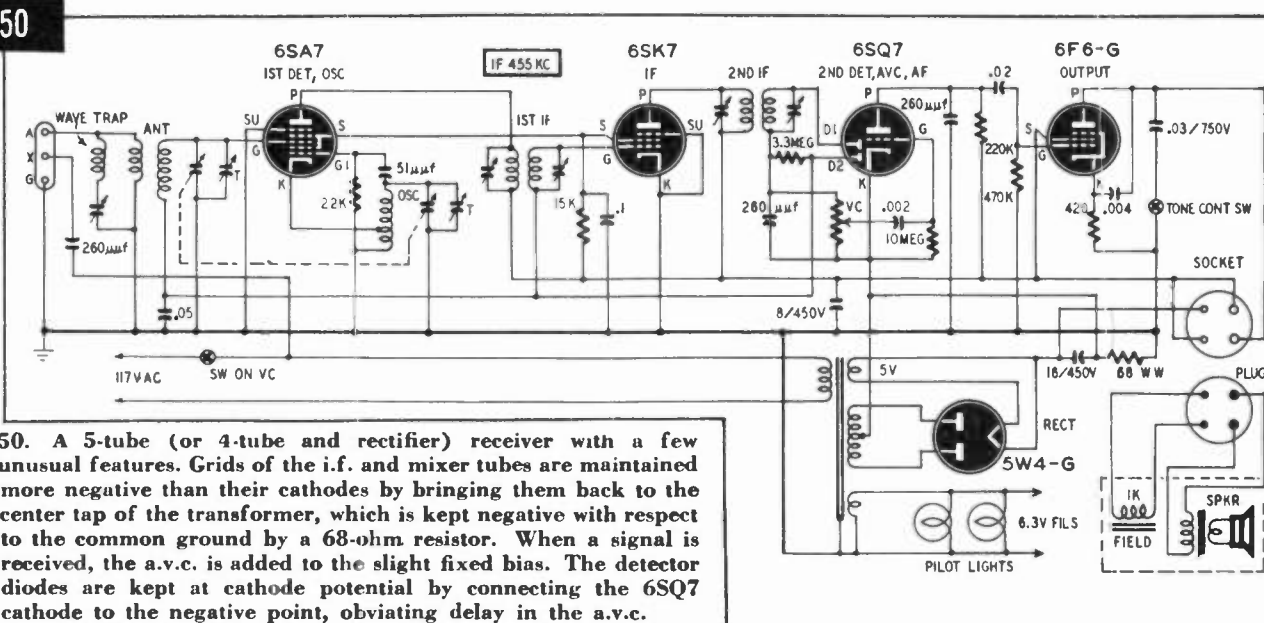
47. The Miniport is a very-small-space superheterodyne. In spite of its compactness, it has considerable power, employing two 1S4's in the output stage. (A suitable out-put transformer is required; the original receiver used an Oxford-Tartak U21). Dimensions of the chassis and details of the loop, as well as mechanical data on the battery holder and controls, is given to aid the constructor. The set can be kept down to 4 x 6 inches and 3 3/4 pounds.

48. This 5-tube t.r.f. with regeneration should be a good distance-getter. Vary C7, using the smallest capacity that permits oscillation over the whole dial. Coils L1 to L4 may be standard t.r.f. type radio-frequency transformers, and L5 may be wound on the end of one of the forms with 15-20 turns of No. 28 or smaller wire (for the broadcast band). Standard shortwave coils will permit reception on international bands. The 38 and 12Z3 tubes may be replaced with the more modern and easily obtainable 25A6 and 25Z6. The 25A6 cathode resistor would then be 270 ohms and the linecord resistor between 160 and 180 ohms.

48



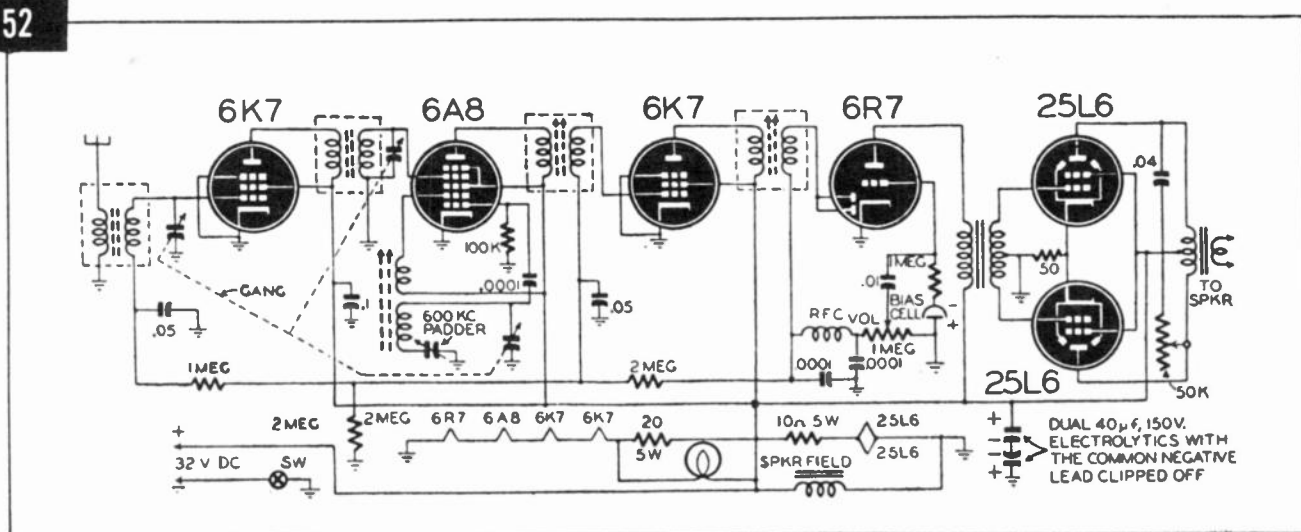
50



101 RADIO-ELECTRONICS CIRCUITS

[illegible]

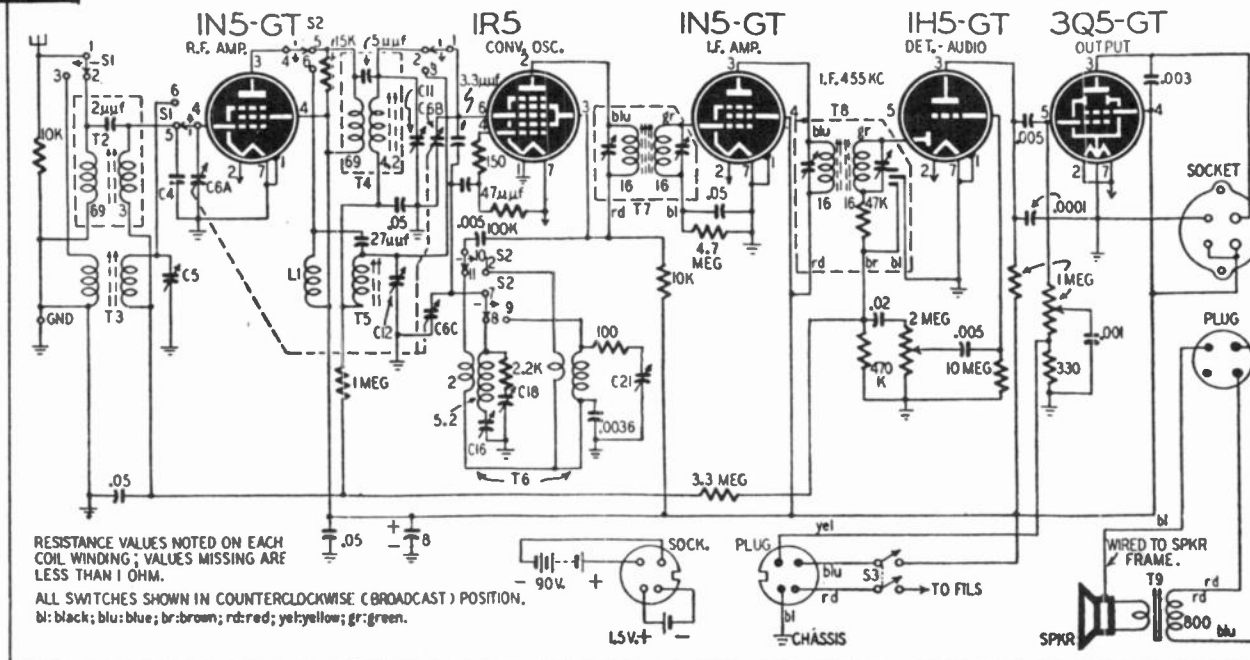
52



101 RADIO-ELECTRONICS CIRCUITS

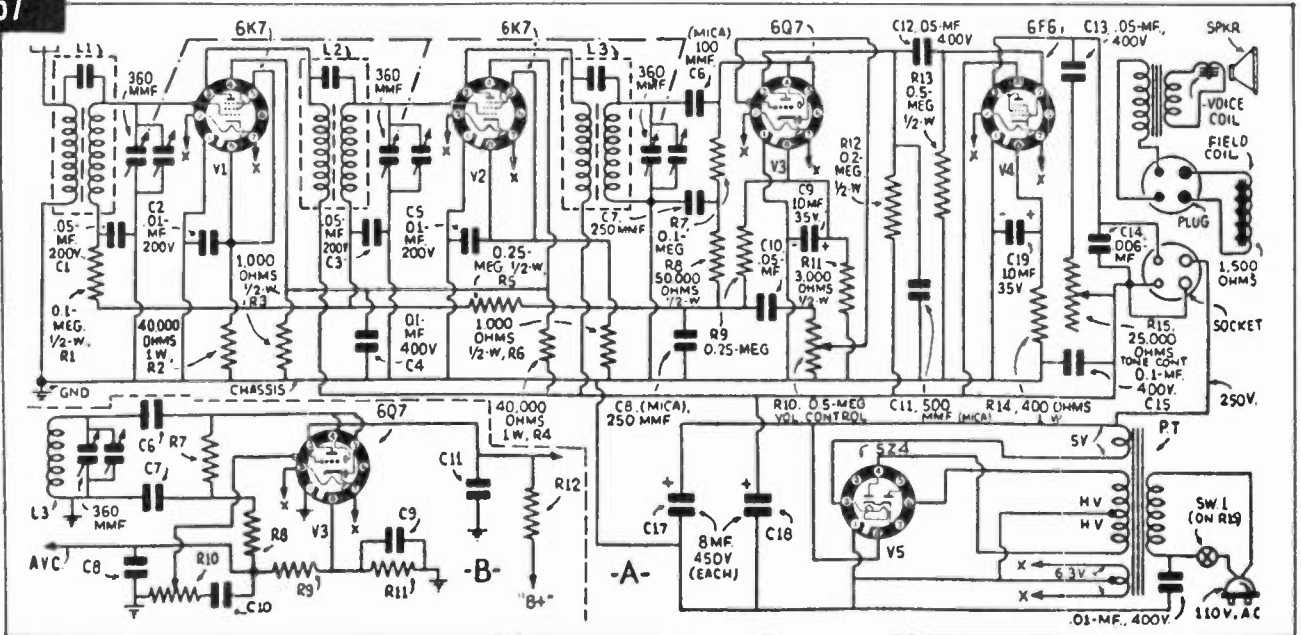
[illegible]

54



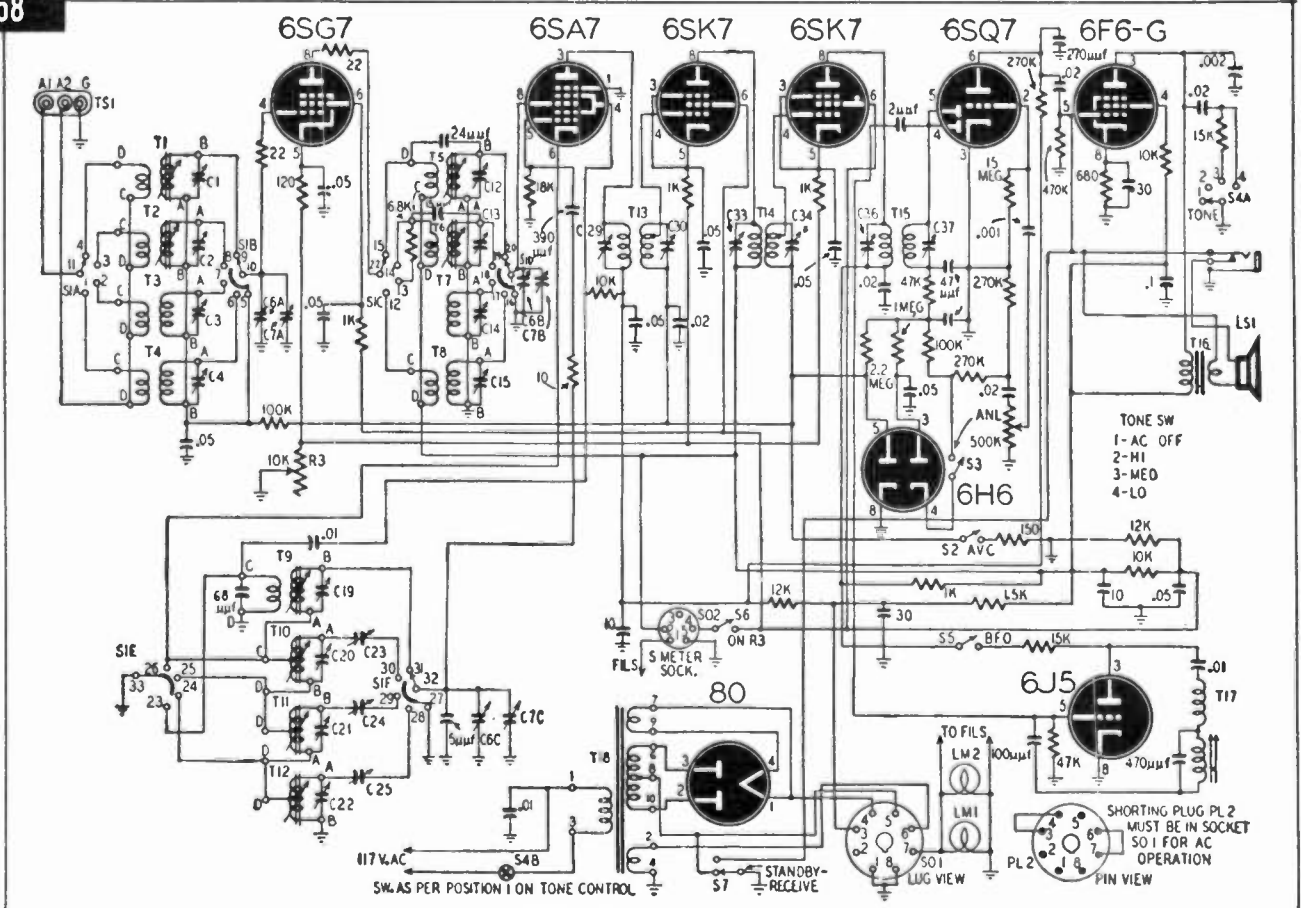
101 RADIO-ELECTRONICS CIRCUITS

57



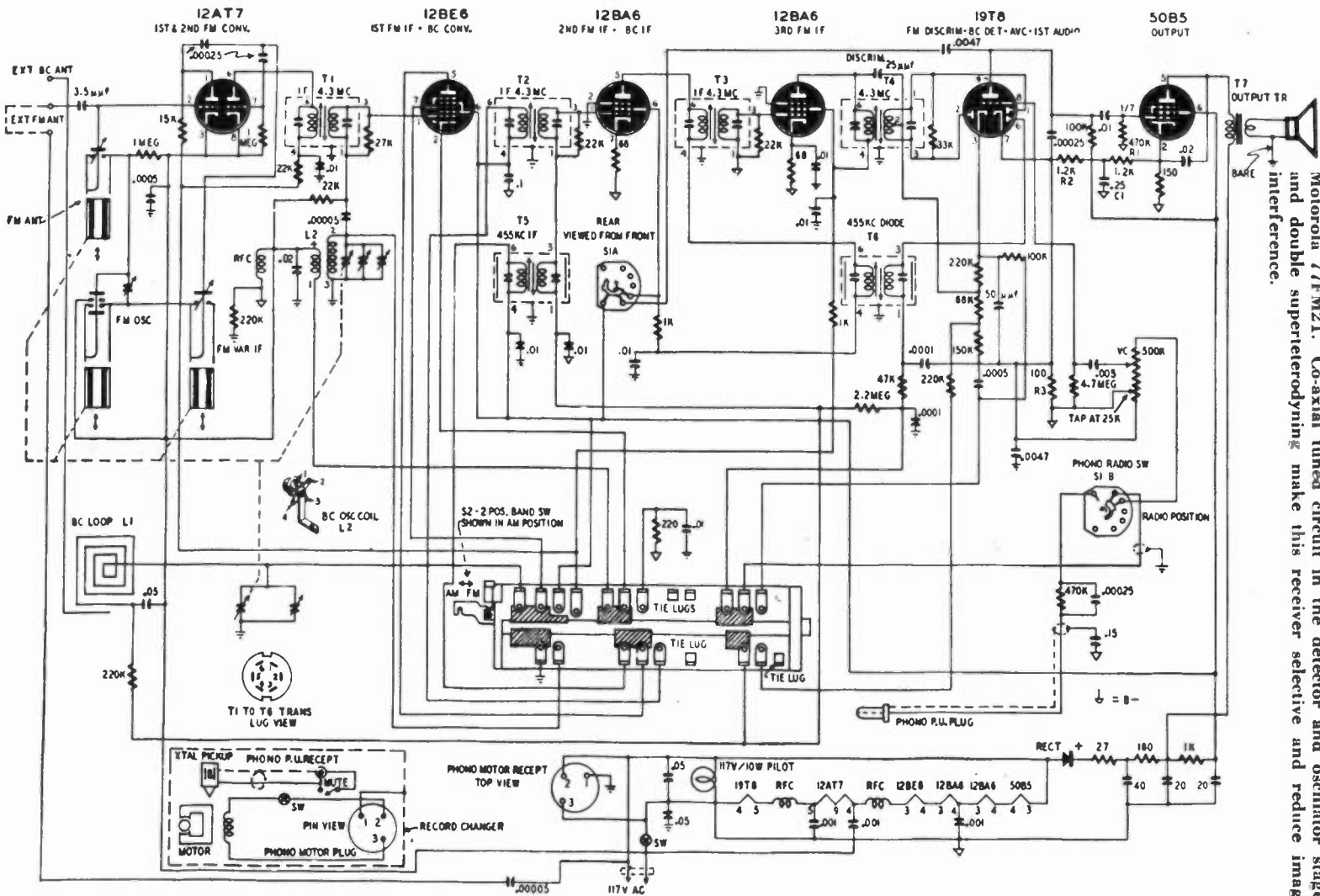
57. The Denton t.r.f., which uses a simple method of applying a.v.c. to a tuned radio frequency circuit. The a.v.c. system is detailed in the lower left-hand corner. This receiver combines sensitivity and selectivity in a t.r.f.

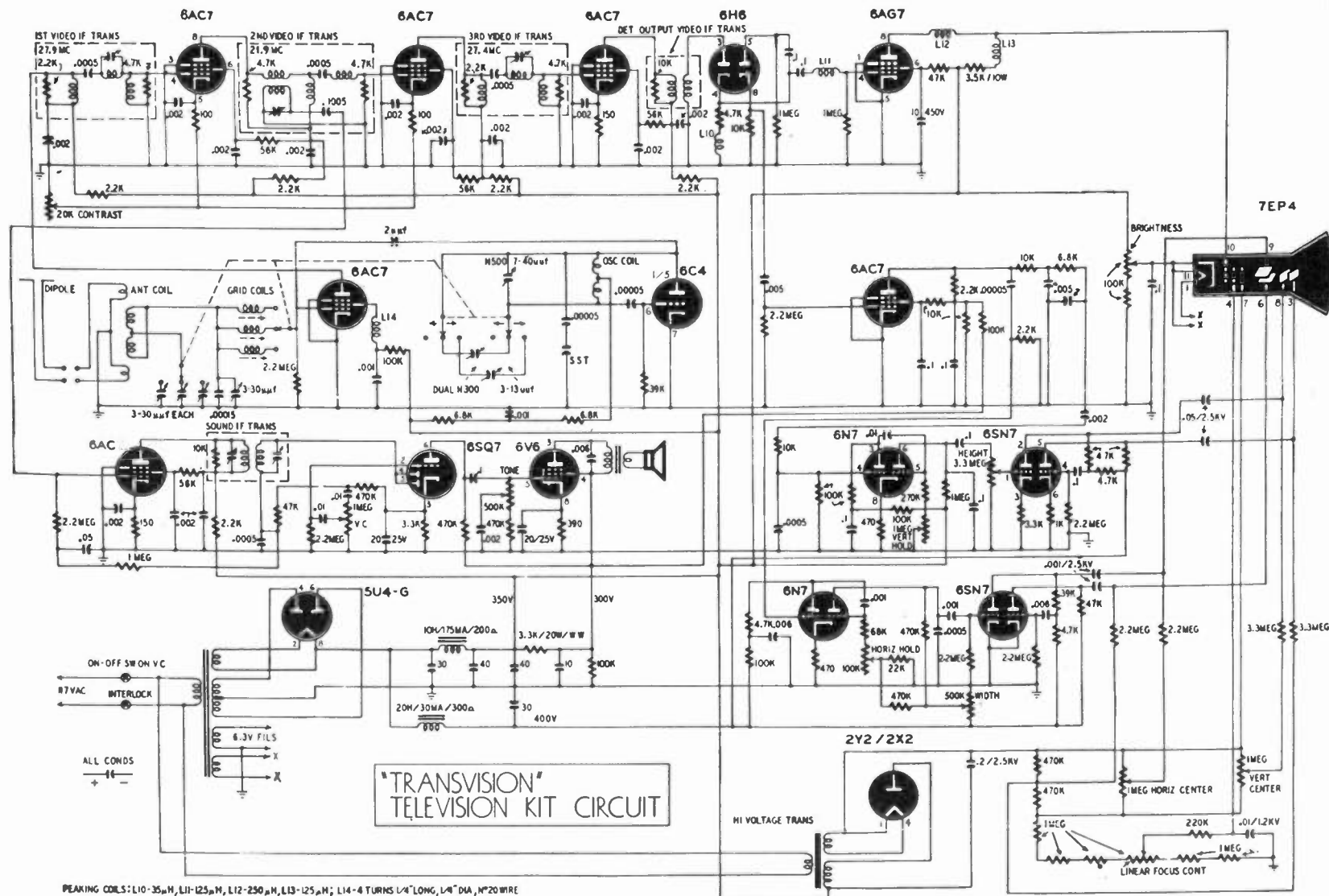
58



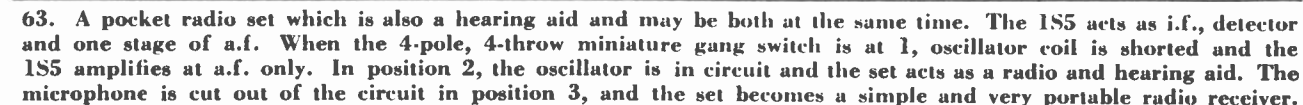
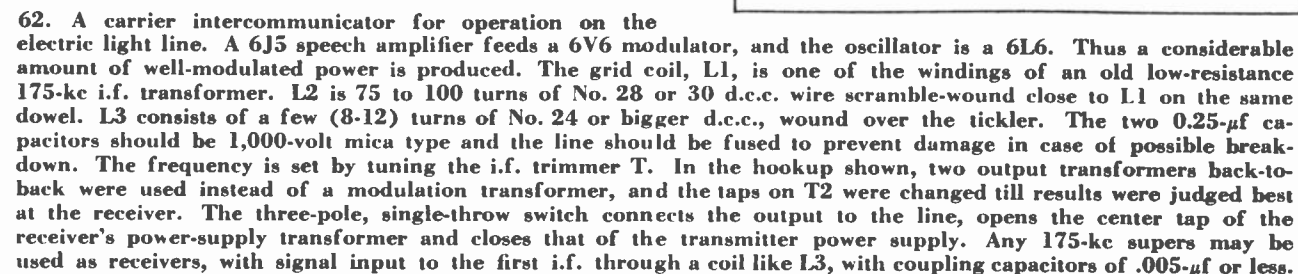
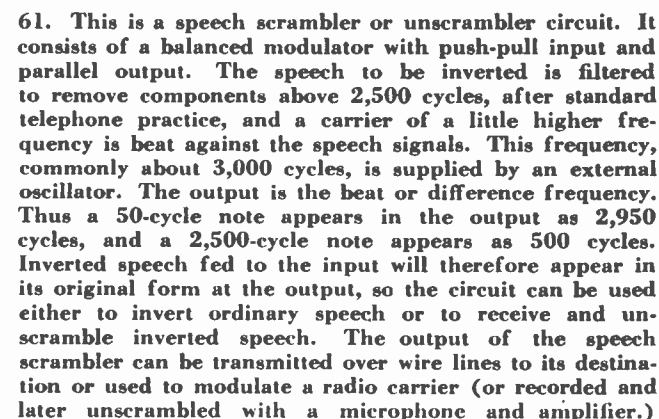
58. A modern communications receiver, the Hallicrafters S-40 ranges from 540 kc to 43 mc. Some tubes have special functions. Half the 6H6 is a gas gate and the other a noise limiter. The 6J5 is a beat-frequency oscillator.

59. An a.c.-d.c. FM-AM radio receiver and phonograph combination, the Motorola 77FM21. Co-axial tuned circuit in the detector and oscillator stages and double superheterodyning make this receiver selective and reduce image interference.

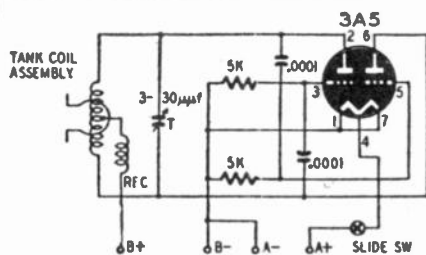




60. This early Transvision model is one of the simpler television circuits. It lacks features of later circuits, but is one of the easiest for the student.

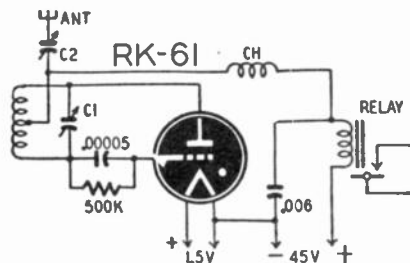


64



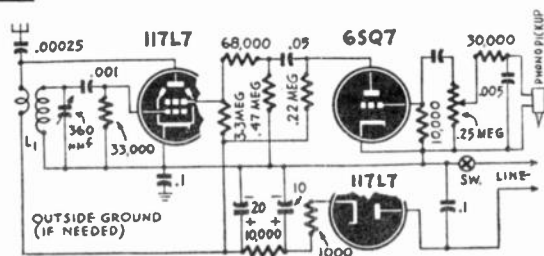
64. A high-frequency transmitter for low-power control purposes. Used with the receiver of Circuit 67, it gave excellent results over a distance of several yards. The 3A5 is used as a push-pull oscillator feeding a tank which consists of eight turns of bare copper wire, spaced to one inch, and a small 3-30- μ F trimmer capacitor. The coil diameter (inside) is five-eighths inch. A piece of stiff wire about two feet long with a half turn or hairpin loop in the center, is the antenna. It may be clipped off at the ends till the strongest signal is obtained. A pair of small dry cells furnish filament current, while the B-battery may be two of the small 45-volt units.

67



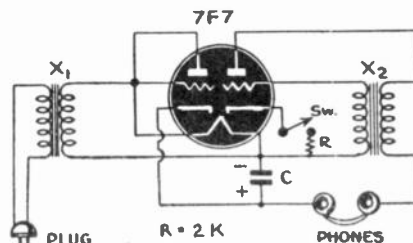
67. A receiver for the transmitter of Circuit 64; a superregenerator with an RK-61 subminiature thyratron. Coil is 14 turns of No. 14 tinned copper wire, one-half inch inside diameter and spaced to 1½ inches. Antenna is two feet of copper wire. C1 and C2 are 3-30- μ F ceramic trimmer capacitors, and choke coil CH is 35 turns of No. 32 enamelled wire closewound on a polystyrene rod. The relay is of a type that pulls down at about 2 ma. and lets go at 1 ma. Antenna trimmer is adjusted so that with transmitter off the plate current is about 2 ma. and with transmitter on, 1 ma. The relay's hair-spring is then adjusted to close on no signal and release on signal.

65



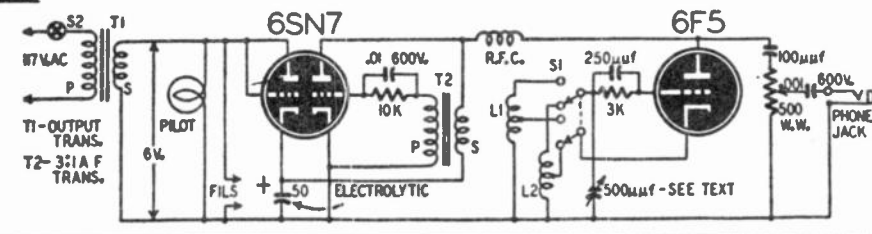
65. A phono oscillator with considerable gain, suitable for use with many magnetic pickups and high-sensitivity microphones as well as crystal pickups. The 6SQ7 speech amplifier screen-modulates the 117L7 oscillator. A volume control cuts down excessive input signal, reducing oscillator loading and distortion. The input resistor-capacitor network will vary with the pickup. L1 may be a standard replacement broadcast oscillator coil, and the antenna not more than two or three feet of wire, to avoid causing any illegal interference.

68



68. A simple and excellent code oscillator which can be built from a minimum of parts. X1 is a filament transformer (or old output transformer whose secondary will supply 5-8 volts with the primary connected across the 117-volt line). X2 can be an old audio transformer (any ratio). A small replacement type will give best results. The key is placed at the point marked SW. A 25- μ F, 25-volt electrolytic capacitor and a 7F7 (or any similar tube) completes the oscillator. If the oscillator fails to work, try reversing one winding of the audio transformer, X2.

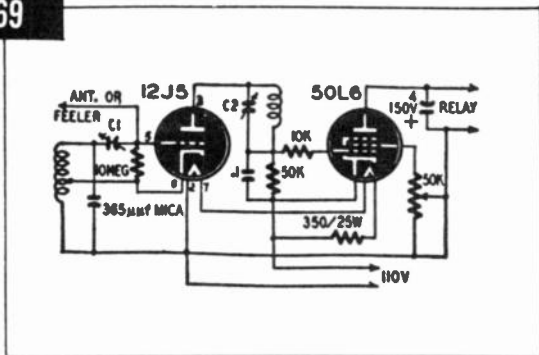
66



can be used for broadcast and i.f. bands. The two coils are wound on 1½-inch coil forms, one with 150 turns of No. 30 and the other with 90 turns of No. 28 enameled wire, and tapped one-third the way from the ground end. To use as a good code oscillator, simply plug a short piece of wire into the phone jack. A key may be inserted to break the cathode circuit of the 6SN7 audio oscillator section or in the negative supply lead to the 6F5. The variable capacitor is a 2-gang midget with both sections tied together. The equipment can also be used as a straight code oscillator by inserting a pair of headphones by-passed with a .005 capacitor in the lead between S and the plus sign.

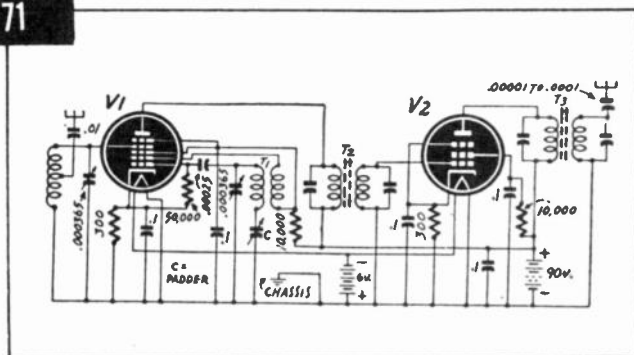
66. An interesting combination unit which can be used as a code oscillator which transmits to a nearby radio, or as a signal generator. For use as a signal generator, output is taken from the phone jack as shown. A double-pole, double-throw switch permits changing from one of the two Hartley oscillator coils to the other. Thus the generator

69



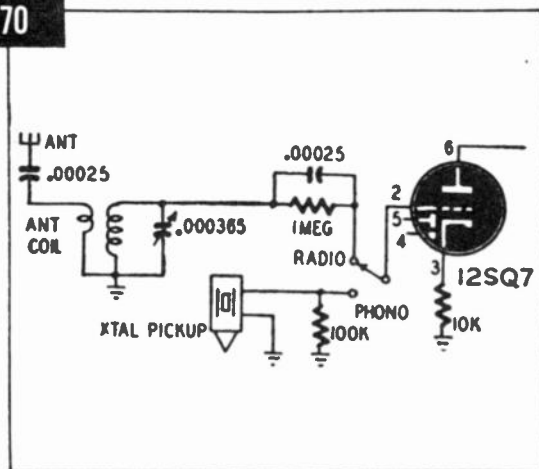
69. A capacity-operated relay or intruder alarm. Coils are standard broadcast oscillator (6SA7 type) and secondary of an antenna coil. Tune to about 550 kc with large-capacity trimmers across the 365- μ f mica capacitor, and with C2 (mica fixed and trimmer capacitors to about 650- μ f). The "feeler" or antenna is a long wire strung around doors, windows or other points to be guarded. Keep it well away from grounded objects. Relay should be designed to close at 3 ma. and open at 1. To adjust, resonate plate circuit with C2. Plate current should dip sharply. With C1 (a large broadcast variable) at full capacity, adjust the relay till it just fails to "make". Then decrease C1 till relay is actuated. Approach to the "feeler" detunes the circuit, causing plate current to rise, cutting off the 50L6 and releasing the relay. Check and readjust if necessary.

71



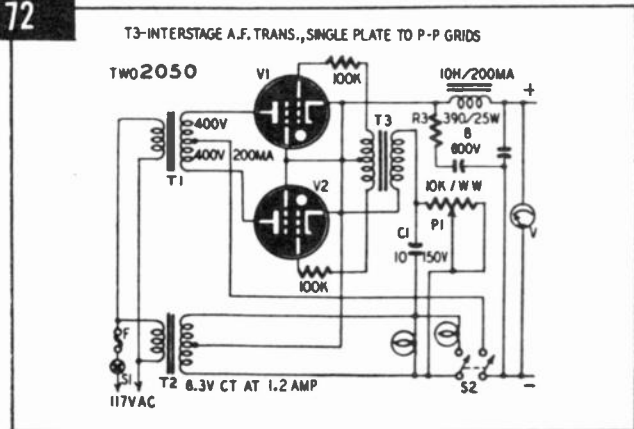
71. Remote control for radio receiver. Stations are tuned in the usual manner by the remote unit, which produces an i.f. which should be set at some quiet spot between 550 and 600 kc. The front end of a midget broadcast receiver may be used for the unit, though it may be necessary to replace the i.f. transformers or remove turns from them. Tubes may be any convenient pentagrid converter and supercontrol r.f. amplifier (6A7 and 6K7 for example). Antenna coil and T1 are ordinary antenna and oscillator broadcast coils, with turns removed if necessary to produce an i.f. between 550 and 600 kc. T2 and T3 are intermediate-frequency transformers of the type tunable to 600 kc (see manufacturers' catalogs). The antenna coil may be replaced by a loop. Tune the radio to the remote's output frequency and do all further tuning with the remote unit.

70



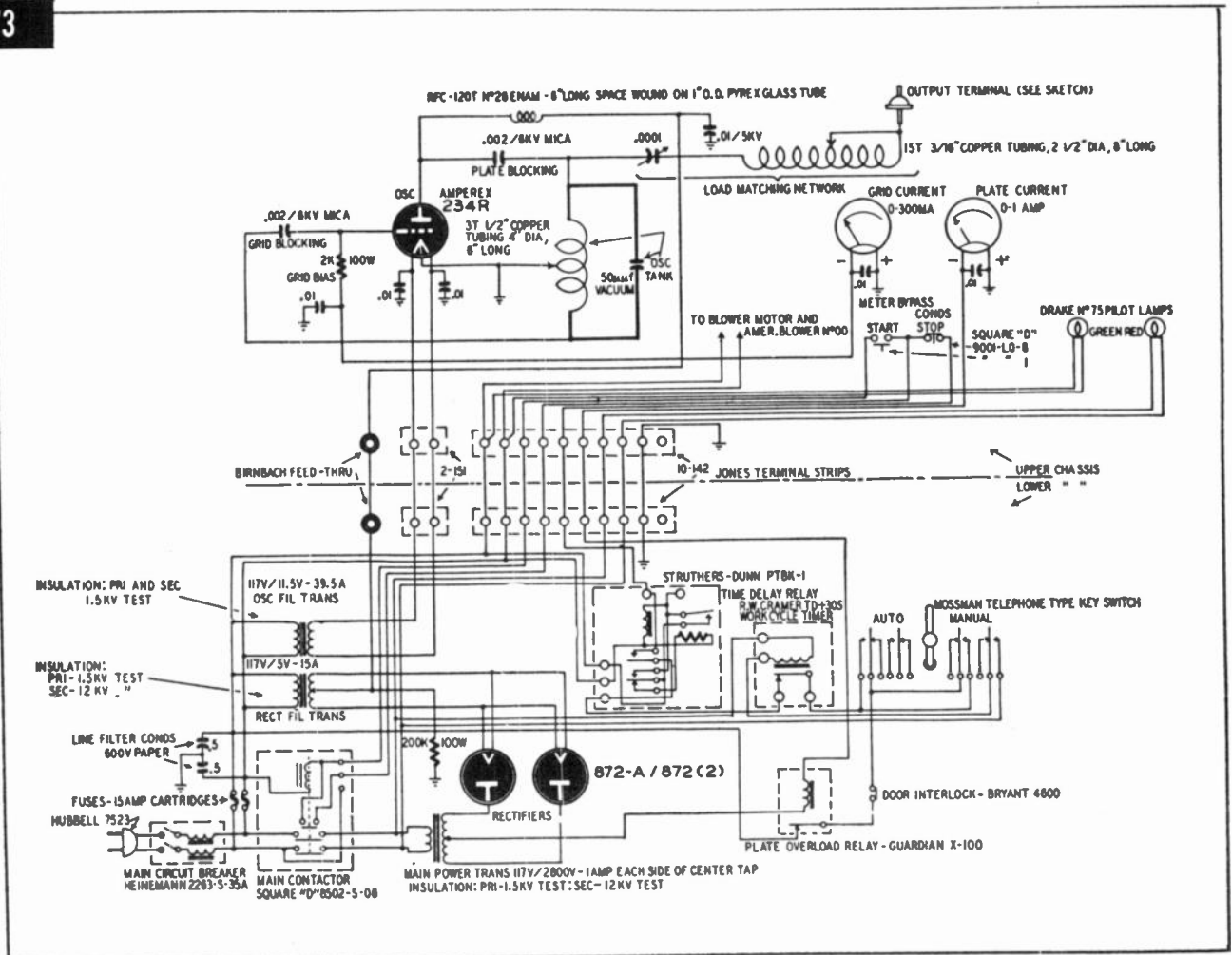
70. Radio tuner for phonograph amplifier. The equipment represented by the 12SQ7 may be the input of any amplifier. A standard broadcast antenna coil with a 365- μ f variable capacitor is the tuner. The 1-megohm resistor and the 250- μ f capacitor cause the tube to detect the radio signals. A single-pole double-throw switch inputs radio or phonograph as desired. This circuit is very non-selective, but in areas where one station can be received without interference, the quality may be better than with an expensive superheterodyne. Where a number of strong stations are broadcasting on neighboring frequencies this tuner will not be satisfactory. In such cases one of the best tuners for a public address system is the r.f. and detector section of a midget superheterodyne. Better quality with less selectivity can be obtained from a t.r.f. receiver.

72



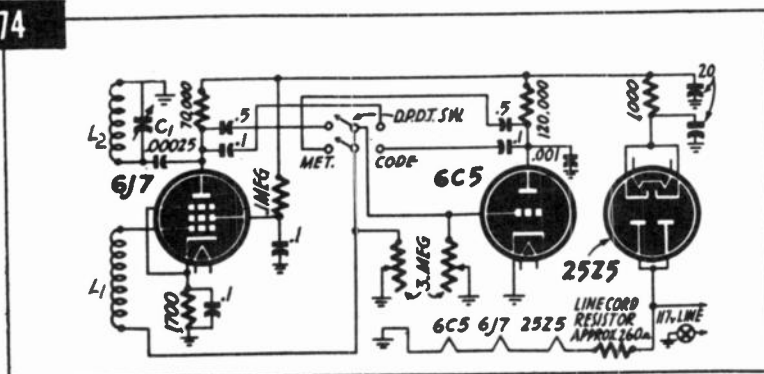
72. A variable voltage supply using thyratrons, which can be regulated smoothly from zero voltage to full output. Since the thyatron operates by so biasing the grid that plate current can be made to flow through all, part, or none of the a.c. cycle, output can be controlled without dissipating unwanted power through resistors. P1 and C1 are the phase control elements, which set the percentage of the cycle during which the tubes rectify, and output voltage is set with P1. Filaments are so connected that they are turned on by S1. After about a minute, high voltage is applied with S2. Pilots indicate when filaments are lit, and when power is on. The filter is of the condenser-input type, with a 400-ohm resistor (R3) to limit current through the input capacitor, preventing possible damage from initial surges. This is an extremely useful circuit for the experimenter or research worker who may require a power pack with a wide variation of output voltage.

73



73. An experimental 1-kilowatt radio-frequency dielectric heater or diathermy unit. While a low-power unit for most r.f. heating jobs, it has a wide range of application for small work. It is usable only for heating non-conductors or imperfect conductors—the induction heater must be used for metals. For diathermy a less powerful unit could be constructed along the lines of this one but with lower plate voltages and possibly a lower-power tube. Many of the units shown here are specialized, so the trade names of them are given.

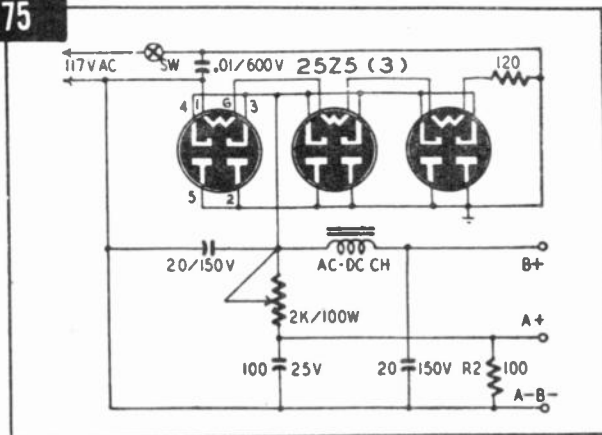
74



74. An electronic metronome, which can also be used as a code oscillator. It operates and is adjusted like a wireless phonograph oscillator. L1, L2, are a low-impedance broadcast antenna coil, L2 being the secondary. It is tuned with a 365- μ f variable capacitor, or a couple of mica trimmers in parallel. Beats from as low as 20 per minute to above the audio range are obtainable in one of the two switch positions.

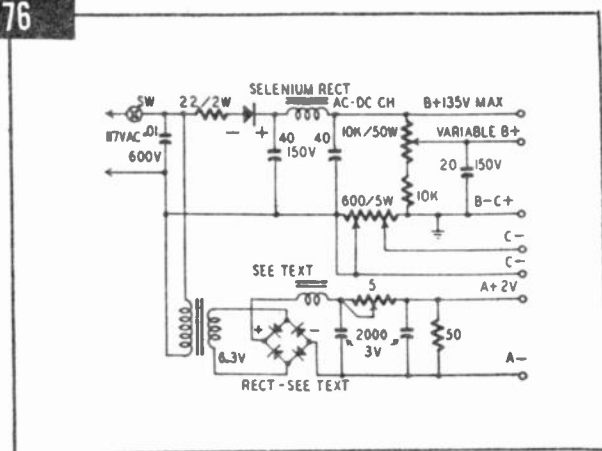
Other units, like the transformers, will in most cases have to be specially wound for the job. Full specifications of voltage, current and insulation have been given for these on the diagram, as well as information on the r.f. coils, which can be wound by the constructor. The output terminal is connected to the "hot" electrode which is placed on the object to be heated. The other electrode is below the object, and is grounded firmly to the heater ground. Power is applied and the tuning capacitor rotated till the plate meter reads about 0.6 ampere, which is full power. If it is impossible to reach a point near 0.6 ampere the match to the load is probably poor. Move the tap on the load-matching coil to another point and retune. As a first approximation, the tap can be placed on the middle turn, then varied a turn each way to find the correct load. This equipment is a good lesson in industrial safety practices. Do not omit any of the interlocks or circuit breakers indicated—they can save your life.

75



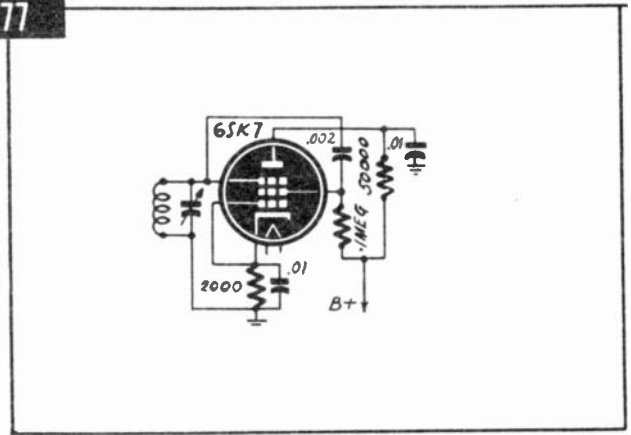
75. A universal power pack for portable receivers. Designed for the service bench rather than the individual set owner, it can be adjusted for sets of widely different filament currents and voltages. Maximum filament current may be 0.45 ampere, more than enough for practically all portables. The filament voltage, as well as current, is adjusted with the 2-000-ohm, 100-watt adjustable resistor. Dry-cell filaments burn out easily—place a voltmeter across the A terminals and set the resistor to full resistance. Then adjust it carefully till the voltage rises to the correct value. B-voltages are less critical and may be varied within limits by changing the input capacitor's size or inserting a resistor in the B-plus line.

76



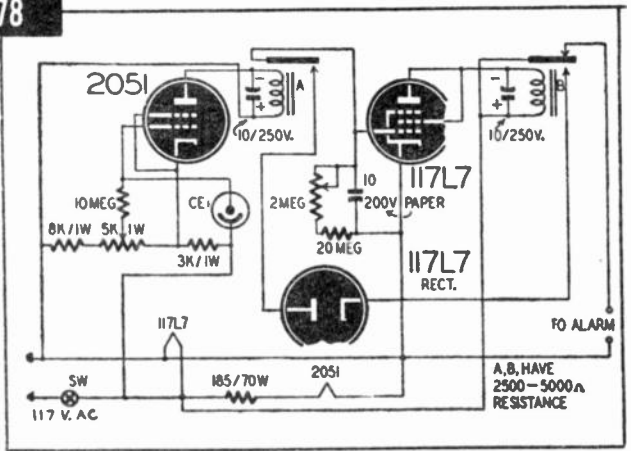
76. This power pack for portables is suitable for construction for a single portable of known characteristics. It can be made more compact than the one just described, and when built with components suited to the radio, is equally efficient. The filament is powered with a small bridge-type rectifier. These can be purchased from large manufacturers of rectifiers to meet almost any required specifications. Catalogs give input and output voltages under given loads—all that is necessary is to calculate the load and select a rectifier. The transformer secondary should then deliver the voltage specified for the rectifier. The filament choke should have the lowest possible resistance. The primary of a large power transformer may be suitable, or the core of a large transformer wound full of No. 14 wire may be used. The 5-ohm resistor may be an old-time rheostat. The B-supply is conventional, but note the wattages of the fixed and adjustable bleeder resistors.

77



77. The Transitor oscillator circuit. Operating on a different principle from most oscillating circuits, it uses a single two-terminal coil. By varying the size of this coil and its tuning capacitor, it can be made to operate at frequencies above 100 mc to below audio. The circuit shown is applicable to the middle radio frequencies, and could be used as an i.f. signal generator, for example, with a coil and trimmer capacitor from an i.f. transformer. For use on audio frequencies the .01 and .002 capacitors may be much larger. In some transitor models, output is controlled by shunting a potentiometer of 100,000 ohms or more across the cathode resistor and connecting the control grid to its center arm through a 1-megohm isolating resistor.

78

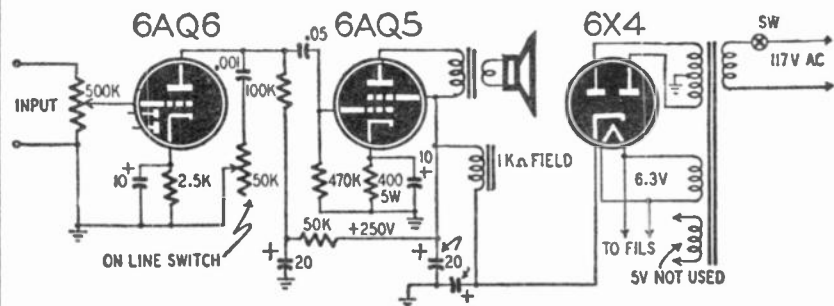


78. A photocell alarm which operates whenever a beam of light is broken. While light shines on the photo-tube the grid is practically shorted to the negative end of the bleeder, and the grid remains sufficiently negative to prevent the 2051 from firing. When the light beam is broken, the photo-tube becomes an open circuit and the grid goes positive with the next positive a.c. cycle. Plate current flows and relay A closes. Meanwhile the 117L7 has been operating with grid at cathode potential, drawing enough current to keep relay B closed. When A closes the circuit through the rectifier section of the 117L7, its grid is given a negative voltage. Plate current is cut off and relay B released, closing the alarm circuit. When the charge on the 10-μf capacitor leaks off relay B closes and the alarm stops. Time alarm rings is adjusted with the 2-megohm potentiometer. A light-actuated alarm results from interchanging CE₁ and the 10-megohm leak.



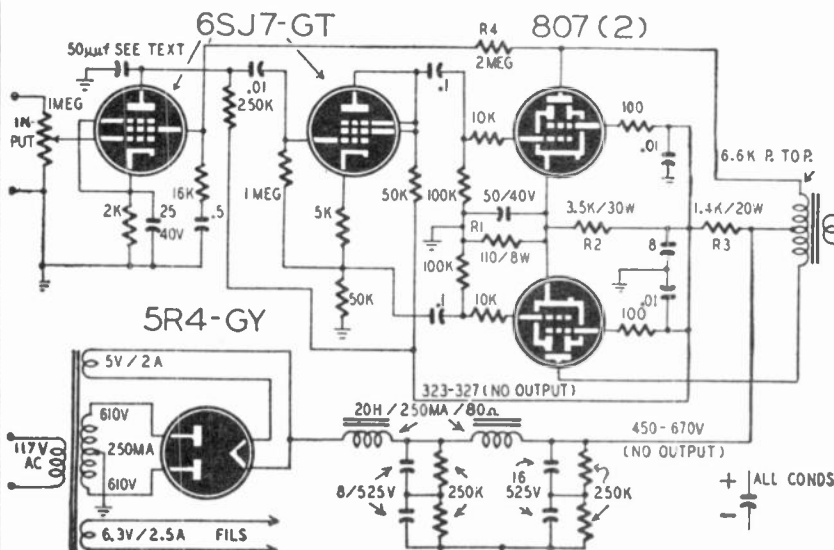
79. A 4-watt amplifier suited to applications where very compact equipment is required. The miniature tubes occupy very little space, and if a special transformer with no 5-volt filament winding is used, the size of that component can be reduced. The filter choke is the speaker field. A tone control is provided in the plate circuit of the input tube. If a more elaborate circuit were to be used, another tube would become necessary. The impedance of the output transformer primary may be in the order of 5,000 or 5,500 ohms.

79



80. A 30-45-watt amplifier, designed by the Australian associate of RCA. With the component values given, it is a 30-watt amplifier. With a plate transformer having an 850-850-volt secondary and an output transformer with a minimum rating of 45 watts (10,000 ohms plate-to-plate) it becomes a 45-watt job. R1 is changed to 134 ohms, 10 watts, R2 to 2750 ohms, 50 watts; R3 to 2950 ohms, 50 watts, and R4 to 3 megohms for the adaption to 45 watts.

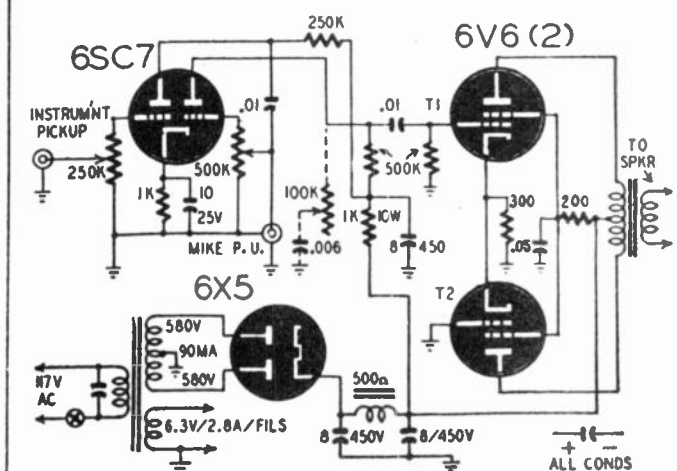
80



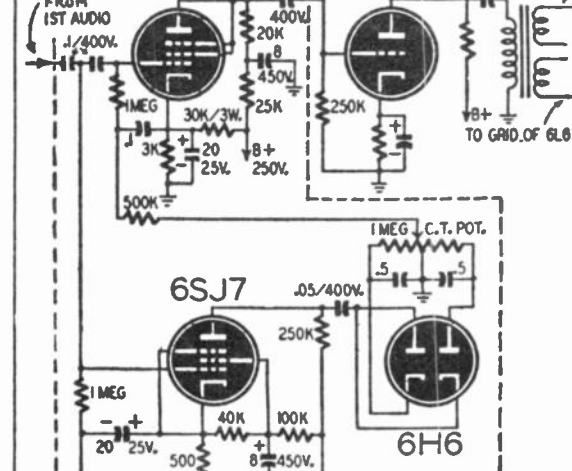
81. A small amplifier with considerable gain, used originally for a musical instrument. It could be made even more compact by using new miniature tubes (6AQ5 for 6V6, 6AX7 for 6SC7, etc).

82. This volume expander can be tapped in after the first audio stage of an amplifier and used for both expansion and compression, according to the position of the 1-megohm potentiometer arm with respect to the ground tap. Any type of output from the 6C5 may be used, so the unit can be inserted into practically any amplifier. This "expressor" can be made more flexible by substituting volume controls for the gridleaks of the 6SK7 and 6SJ7 tubes.

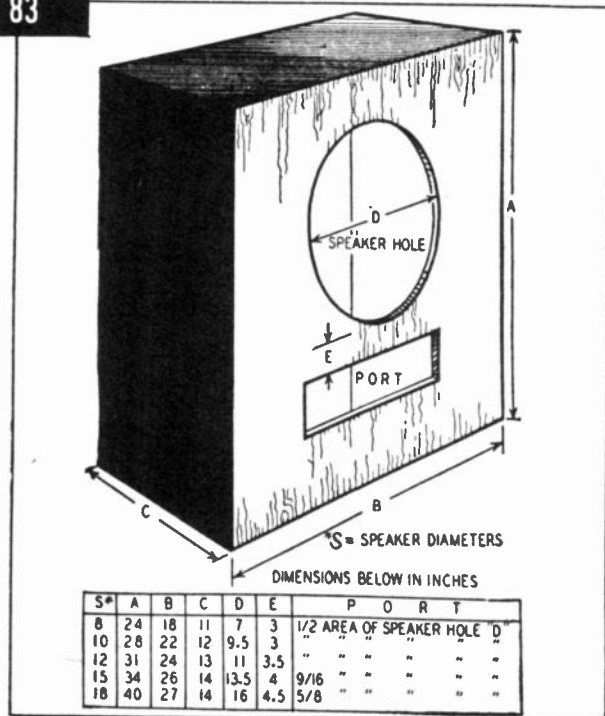
81



82



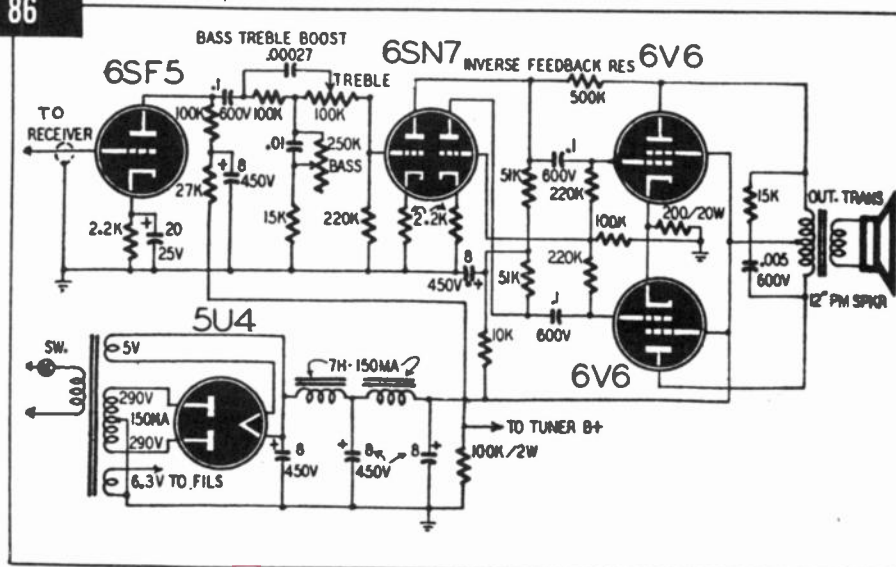
83



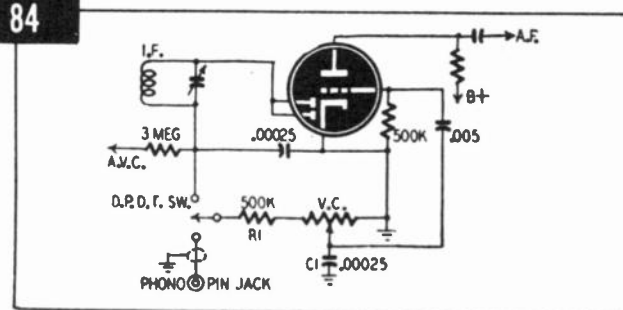
83. A reflex speaker enclosure. Dimensions are given for various speaker sizes. The enclosure is made of heavy wood or building board, with a solid back. If the box is made of light material it is likely to vibrate and add its own resonances to the program. With certain loudspeakers a larger or smaller port opening may produce better results on the lower frequencies. Check by sliding a piece of plyboard over the port to close more or less of it. If an audio oscillator is available check with several frequencies below 100 cycles and so adjust the port as to weaken over-strong and strengthen weak frequencies. If the enclosure is built of hard wood, it may be advisable to cover from one-third to one-half the inside with sound-absorbing material. Experiment with both quantity and position of the material.

86. This really high-class audio system is the Browning RJ-12 amplifier, designed for use with an AM-FM radio tuner. The circuit has bass and treble equalization and is therefore excellent for use with a phonograph record player as well as with a radio tuner. Following the equalizing circuit is a phase inverter of the self-balancing type, which neutralizes the effects of any difference in signal voltage to the two 6V6 grids. Negative feedback improves the quality of the reproduction. The power supply was designed to provide power to the tuner as well, but if built as shown will have a surplus of power, which makes for better fidelity. The filter has two sections and a bleeder, improving regulation and smoothness of the d.c. for the amplifier.

86

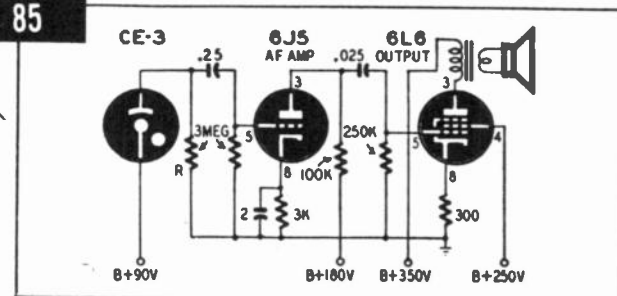


84



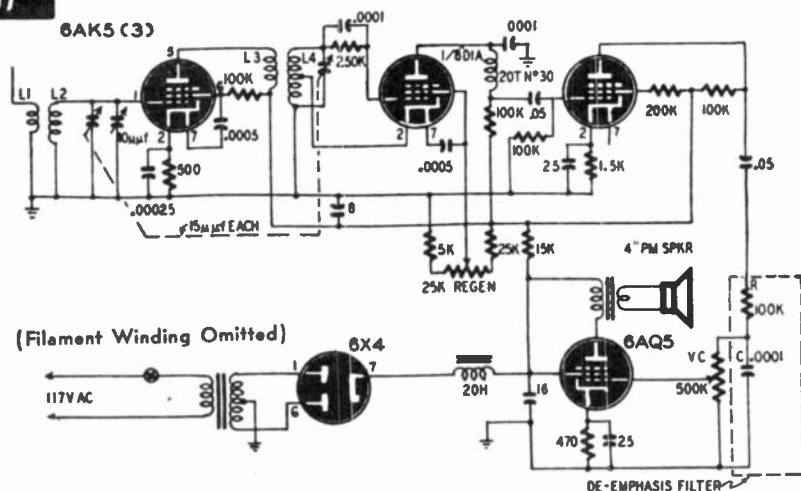
84. Method of attaching a phonograph record player to any radio receiver which uses the now standard diode-detector-triode-amplifier tube. The circuit is broken at the point where the diode return circuit connects to the r.f. filtering resistor. This resistor may be increased in value as shown, or may be left at its usual 50,000 ohms. Capacity effects cause radio signals to mix with the phonograph music in some receivers. In such cases the receiver may be tuned to a quiet spot between stations or may be silenced positively by using a double-pole-double-throw switch, one section of which is used to open an i.f. cathode in the phono position.

85



85. A phototube amplifier for use in home movie projectors, for a light-beam telephone or any other application where an amplifier which turns variations of light into variations of sound is required. If used in a signalling system where audio quality is not needed, the 6L6 cathode may be bypassed with approximately 10 μ f.

87



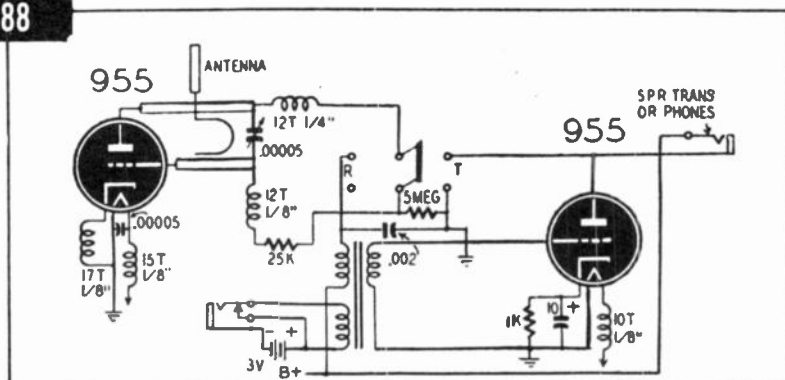
All coils wound with No. 22 enameled wire—detector secondaries are center-tapped—

	<i>Band 1</i>		<i>26-34 mc.</i>	
	<i>L₁</i>	<i>L₂</i>	<i>L₁</i>	<i>L₁</i>
turns	6½	3	7½	3
height	3/8	1/8	3/8	1/8
	<i>Band 2</i>		<i>42-56 mc.</i>	
	3	2	4	2
turns	1/4	1/16	1/4	1/16
height				
	<i>Band 3</i>		<i>85-110 mc.</i>	
	4*	2	3*	2
turns	5/16	1/16	1/4	1/16
height				
	<i>Band 4</i>		<i>120-150 mc.</i>	
	3*	1½	2*	1
turns	1/4	1/16	3/16	1/16
height				

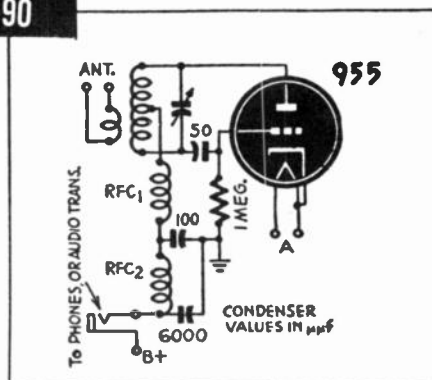
* $\frac{1}{4}$ -inch diameter coils placed within coil forms—all others are wound outside the $\frac{3}{4}$ -inch forms.

87. This superregenerative receiver can be used on any frequencies between 1 and 10 meters (30-300 mc). Four sets of plug-in coils are required to cover this range. Because the set is a superregenerator, it can be used for receiving AM, FM and c.w. signals, though not with the fidelity of a standard FM receiver nor the selectivity of a c.w. superhet. The coil forms should be 3/4-inch polystyrene of a type suitable for winding high-frequency inductors.

88

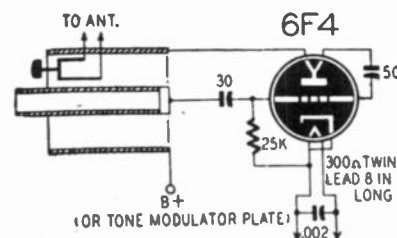
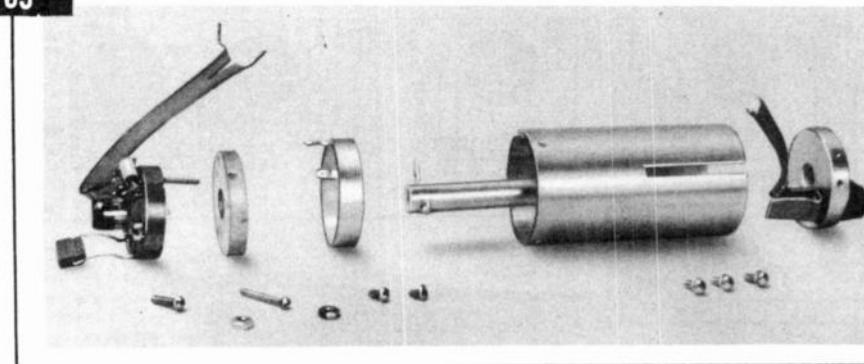


90



88. (left) A 420-450 mc transceiver which uses "long lines" at frequencies where lines are no longer long! These are quarter-inch copper tubing, two inches long, spaced one inch. 90. (right) A receiver for the 146-mc amateur band. The coil is eight turns of No. 14 wire, one-half inch in diameter and spaced out to three-quarters inch in length. The RFC's can be wound with 30 turns of No. 26 wire, one quarter inch in diameter. 180 to 250 volts are used on the 255. Note well that unlicensed operation of any transmitter is illegal—operator must be licensed.

89



89. A coaxial cavity type circuit, used as a transmitter in the 430 mc range. Parts shown in photo are of silvered copper. 1—tube and socket; 2—circular piece of polystyrene; 3—brass ring; 4—inner cylinder; 5—outer cylinder; 6—metal short-circuiting disc. Ends of coupling hairpin attached to (6) are connected to twinlead which goes through slot in outer cylinder. Filament is connected through a half-wave section of eight inches of twinlead, eliminating chokes.

When we reach FM frequencies, we begin to find ourselves in that realm where the cut-and-dried principles of lower frequencies no longer apply. No longer can we wind coils from specifications and expect circuits to tune correctly without further adjustment. Chief reason is that capacitances and inductances in the wiring itself become very important factors in tuning the circuits. No longer may capacitors be attached with leads of any convenient length. Ceramic capacitors connected directly to the tube socket terminal at one end and a common tiepoint for the stage at the other are the rule. All r.f. wiring must be planned to run shortest possible distances, and connecting leads to coils and capacitors must be considered as part of the total inductance (and capacitance!)

Tuning inductors for these circuits must therefore be constructed experimentally. The original builder's figures can be taken as a guide, and the coils then fitted to the desired range. This is done by compressing or expanding them to increase or decrease the inductance. A signal generator becomes almost a necessity for constructors working at these frequencies.

Where capacity tuning is used, variable capacitors must be of the very-high-frequency type, with low minimum capacitance, positive contacts and heavy, rigid plates.

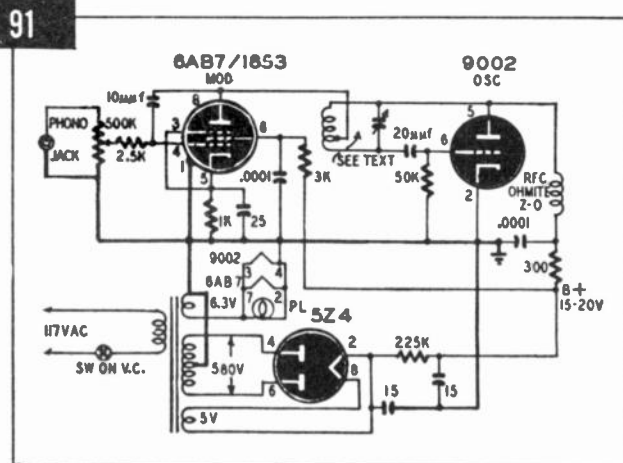
Taps on coils may find themselves in queer positions. A tap indicated as one turn from ground may work better exactly at the ground terminal, or even a fraction of an inch out on the ground lead. Such is the tuning effect of connecting leads.

Filaments may have to be by-passed to cathode or ground, or even, as in the 7-tube circuit shown on this page, isolated from ground and the rest of the set by r.f. chokes. These chokes must often be of the special high-frequency type, which can be wound with from 12 to 20

turns of No. 16 or 18 wire on a quarter-inch dowel, spacing turns very slightly.

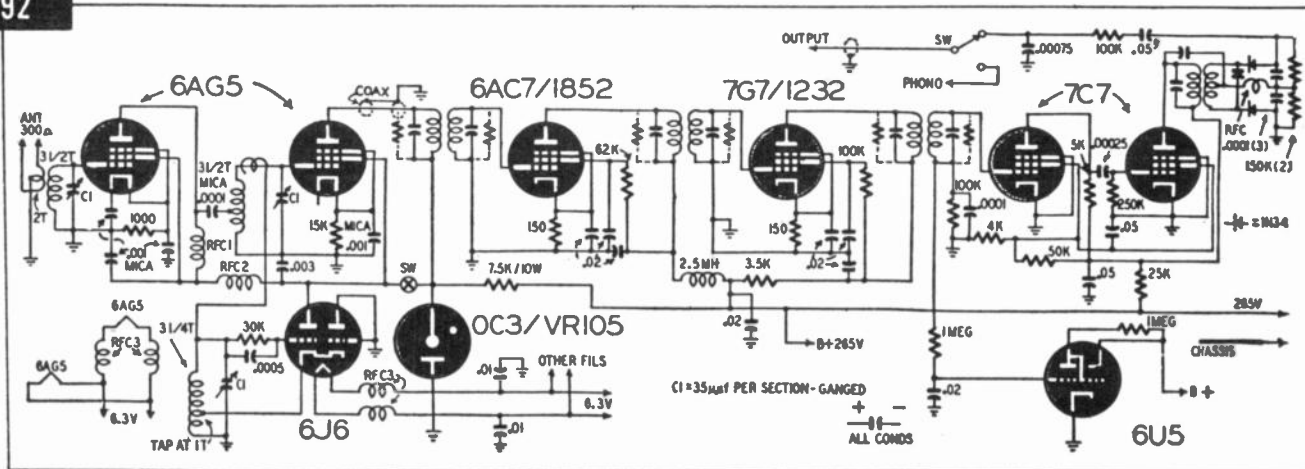
Power supplies must also be watched, and careful filtering plus voltage regulation will be found worth while, especially in oscillator circuits. I.f. coils must be watched, and in some cases broadened with 47,000-ohm resistors across them, to give full fidelity. While crystals are often used in discriminators to cut down the number of tubes, the 6AL5 will usually give more consistent results.

Dipoles cut to length are the commonest FM antennas, though in remote areas special arrays are often needed. Where FM stations are powerful and close, any piece of wire is a good antenna, and built-in or line-cord antennas have been used in a number of commercial sets.



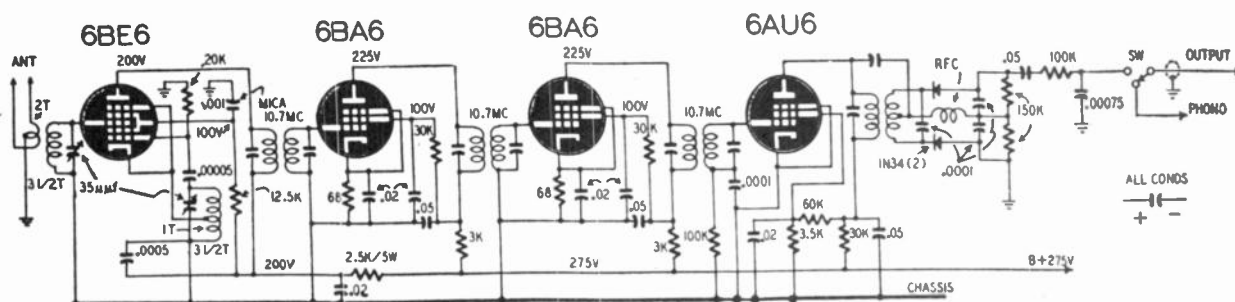
91. A phonograph oscillator built to work with an ordinary FM radio receiver. The coil consists of three turns of No. 12 or 14 copper or silver-plated wire, three-quarters inch inside diameter and spaced out to one inch. The tap is one-half turn from the grid end.

92



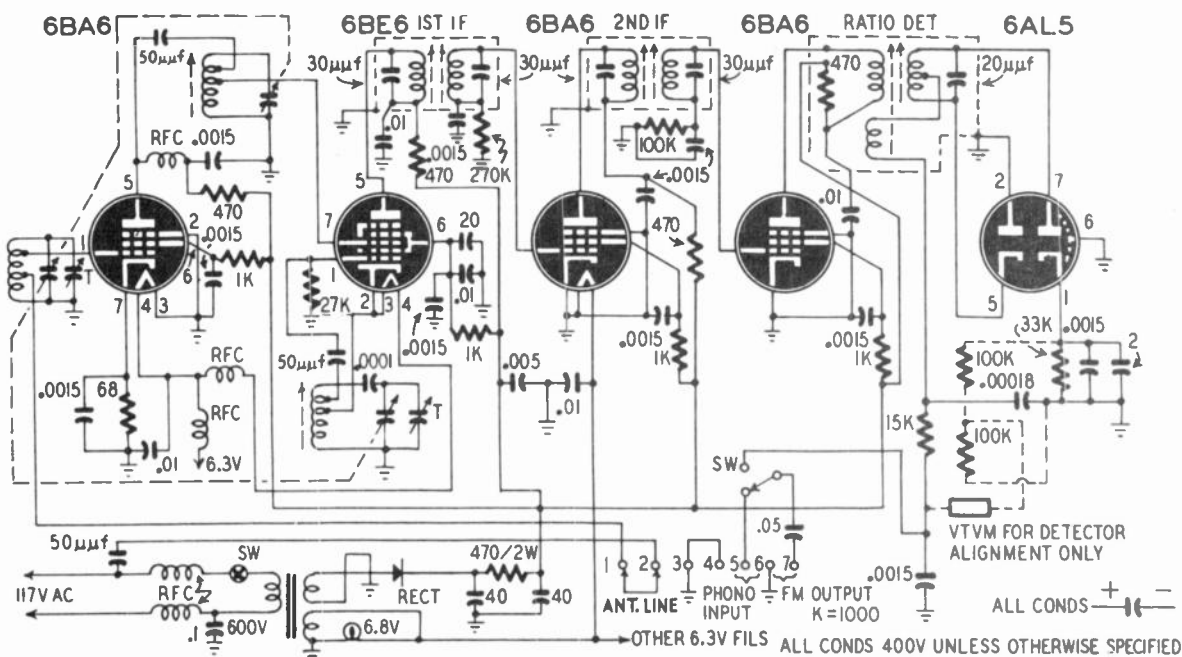
92. A complete FM tuner, with voltage regulator and electron-ray indicator. Constructed for use in fringe areas, it has an r.f. and two i.f. stages. Two limiter stages suppress interference. The coils are of No. 12 wire, one-quarter inch in diameter and three-quarters inch long. Grid coils are all of $3\frac{1}{4}$ turns, and the antenna has two turns. The oscillator coil is tapped at one turn from ground, though fractional variations may produce better results.

93



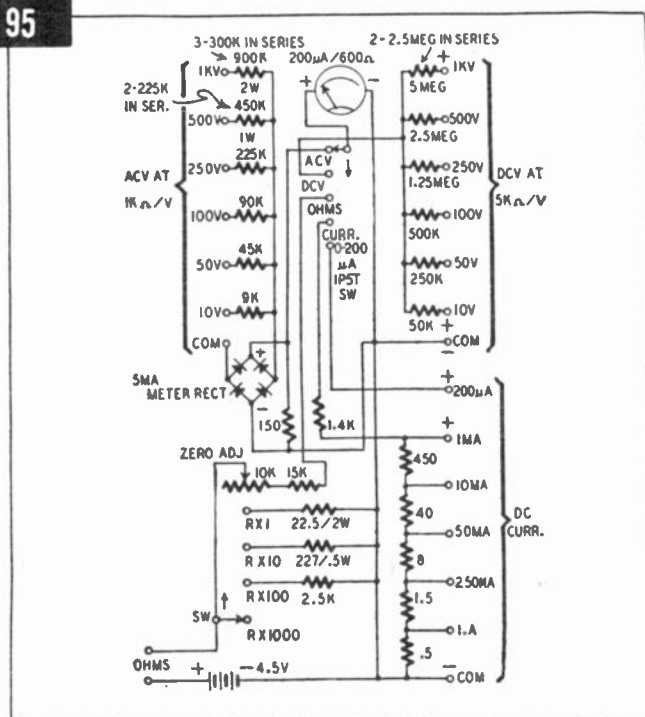
93. A 4-tube FM tuner, similar to but simpler than that described in Circuit 92. The set may be made slightly more sensitive by using a 6AL5 instead of the germanium crystals shown in the diagram. All transformers (i.f. and discriminator) are high-class commercial units. Experience has shown that it is not often practical to wind one's own. R.f. and oscillator coils are identical with those described for circuit 92, of which this is in fact a variant, being intended for use where FM stations are not at horizon distance and where signal levels are high. If more sensitivity seems desirable, either an r.f. or an i.f. stage may be added, using Circuit 92 as a reference.

94



94. The Pilotuner is one of the more successful of the small commercial FM tuners. It uses a ratio detector instead of the discriminator-limiter combination, making possible a stage of radio frequency amplification in a 5-tube set. Coupling of the r.f. stage is interesting. Both input and output are tapped down on the plate tank coil of the 6BA6 for greater signal stability. The tapping-down process is repeated in the mixer stage, where the oscillator grid is tapped down. The variable capacitors are made with copper plates, also to improve signal stability. Connections are provided for an FM dipole, and in strong-signal areas the built-in line-cord antenna may be used.

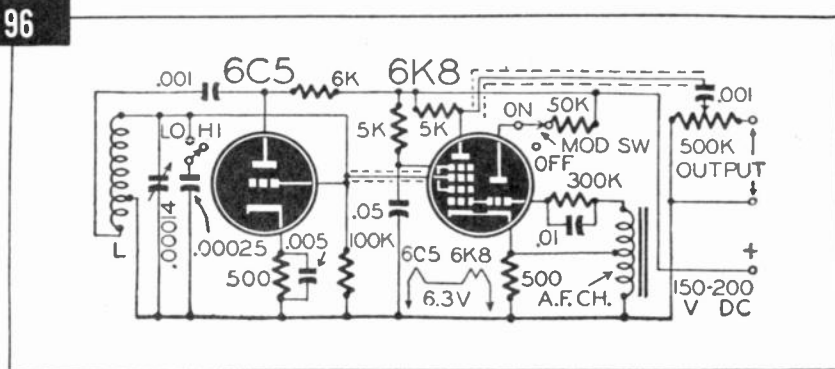
95



95. Most necessary of all instruments is the common multimeter. This instrument uses a 200- μ A meter, but meters ranging from 50 μ A to 1 mA can be substituted by changing the resistors. To do so, calculate the number of ohms which in series with 1 volt will produce the full-scale reading of the meter to be used, and multiply this ohms-per-volt rating by each voltage range to find the correct multiplying resistor. Thus, by Ohm's Law, 5,000 ohms across 1 volt equals 200 μ A, and each multiplier resistor for this meter is 5,000 times the voltage measured by it. For a 50- μ A meter, for example, the resistors would be 20,000 ohms per volt, and the hundred-volt range would use a 2-megohm multiplier. A 1-mA meter (1,000 ohms per volt) would use a 100,000-ohm resistor for that range.

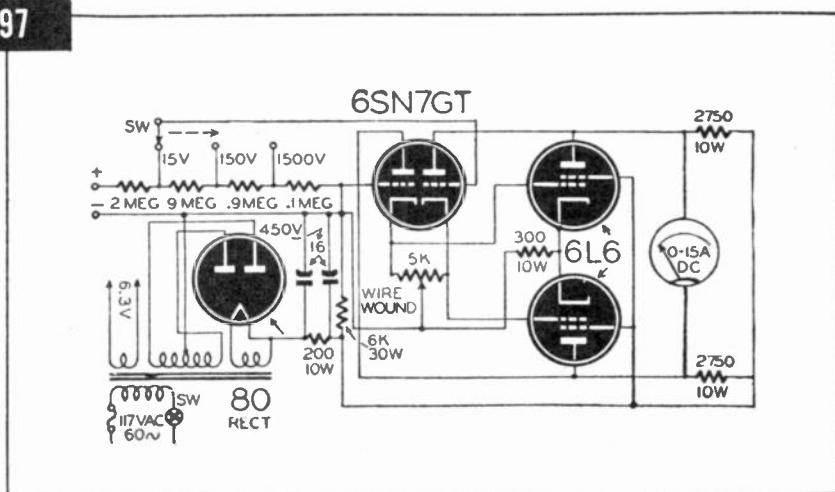
Milliammeter ranges depend on the internal resistance of the meter. To multiply the range by any figure, put across the meter a shunt which will *reduce* the total resistance of meter and shunt by that figure. Thus, a 27-ohm, 1-mA meter will read 10 mA when shunted by 3 ohms (one-ninth the resistance of the meter across the meter makes a current path one-tenth the resistance of the meter alone.) To multiply by 100, use a shunt 1/99 the meter's resistance, and by 1,000, 1/999 of it. With a milliammeter whose sensitivity is from 1,000 to 5,000 ohms per volt (1-mA to 200- μ A movement) this is an excellent all-round instrument. With a more sensitive movement (20,000 ohms per volt) it can do many of the jobs commonly done with a vacuum-tube voltmeter.

96



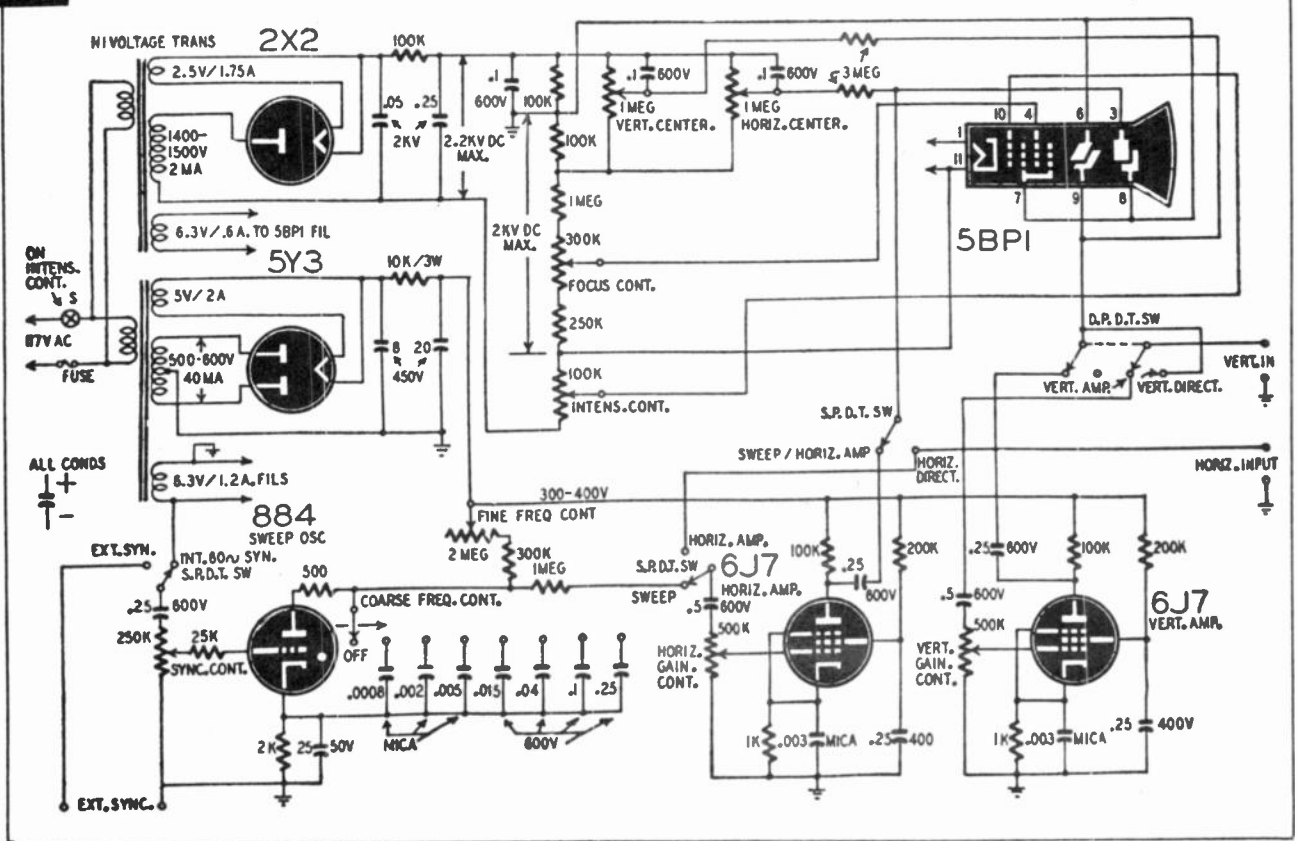
96. A signal generator constructed to cover either the 425-525 kc i.f. range or the broadcast band. The coil is 130 turns of No. 32 enamel-covered wire tapped about 30 turns from the bottom. If the rather odd-sized capacitances in the original circuit are not available, a pair of 365- μ F capacitors may be used. Audio choke CH can be the primary of any push-pull output transformer. A low-voltage source of audio signals may be obtained simply by bringing the secondary terminals out to pin-jacks on the instrument panel.

97



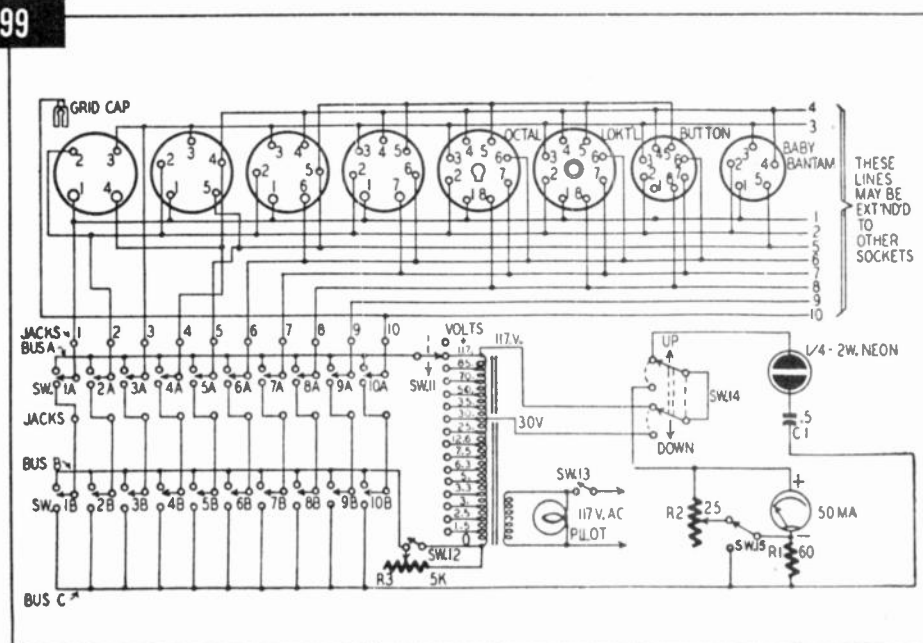
97. A simple vacuum-tube voltmeter built out of surplus equipment. The meter is an old ammeter from which the shunt has been removed, leaving a movement with a range in the order of two to three milliamperes. Any low-range milliammeter may be used in this circuit. The meter is balanced by shorting the leads and adjusting the 5,000-ohm potentiometer till the output meter reads exactly zero. Any voltage then causes one half the 6SN7 to pass more current than the other, the unbalance being amplified and applied to the meter. Sensitivity may be adjusted in a number of ways—by increasing or decreasing the bleeder resistance, by varying the 6L6 cathode resistance, and by varying the input resistors till all readings are right.

98



98. An oscilloscope is one of the most useful pieces of servicing equipment and is a necessity for the advanced experimenter. This circuit is simple, though it includes many features of the more advanced jobs. Provision is made for direct input to the tube's vertical deflecting plates, a necessity in some measurements. Power transformers must be placed under the chassis, well away from the 5BPI. Oscilloscopes use very high voltage—safety first!

99



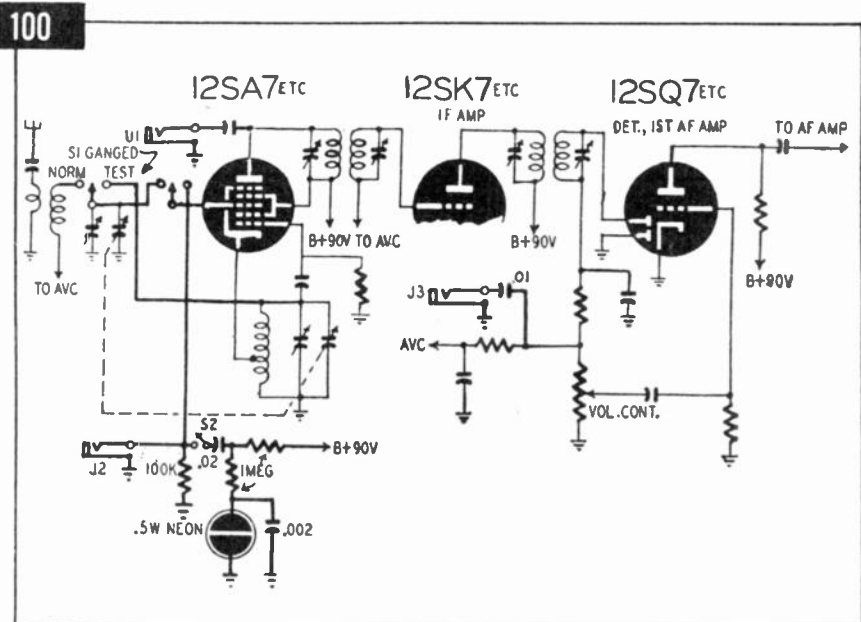
99. Tube checkers are not easily constructed, because of their numerous soldered connections, and need calibration with a known good tube of every type to be tested. Therefore tube testers are not popular with constructors. This is one of the simplest circuits. Filaments are connected to busses A and B, all other elements but the cathodes to bus C. Cathode is connected to one side of filament. The transformer is a commercial tube-checker type. The UP position of the switch tests for short circuited elements and the DOWN position for emission. Values of R1 and R2 depend on range and internal resistance of the meter used. A suitable arrangement is to use a 10-ma meter, making R2 of such a value as to increase the range to 100 ma.

100. This circuit can be used as a signal tracer, signal generator, wireless phono oscillator and radio receiver. It is easily made, being constructed from almost any old 5-tube super-heterodyne radio receiver. The converter, i.f. and detector stages are the ones used. A 455-kc i.f. is best, as most sets have i.f.'s at approximately that frequency. An a.c.-operated set should be selected if possible. If not, an isolating transformer should be used between it and the line, or it will be useless for testing a.c.-d.c. radios.

For signal tracing, plug a single probe into J1 and connect chassis of tracer and radio together. Throw S1 to NORMAL, and tune tester to a clear channel. It is then ready to check 455-kc i.f.'s and will work as well on sets whose i.f. is listed as 456. The i.f.'s of a 455-kc set can be aligned by adjusting the trimmers for maximum output from the tester. Signals can be traced in the normal manner, following the signal till it disappears. If it cannot be found at all, the trouble is in the antenna or oscillator circuits.

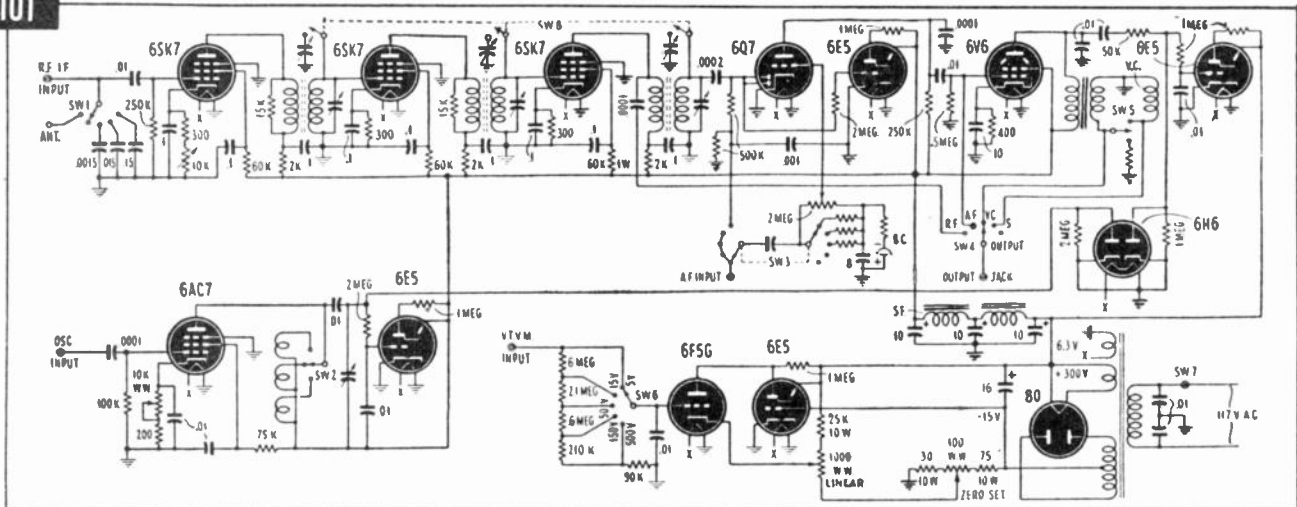
Audio signals may be traced by inserting the plug in J3, tuning the tester to a clear channel with switch at NORMAL.

To use the instrument as a signal generator, set S1 to TEST. This disconnects the antenna circuit and places the antenna and oscillator capacitors in parallel, lowering the frequency. The unit should be calibrated for the new range, though it will not be far from that indicated on the



receiver dial. For modulated r.f., throw S2, which cuts in the neon relaxation oscillator. The modulated or unmodulated r.f. output is taken off at J2. Modulated i.f. signals may be taken from J2 with S1 in the NORMAL position. Remove the neon lamp and plug in a phono pickup, and the unit is a phono oscillator. S1 is put in the Test position and S2 opened. If the phono pickup is connected to J3 the equipment becomes a small phono amplifier, and if connected to a good antenna, a headphone radio receiver.

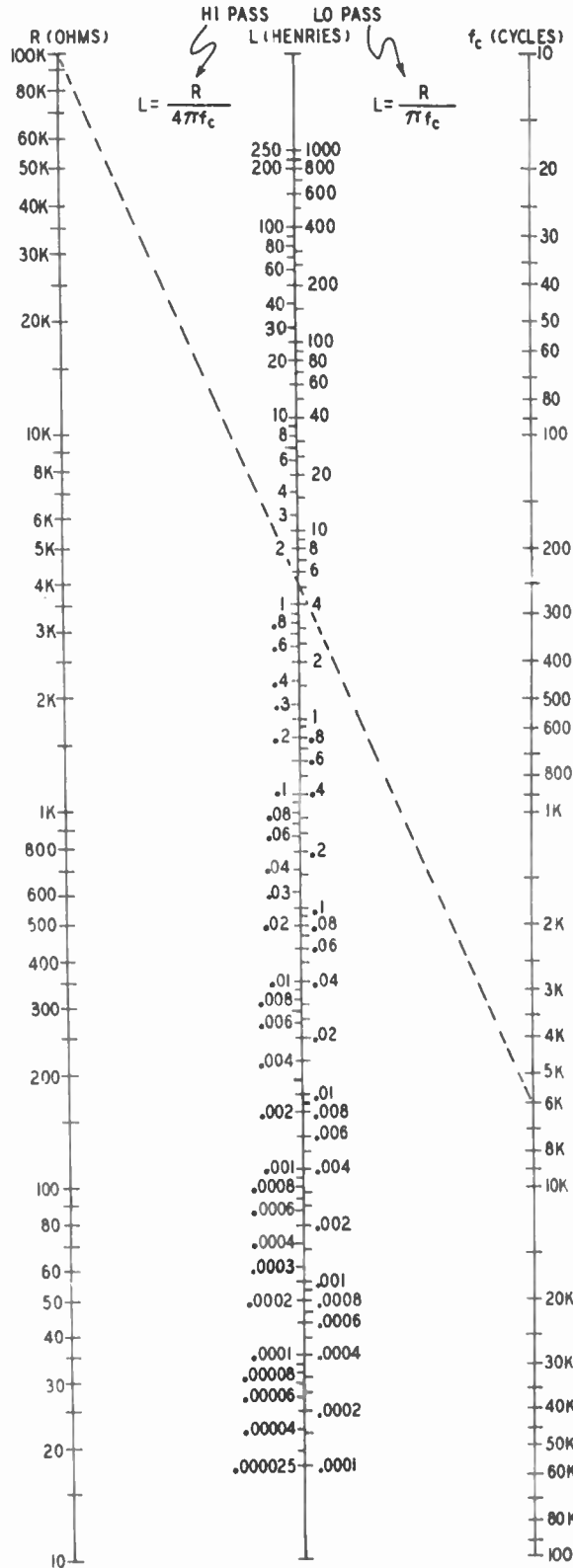
101



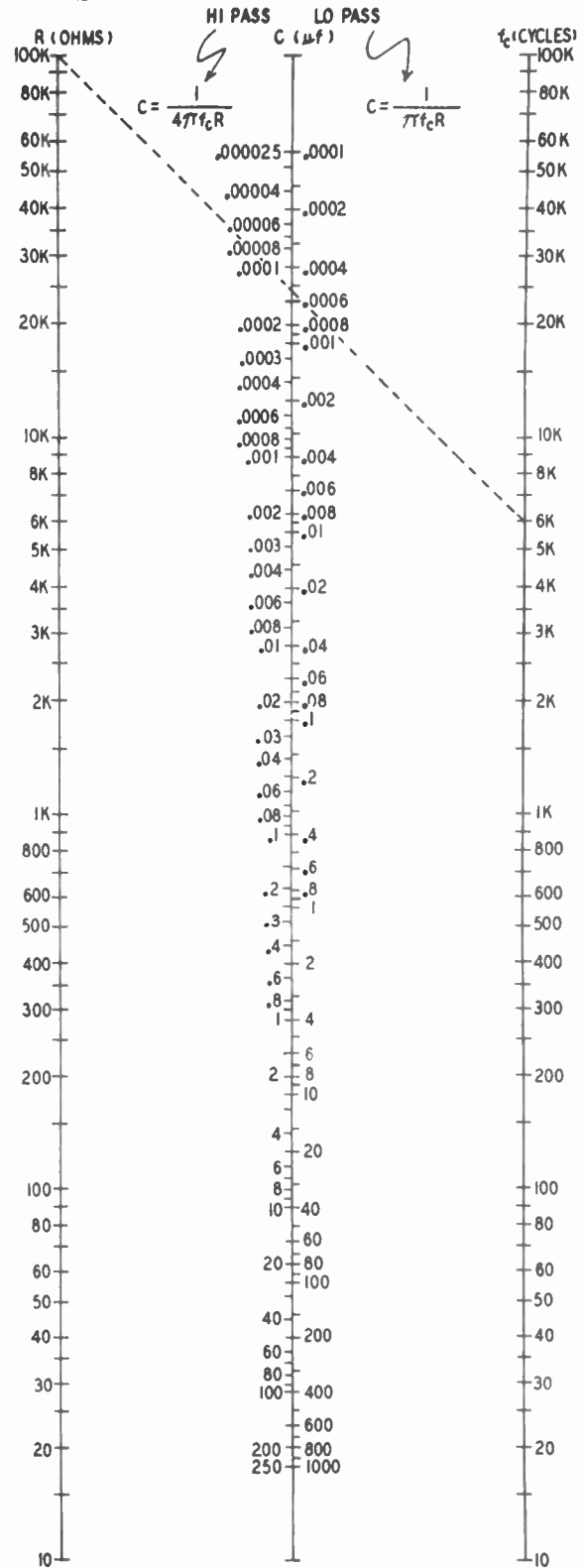
101. The ordinary signal tracer is too insensitive for servicemen far from broadcast stations. This job was built by a Canadian who needed plenty of sensitivity. Three tuned r.f. stages are used to tune over the broadcast band. By switching in the three trimmers, the set covers intermediate frequencies as well. Trimmers should be adjustable to about 250 μ f. The set is an excellent receiver when desired, having better than usual fidelity on account of its broad-banded r.f. coils, but can be made absolutely silent by throwing Sw5 to the resistor, which should have the same resistance as the voice coil. Sw 3 is the audio input circuit. The resistors are 2,000, 20,000 and 200,000

ohms, with 50,000 ohms in series with the bias cell. The switch is used to reduce the volume on incoming signals to keep them from overloading the output stages. A vacuum-tube voltmeter and an oscillator tester are also made a part of the instrument, increasing its usefulness. While these features could be dispensed with, the flexibility gained by the large number of switches should not be dispensed with. The output jack's variety of signals for use or measurement will be found especially useful on the service bench. The designer recommended only one precaution to the constructor of this instrument: Print all the control and switch names and positions on the panel.

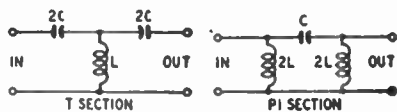
NOMOGRAM 1



NOMOGRAM 2

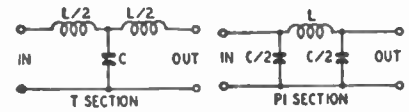


Hi-Pass



Knowing the desired cutoff frequency and terminating resistance, place a straightedge across these values. Get L from the left and C from the right nomogram. Apply these values according to the configurations shown at sides.

Lo-Pass



Hum Reduction	-I-	Aug. 48	36
IBM Electronic Calculator		May 48	28
I.f. FM (See FM Receivers)		Jan. 48	61
I.f., Variable-Bandwidth		Aug. 48	29
Impedance Measurement		Sept. 48	50
Inductance Bridge		Feb. 48	35
Inductance Bridges		Apr. 48	37
Induction Heater			
Intercoms		Sept. 48	41
Quick-Heating		Feb. 48	48
Receiver		June 48	62
Switchless		Apr. 48	44
Tubeless		Nov. 47	56
Wireless		Sept. 48	74
Intermittent Checker		July 48	33
Ionosphere experiments, 3.6 mc			
Isolation Transformers			
(See Transformers)			
Jenkins, C.F.	-J-	Jan. 48	32
Kiss Meter	-K-	Sept. 48	22
	-L-		
Labels, Panel		June 48	67
Langevin 122 Amplifier		July 48	42
Latin American Radio		Aug. 48	69
Light Magnifier		Aug. 48	23
Lightning Arrester with T-R Tubes		Aug. 48	60
Line Cord, Anchoring		May 48	50
Litz Wire (See Wire)			
Loudspeakers			
Cleaning		Apr. 48	50
Cleaning		June 48	67
Repairing		Mar. 48	42
Test, Universal		Jan. 48	53
Grill Cloth, Tightening		Aug. 48	58
Magazines, Binding	-M-	Mar. 48	42
Magnetism		Oct. 47	26
Maico Hearing Aid		Sept. 48	41
Medical Electronics			
Part I		Mar. 48	28
Part II		Sept. 48	28
Metal Locator, compact		Sept. 48	79
Meters			
Ampero, AC, Servicing Uses		Sept. 48	45
Field Strength		Oct. 47	22
Field Strength		Oct. 47	46
Kiss		Sept. 48	22
Milliamperes, for Servicing		Jan. 48	70
Multirange		June 48	66
Multirange		June 48	80
Output, Crystal-Rectifier		July 40	56
Recording-Level		Feb. 48	50
Shunts		Nov. 47	56
Shunts		Mar. 48	60
Shunts, Mounting		Aug. 48	59
Viscosity		Mar. 48	66
Visibility		May 48	22
Volt, Vacuum-Tube		Aug. 48	26
Volt, Vacuum-Tube		July 48	56
Volt, Vacuum-Tube, Double-Bridge		July 48	28
Watt, a.c.		Aug. 48	63
Microphones			
Carbon, repairing		Jan. 48	80
Case		Nov. 47	62
Contact		Mar. 48	26
Contact		Aug. 48	60
Oscillator		Nov. 47	38
Mirror, Dental		July 48	48
Mixers, a.f., Vacuum-Tube		Mar. 48	54
Mobile B'dc'st Relay in Denmark		July 48	66
Modulator, Flea-Power		Aug. 48	58
Motion Picture Amplifier		July 48	32
Motorboating, Curing		July 48	48
Motorola (See Receivers)			
Multimeters, Comparison with VTVM		Mar. 48	32
Multitester, Condenser, Checker-			
Sig Gen, Tracer-Multimeter		Sept. 48	46
Musical Instruments, Electronic,			
Fototone		Aug. 48	30
National NC-173 Receiver	-N-	Oct. 47	32
Neon Experiments		Aug. 48	52
Neon Lamp as Phototube		Sept. 48	78
Neon Lamp, varying with sound			
level		July 48	48
Noise, Limiter, Diode-Type		May 48	80
Noise Suppressors		May 48	23
Odor Detector, Electronic	-O-	July 48	23
Ohmmeter, High Range		July 48	63
Organs, Electronic, Fototone		Aug. 48	30
Oscillators			
A.f., code-practice		May 48	80
A.f., code-practice		Apr. 48	44
A.f., code-practice		Mar. 48	63
A.f., code-practice		Feb. 48	48
A.f., code-practice		Jan. 48	78
A.f., code-practice		Oct. 47	66
A.f., code-practice		Sept. 48	82
A.f., code-practice		Nov. 47	60
A.f., R-C		May 48	82
A.f., R-C, single control		Aug. 48	28
A.F.-R.F.		Mar. 48	87
A.f., sine-, square-wave		July 48	30
Crystal		May 48	27
Dynatron		May 48	27
Electron-Coupled		May 48	72
Laboratory-Type		May 48	27
Microphone (See Microphone)			

Every Radio Serviceman Needs This

FREE

68 PAGES

AC-DC BALLAST

TUBE MANUAL

To get YOUR FREE COPY of this indispensable manual (value \$1.50) merely mail in to JFD Radio Dial Belt envelopes; include 10¢ in postage to cover mailing cost. (Buy your JFD Dial Belts and Belt Kits from your nearest parts jobber.)

JFD's new 68-page Ballast Manual is a treasury of information for Radio Servicemen and Dealers — Lists more than 3000 radio ballasts — ACDC Ballasts for Fluorescent lights and electrical appliances — 220 volt to 110 volt Stepdown Ballasts.

Send 12 Envelope Flaps to:

J.F.D. MANUFACTURING CO. INC.

4109-4123 FT. HAMILTON PKWAY, BKLYN 19, N.Y.

Phonograph	Apr. 48	42
Phonograph	Mar. 48	40
Phonograph	Jan. 48	77
Phonograph (See Also		
Phonograph)		
Phonograph, FM	Feb. 48	27
Test (See Signal Generators)		
Transitron	May 48	27
Oscilloscopes		
Checking Car Radios with	Apr. 48	56
5-Inch	Nov. 47	56
Osculation Meter (See Kiss)		
Output Meter (See Meters)		
- P -		
Panel Marking	June 48	67
Phase Inverters	May 48	32
Phase Inverters	Feb. 48	48
Phase Inverters	July 48	34
6AD7	May 48	25
Phonocardiograph	Sept. 48	28
Phonograph		
Amplifiers (See Amplifiers, AF)		
Cable Adapter	Aug. 48	58
Care of	Mar. 48	25
Changer Adjuster	May 48	44
Changers, Holder for	Mar. 48	42
Noise Suppressor	Jan. 48	77
Noise Suppressor	Feb. 48	70
Oscillators (See Also Oscillators)	Nov. 47	60
Oscillators	Sept. 48	40
Pickups, Mount, detachable	June 48	67
Pickups, Performance Checking	Aug. 48	33
Pickup, Vacuum Tube	July 48	36
Plug	Mar. 48	42
Pilot Lights, low-voltage operation	Sept. 48	75
Platform, Insulated	July 48	48
Polarity Tester	May 48	62
Power Supply		
6-Volt	Jan. 48	76
6 Volts d.c.	Apr. 48	36
12, 24-Volt	May 48	58
24-Volt d.c.	Apr. 48	42
Auto Radio Test	June 48	63
For BC-654-A	Apr. 48	36
Bias, Full-Wave	Apr. 48	44
Filter, Tuned	May 48	44
Mobile	Apr. 48	44
Regulated	Aug. 48	57
R.f.	Feb. 48	42
R.f.	Mar. 48	44
Television (See Television		
Receivers)		
Variable	July 48	32
Variable	Mar. 48	23
Voltage Reduction	July 48	57

hallicrafters

proudly presents

the SX-62!

\$289.99

(slightly Higher West of Rockies)

Communications-type
Broadcast Receiver
540 KC to 110 MC

For discriminating listeners on all wave bands (FM/AM) . . . who appreciate the thrill of superior performance . . . with high-fidelity audio . . . who want a few extra controls but not too many.

An "SWL" version of our famous SX-42. Two stages RF, three stages IF amplification — 14 tubes plus Rectifier and Voltage Regulator. See it at your local Hallicrafters dealer.

the hallicrafters co.

4401 W. FIFTH AVENUE
CHICAGO 24, ILLINOIS

Preselector, Amateur	Feb. 48	42
Probes		
Crystal	Aug. 48	66
Crystal, Dutch	Feb. 48	50
From Pencil	Mar. 48	42
Production Line Technique		
for Service Shops	June 48	72
Pulse Code Modulation	Feb. 48	28
Punch, Tube Socket	Apr. 48	50
- Q -		
Quiz, Radio	June 48	61
- R -		
R-44/ARR-5, Modifying	Sept. 48	58
Radar, Highway	Nov. 47	22
Radio City Sig. Gen.	Jan. 48	64
Radio Control		
Light	May 48	30
of Plow	Oct. 47	20
Receiver	Oct. 47	37
Transmitter-Receiver	Sept. 48	83
Rain, Effect on Radar	July 48	71
RCA 630TV Receiver	Jan. 48	48
Receivers		
1-Tube, Pocket	Mar. 48	62
1-10 Meter	Feb. 48	23
2-Tube, Permeability-Tuned	Oct. 47	48
4-Tube, Reflex	July 48	31
6-Volt	Aug. 48	51
10-Meter, Superregenerative	Jan. 48	79
Alignment with 6E5 as Indicator	Sept. 48	82
Aligning without Sig Gen	Mar. 48	77
Antenna Coupling, Capacitive	Sept. 48	75
Automobile, Servicing 'Scope	Apr. 48	56
Automobile, Test Voltage	June 48	63
Battery, A.C. Conversion	Aug. 48	44
Battery, Six-Tube, Superhet	Aug. 48	51
BC-312, Power Supply for	Jan. 48	74
BC-946, Broadcast Use	Feb. 48	26
British	Apr. 48	26
Cleaning	June 48	67
Coil Data for	Aug. 48	66

RADIOMEN!

GET THIS
Brand New! Valuable Book
OF "150 NEW
RADIO DIAGRAMS
EXPLAINED"
FREE

10 to 1 Satisfaction
GUARANTEE

"I personally guarantee that at the end of 1 year from date of receipt, my Applied Practical Radio set will have earned for you at least 10 times its cost, or you may return it and I'll return every cent you paid."

B. W. Cooke, Pres.



Here's a sensational "get acquainted" offer! This big, new book, "150 New Radio Diagrams Explained" is yours, absolutely FREE! It contains circuits and data on the latest Radio and Television sets. Easy-to-read, 8 1/2 x 11" size, with full instructions on how to read and use diagrams. Be- longs in every radioman's kit.

HOW TO GET YOUR FREE BOOK

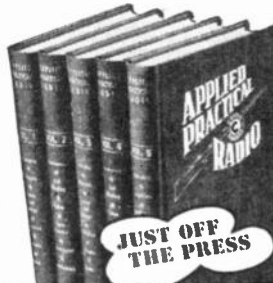
You get this book Free just for looking over—without cost or obligation—the sensational new 5-volume Coyne set "APPLIED PRACTICAL RADIO." It's just off the press. Here's everything you want to know about radio, from basic principles to up-to-the-minute

Television and FM! PA, shortwave, aviation-auto radio, multibands, tele- transmission, testing instruments and trouble- shooting short-cuts, phototubes, etc., all clearly explained. Shows how to construct, install, service all types of apparatus. Step-by-step photos break equipment down before your eyes! Newest testing methods. Hundreds of subjects, over 1500 pages, almost 1000 illustrations, diagrams. Writ- ten for home training and field reference—so com- plete, so up-to-date and practical that every man interested in radio should see it.

SEND NO MONEY You can see how much this set can mean to your future, without cost or obligation. I'll send "APPLIED PRACTICAL RADIO" postpaid, for you to look over for 7 days FREE—and with it, the Radio and Television Diagrams book as an outright Gift! This book is yours to keep free whether or not you decide to keep the 5-Volume Set! In 7 days, either return the 5-Book Set and owe nothing or pay \$3 then and \$3 a month until \$16.75 is paid. Or you can save \$1.75 by paying \$15.00 cash price.

Use Coupon Now!

YOU ARE NOT BUYING THE 5-VOLUME SET WHEN YOU SEND THIS COUPON. You are merely asking to see the books free for 7 days. Free Book Offer is limited—so mail coupon to- day.



FREE BOOK COUPON

B. W. Cooke, Pres., Coyne Electrical & Radio School
500 S. Paulina St., Dept. 19-E1, Chicago 12, Ill.

Send me the NEW 5-Volume Coyne Set, "APPLIED PRACTICAL RADIO" for 7 days FREE examination per your offer. Also send "150 New Radio Diagrams Explained" as a FREE gift.

NAMEAGE.....

ADDRESS

TOWNZONE.....STATE.....

Collins 75A-1
Crystal
Crystal
Crystal
Crystal, 1-tube
Dutch
FM (See also FM)
FM, Crystal
Gain Control, r.f.
Italian, Band Change
Midget, 5-100 Meter
Midget, Improving
Motorola 77FM21, FM-AM
National NC-173
Output Measurement
Portable, 2-Band
Portable, 3-Way
Portable, 3-Way
R-44/ARR-5 (See R-44)
Radio Control
Reflex
Reflex, One-Tube
Reflex, 3-Tube
Regenerative, with Lamp
Regenerative, Stable
Sentinel 286 PR
Silvertone 4722
Superhet, 2-Tube
Super Reflex
TRF, Communications
V.H.F., 1-Tube
Ward 74BR-2003A, 84BR-1515A

Recorders and Recordings
Magnetic
Magnetic, Wire, Servicing
Amplifiers (See Amplifiers, a.f.)
Engraved Cylinder
Magnetic
Magnetic, Heads, and Tape
Pullers
Tap

Relays
Capacity-Operated, Intruder
Alarm
Photoelectric
Resistance-Controlled
Resistance Bridge
Resistance Wire (See Wire)
Resistors, Odd-Size

Sams, H. W., Service Shop Survey

SCR
SCR-178, 179, Converting
SCR-274-N, Loudspeaker
Reception
SCR-284-A (See BC-654-A)
Screws, Measuring Pitch
Screw Starting Tool
Selenium Rectifier Holder
Servicing
Farm Radios
FM Receivers
Milliammeter Use in
Production Line Methods
Television Receivers
Shield Cans from Battery Cases
Short-Circuit Indicator
Shunts, Meter (See Meters)

Signal Generators
1-Tube
FM Sweep
Heterodyne
Miniature, Crystal
Push-Button, European
Radio City, Pocket-Size
Tracer
From Vibrator
Wobulated
Signal Tracers
Signal Tracer
Signal-Tracer-Amplifier
-Condenser-Checker
-Generator
Matchbook
Miniature
Receiver as
Sensitive
Silvertone (See Receivers)
S-Meter
Soldering Aluminum
Soldering Chassis
Soldering Irons, Tinning
Spark Plugs, Resistor
Stethoscope, Electronic
Stroboscope
Substitution Box
Substitution Box C-R
Sunspots
Switch, Band
Synchro as Autotransformer

Telephone Amplifier
Telephone, for TV Installation
Television
Amplifiers
Amplifiers
Antennas
Camera Preamplifiers
Counters
Double Modulation
French
Frequencies
Ghosts
Interference, Classifications
Kit, Transvision

Feb. 48 32
Jan. 48 72
June 48 69
Aug. 48 60
Aug. 48 65
Aug. 48 49
June 48 32
Oct. 47 60
Apr. 48 44
Jan. 48 62
Sept. 48 38
Mar. 48 30
Oct. 47 32
Sept. 48 74
Feb. 48 73
Feb. 48 42
Apr. 48 42
Sept. 48 58
Oct. 47 37
Sept. 48 83
June 48 62
Jan. 48 78
Oct. 47 35
Apr. 48 34
Nov. 47 36
July 48 50
Jan. 48 76
Apr. 48 44
Sept. 48 81
Feb. 48 48
Sept. 48 34
July 48 35
Nov. 47 68
Aug. 48 35
Feb. 48 31
Aug. 48 35
Nov. 47 30
Apr. 48 25
Jan. 48 77
Mar. 48 40
Sept. 48 50
May 48 50
May 48 66
Sept. 48 70
Aug. 48 35
Apr. 48 36
Aug. 48 59
Mar. 48 42
Apr. 48 50
July 48 50
June 48 30
Jan. 48 70
June 48 72
Jan. 48 50
Aug. 48 55
Apr. 48 50
Mar. 48 40
June 48 25
May 48 44
May 48 26
May 48 37
Jan. 47 64
Nov. 47 23
Apr. 48 50
May 48 34
July 48 48
Feb. 48 48
Aug. 48 42
Nov. 47 62
Apr. 48 58
Aug. 48 58
Sept. 48 86
June 48 66
Oct. 47 44
June 48 62
Nov. 47 60
Feb. 48 24
May 48 50
Sept. 48 84
July 48 36
Sept. 48 74
Mar. 48 27
Sept. 48 69
Jan. 48 45
July 48 24
July 48 26
Jan. 48 39
Sept. 48 33
Jan. 48 133
Jan. 48 40
Nov. 47 90
Feb. 48 36

Network Predictions
Optical Filters
Preamplifier, Grounded-Grid
Progress
Projector
Television Receivers
Alignment of
British
Capacitor Discharger
Glare Filter for
Installation, Telephone for
RCA 630TS
Power Supplies
Power Supply, Kickback
Projection, Spellman
Servicing
From Surplus
Trouble Chart
Terminals, Safety

Tester
Combination
with Electron-Ray Indicator
with Neon Lamp
Test Instrument, Combination
Test Lead Polarity
Test Lead Switching
Test Leads, Switching
Thermometer, Remote-Indicating

Timer
Low Frequency
Radio-Playing
Time Saving Repair Tips
Tip Jacks from Tube Pins
Transceiver, Amateur, 2 Meter
Transformer

Checker
Interstage, from 2 Single-ended
Transformers
Isolation
Old, Using
Transistors
Transmitters

Amateur, 1-Tube
Amateur, 35 Watt, Portable
Amateur, 100-Watt
Amateur, 250-Watt
Amateur, FM-AM, 250-Watt,
Part IV
Amateur, FM-AM, 250-Watt, Part V
Amateur, using Receiver
Amateur, Relay-Controlled
Amateur, Sailplane
Mobile, Power Supply for
-Receiver, BC-654-A
(See BC-654-A)

-Receivers, Amateur, Low-Voltage
Transmitter, Wrist-Watch, Brunetti
Transvision Television Kit

Tubes
6AD7 as Phase Inverter
6AS5
6N6, Substitute for
35C5
50C5
5651
5691, 5692, 5693
Bases as Connectors
Cathode-Ray, Flying-Spot
Characteristic Calculation
Electron Ray, 6AL7-GT
Electron-Ray, in Tester
FM Detector
Phonograph Pickup
Pins as Tip Jacks
Power, Audio, Triode, Balancing
Puller
Removing from Socket
Testers
Testers, Modernizing
T-R, as lightning arresters
Voltage Reference (See Tubes, 5651)
Voltage Regulator

Tuners
AM
AM Superhet
AM, T.r.f.
AM, T.r.f.
(FM See FM)
Tuning Motor, Whip Type
Tuning Unit, Butterfly

Ultramike
- U -
- V -

Vacuum Tube Voltmeter
Battery-Operated
Comparison with Multimeter
Video (See Television)
Visibility Meter
Voltage Booster
Voltage Regulators (See Tubes)
Volume Control, Preset
Volume Expander, Lamp Type
VR Tubes (See Tubes)

- W -
Ward (See Receivers)
Wattmeters (See Meters)
Wind Generators, Servicing
Wind Indicator
Wirecorder, Adding a.f. Amp
Wire Data, Slide-Rule Calculation
Wire, Litz, Stripping
Wire, Resistance
Wire Stripper
WKY Mobile Studio
WWV Schedule

Jan. 48 26
Jan. 48 28
May 48 31
Jan. 48 20
July 48 76
Sept. 48 30
Jan. 48 43
Apr. 48 44
Aug. 48 58
Sept. 48 74
Jan. 48 48
Aug. 48 24
Jan. 48 59
Apr. 48 21
Jan. 48 50
Jan. 48 57
Jan. 48 54
Nov. 47 62

Sept. 48 46
Sept. 48 81
Sept. 48 84
Jan. 48 73
May 48 50
July 48 48
Feb. 48 50
Aug. 48 62

June 48 76
July 48 48
July 48 49
Sept. 48 75
Aug. 48 41

July 48 57
Aug. 48 58
Aug. 48 59
June 48 62
Sept. 48 24

Sept. 48 84
July 48 38
May 48 24
Mar. 48 20
Oct. 47 27
Nov. 47 34
Aug. 48 54
Sept. 48 62
June 48 77
Apr. 48 44

Aug. 48 61
Apr. 48 28
Feb. 48 36

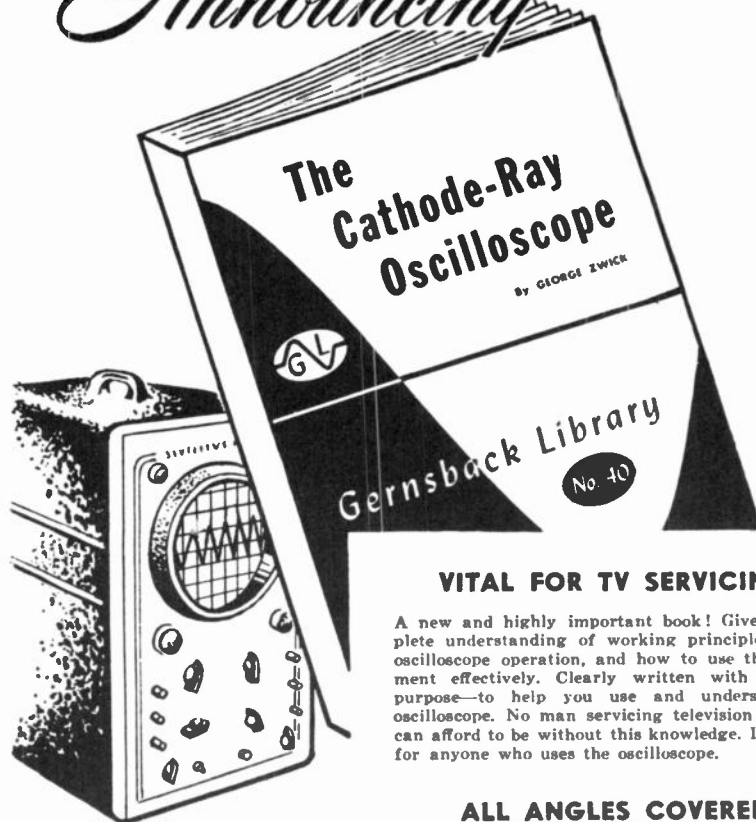
May 48 25
Apr. 48 60
Aug. 48 58
Apr. 48 60
Apr. 48 60
Aug. 48 57
Apr. 48 60
Sept. 48 74
Aug. 48 25
Nov. 47 56
Oct. 47 23
Sept. 48 81
Aug. 48 71
July 48 36
Sept. 48 75
Aug. 48 60
Feb. 48 50
Apr. 48 50
July 48 40
Oct. 47 36
Aug. 48 60

Sept. 48 36
Aug. 48 49
July 48 62
Mar. 48 40
Sept. 48 82
Jan. 48 65
July 48 63
Nov. 47 38

Aug. 48 49
July 48 62
Mar. 48 40
Sept. 48 82
Jan. 48 65
July 48 63
Nov. 47 38

Apr. 48 24
Mar. 48 32
May 48 22
Apr. 48 50
Aug. 48 58
May 48 50
July 48 37
May 48 71

Announcing



VITAL FOR TV SERVICING

A new and highly important book! Gives a complete understanding of working principles behind oscilloscope operation, and how to use the instrument effectively. Clearly written with a single purpose—to help you use and understand the oscilloscope. No man servicing television receivers can afford to be without this knowledge. Invaluable for anyone who uses the oscilloscope.

ALL ANGLES COVERED

Chapter 1—Direct Current and Alternating Current. Visual observation and measurement of varying voltages and currents on the cathode-ray tube. Chapter 2—How beam from electron "gun" projects image of current and voltage variations onto fluorescent screen, and how beam is deflected by electrostatic and electromagnetic means. Chapter 3—How signal deflects electron beam vertically in c-r tube and sweep voltage deflects beam horizontally. Role of the saw-tooth oscillator—the gas discharge tube—the multivibrator—synchronization—locking. Chapter 4—The cathode-ray tube—accelerating and focusing power supplies—the sweep generator—the horizontal and vertical amplifiers—controls on oscilloscope—how to operate a 'scope. Chapter 5—Aligning TV i.f. channels—TV front-end alignment—Alignment of i.f. amplifiers in AM and FM sets. Use of signal generators—i.f. alignment of a.c.-d.c. receivers—bandpass alignment—aligning the discriminator—the ratio detector—r.f. alignment of AM and FM receivers. Chapter 6—Audio output measurement—voltage gain—power output—audio response curve plotting—peak a.c. measurements. Checking saw-tooth amplifiers—magnetic deflection circuits—synchronizing pulses. Ham transmitter measurements—over and under-modulation. Locating hum—incorrect adjustment of vibrator power supplies. Phase shift in audio amplifiers.

112 PAGES 103 ILLUSTRATIONS

Only 75c

See your jobber today or send for **THE CATHODE-RAY OSCILLOSCOPE** along with other titles in the **GERNSBACK LIBRARY**.

MAIL THIS COUPON NOW

RADCRAFT PUBLICATIONS, Dept. 3
25 West Broadway, New York 7, N. Y.

Send me the books checked, postpaid.

☐ NO. 40 CATHODE-RAY OSCILLOSCOPE 75c

I enclose \$.....

Your Name.....
(Print clearly)

Address.....

Jobber's Name.....

Address.....

11 OTHER BOOKS

- | | |
|--|--|
| <input type="checkbox"/> No. 29—Handy Kinks and Short Cuts, 50c | <input type="checkbox"/> No. 34—Radio-Electronic Circuits, 50c |
| <input type="checkbox"/> No. 30—Unusual patented Circuits, 50c | <input type="checkbox"/> No. 35—Amateur Radio Builder's Guide, 50c |
| <input type="checkbox"/> No. 31—Radio Questions and Answers, 50c | <input type="checkbox"/> No. 36—Radio Test Instruments, 50c |
| <input type="checkbox"/> No. 32—Advanced Service Technique, 50c | <input type="checkbox"/> No. 37—Elementary Radio Servicing, 50c |
| <input type="checkbox"/> No. 33—Amplifier Builder's Guide, 50c | <input type="checkbox"/> No. 38—How to Build Radio Receivers, 50c |
| | <input type="checkbox"/> No. 39—Practical Disc Recording, 75c |

GERNSBACK LIBRARY

Each of these books supplies usable information

No. 29—HANDY KINKS and SHORT CUTS. A carefully edited compilation of time savers. Kinks on Antennas—Power Supplies—Test Equipment—Servicing—In the Shop—Phonographs and Amplifiers—Coils and Transformers—Miscellaneous Subjects. 50c each.

No. 30—UNUSUAL PATENTED CIRCUITS. 1944-46. A gold mine in new hook-ups! A selection of unusual circuits, many a result of wartime research—of great value to anyone interested in electronics. Control Circuits—Detectors and Amplifiers—Power Supplies—Miscellaneous Circuits—Foreign Circuits. 50c each.

No. 31—RADIO QUESTIONS AND ANSWERS. Answers to most frequently asked questions. Clear circuit diagrams. Amplifiers—Receivers—Transmitters—Meters and Test Equipment—Interphones—Power Supplies—Phonograph Amplifiers—P. A. Systems. 50c each.

No. 32—ADVANCED SERVICE TECHNIQUE. An up-to-date collection of information for the advanced serviceman: Visual Alignment—Tracking Problems—Negative Feedback—Tone Control Circuits—Adding Microphones to Sets—Matching Loudspeakers—Remote Juke Boxes—Servicing Record Changers—Hum Elimination—FM Servicing. 50c each.

No. 33—AMPLIFIER BUILDER'S GUIDE. Invaluable for the designer and builder of audio equipment. Tells how to build a wide variety of amplifiers with power outputs ranging from 8 to 30 watts. Detailed design information on: Push-Pull—Phase Inversion—Bass and Treble Boosters—Volume Expanders—Resistance Coupling—Internal Feedback. 50c each.

No. 34—RADIO-ELECTRONIC CIRCUITS. An extensive collection of circuit diagrams, with brief, to-the-point descriptions of each, including: Intercommunications Systems—Power Supplies—Balancing Circuits—V. T. Voltmeters—Amplifiers—Receivers—Phono Amplifiers—Short Wave Adaptors—Electronic Relays. 50c each.

No. 35—AMATEUR RADIO BUILDER'S GUIDE. For the "ham" who builds his own. Practical, down-to-earth it tells how to Build: A 2 Meter Band Acorn Tube Set—Miniature Communications Receivers—Long Lines Transmitter—Beginner's Transmitter—Preselector—Rotary Beam Aerial—Power Supplies—and other ham gear. 50c each.

No. 36—RADIO TEST INSTRUMENTS. A MUST for every radio man. This latest book on building test equipment places emphasis on practical construction of: Signal Tracers—Capacity Meters—Portable and Bench Multi-checker—Signal Generators—Tube Checkers—Electronic Voltmeters—and many others. 50c each.

No. 37—ELEMENTARY RADIO SERVICING. For the radio man who knows little about servicing. How to get started, and even more important how to keep going: Planning the Service Shop—Equipping the Shop—Systematic Circuit Checks—Signal Tracing Methods—Servicing the Midget—Soldering—Servicing Volume Controls—How to Service Speakers. 50c each.

No. 38—HOW TO BUILD RADIO RECEIVERS. This book contains a sufficient variety of sets to appeal to every radio fan. Includes: Short-Wave, Broadcast, Portable, A. C. Operated, Miniature and Standard Receivers. Complete coil-winding data is furnished. 50c each.

No. 39—PRACTICAL DISC RECORDING. This invaluable book is the last word on making good recordings. Technique as well as underlying principles are fully covered. Each important recording component is given a full chapter, explaining its purpose and what features to look for when buying. 96 pages. 75c each.

The FIVE BRIGHTEST STARS

in the RECORDING FIELD!



Model 808 Foundation Chassis

Basic recording and playback chassis used in all TWIN-TRAX high fidelity recorders. Supplied with 32-page instruction book. Ideal foundation unit for engineers, technicians, experimenters. Net Price \$89.50



Model 910-B 4 Hour Long Play

The only magnetic tape recorder combining long play with high fidelity. Record and playback continuously any program up to 4 hours duration. Frequency Response 40-10,000 cycles ± 2 db. Net Price \$495

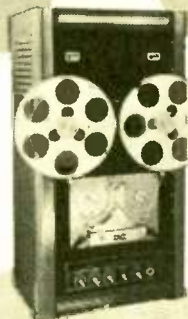
Model 710-B Portable

New idea in portable recording equipment. Divides weight for easy, balanced carrying, into 2 matching luggage type cases. Mechanical chassis and speaker in one case, amplifier in other. Ideal for on-the-spot recording. Net Price \$335



Model 810-B Standard Recorder

In handsome leatherette or walnut cabinet. Records, plays back voice, music, with excellent results. No special technical knowledge required. Records radio programs, without extraneous room noises. Net Price \$285



Model 510-B Rack Panel Series

Economical, highly efficient permanent installations for radio stations. Models available for continuous 1 hr. or 4 hr. programs. 8" monitor speaker; Mechanical chassis and all controls vertically mounted. High fidelity. Standard NAB tape speeds 7 1/2" and 15" per sec. Automatic switchover systems available. Net Price for one-hour model \$435

What TWIN-TRAX* Recording is:

Not one, but TWO independent, isolated sound tracks recorded on standard reels of 1/4" wide magnetic tape — that's the revolutionary new idea behind TWIN-TRAX. One track records during forward tape travel, the second during reverse. Automatic instantaneous reverse action assures continuous flow of program material, eliminates necessity for rewinding. Result: DOUBLED playing time — no loss in frequency response or quality — and best of all, your tape costs are cut in HALF!

Partial List of TWIN-TRAX* Features:

One hour of continuous play. Frequency response 50 to 9000 cycles ± 3 db. Individual bass and treble controls. Simplified tape threading. Low hum level (DC on heaters). No mechanical noises. Instantaneous reverse control — without unthreading tape! Instantaneous stop — no slurring. High speed forward and reverse shuttle without unthreading. Complete elimination of capstan tape slippage. 3.2 and 500/600 ohm balanced line outputs. Twin electronic erase heads. Flutter and wow $\pm 0.1\%$. No belts to loosen or pulleys to slip.

Write TODAY for Descriptive Literature!

*Registered Trademark

AMPLIFIER CORP. OF AMERICA

398-10 BROADWAY

NEW YORK 13, N. Y.