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101

37-AMP

RADIO - ELECTRONICS

Circuits

ED. R. ALLAN TV
39 MARY ST. — BOX 42
PICTON, ONTARIO

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101

**RADIO —
ELECTRONICS**

Circuits

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and

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ED. R. ALLAN TV

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Radcraft Publications, Inc.

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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-tuber. 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.

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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.

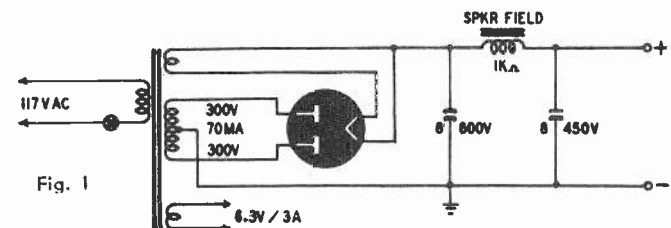
The neophyte would profit by using common sense alone in many cases, if he could see just where and how to use it. For example, how often is a builder puzzled about the voltage rating of the electrolytics in a diagram of an a.c.-d.c. receiver? Common sense would immediately point out that there cannot 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.

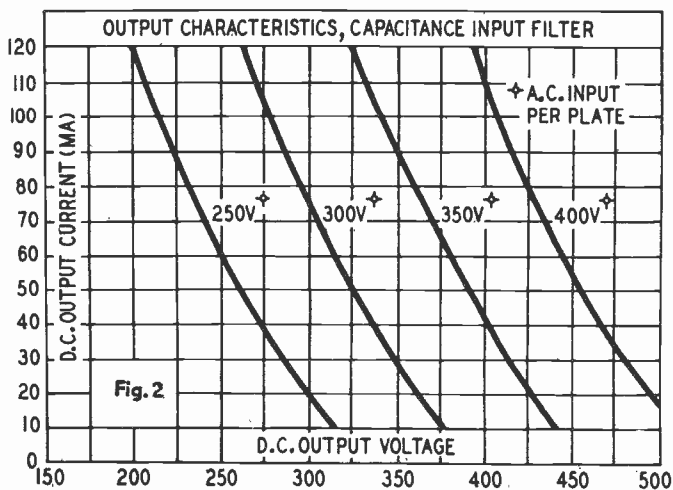
Amperage ratings are different. If voltages and resistances remain the same, the same amperage will flow (see Ohm's Law again) regardless of the amperage rating of the transformer winding or choke coil (or wattage rating of the resistor) through which it flows. Thus for our 60 ma, a transformer with 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 μf 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 μf and 100 μf 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 μf

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- μf 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.

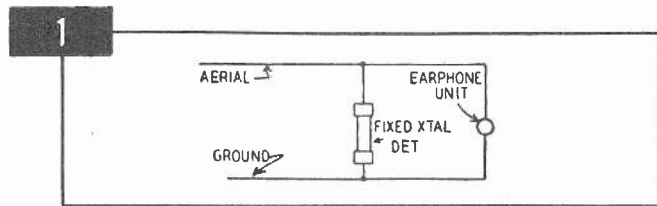
Standard commercial coils, or coils from old receivers, may be adapted to the constructor's uses. Know what you are using, though! If a high-impedance antenna coil primary (one with a large number of turns) is used as tickler in a regenerative circuit, the set will oscillate uncontrollably. The remedy 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.

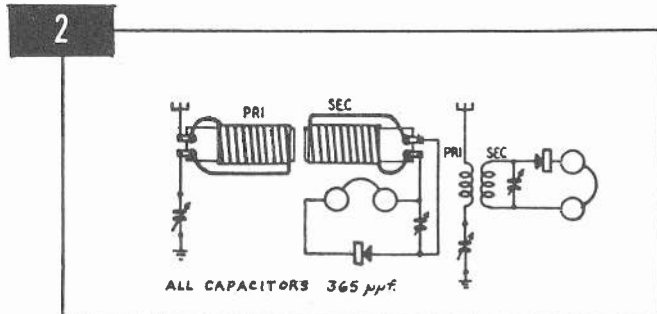


The crystal receiver, if carefully constructed, may be a reasonably selective and fairly long-range radio set, and a real source of radio entertainment. Its quality has always been admitted to be better than that of any other type of receiver. It is probably easier to abuse than any other circuit, and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

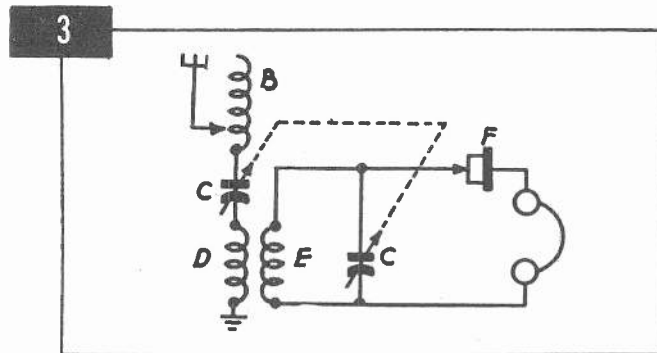
Crystal reception over distances up to 1,000 miles is not at all uncommon, and can be attained regularly under good conditions. If distance is to be sacrificed for selectivity, a two-circuit, loose-coupled set can be made which will compare well with some t.r.f.'s.



1. 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.



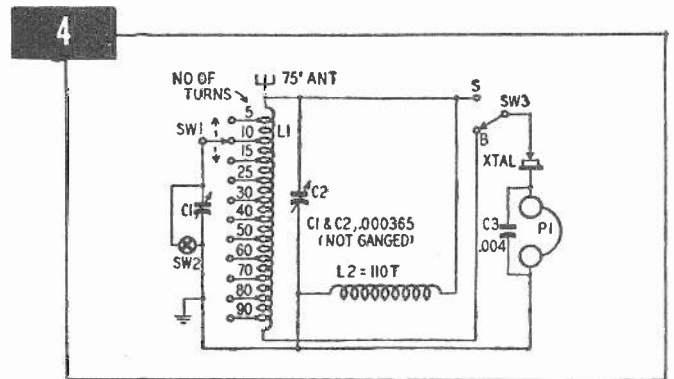
2. Pictorial and schematic of a two-circuit crystal receiver. Coils are two halves of a broadcast t.r.f. coil cut apart and mounted so the coupling is variable.



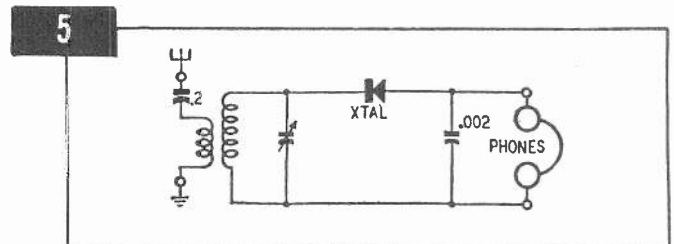
3. The "Loud" crystal radio. Coil B is 60 turns of No. 24 d.c.c. wire, tapped every fifth turn. Capacitor C is a 2-gang 365 $\mu\mu\text{f}$ unit (insulated from the chassis). Coil D uses 15 turns of No. 24 d.c.c. wire, and coil E—separated from it one-eighth of an inch on the same form—is wound with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

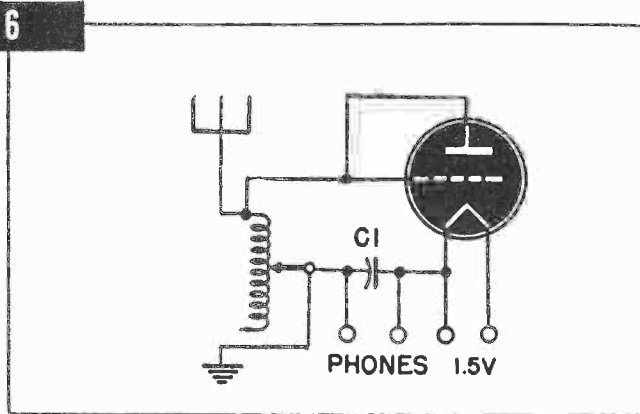
Selectivity depends on loose coupling and good, low-resistance coils. High-Q coils may be wound by using large, double-cotton-covered wire (or better, litzendraht) and by using low-loss coil forms or no forms at all. Coupling may be reduced by winding coils further apart on the same form, or by mounting 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.



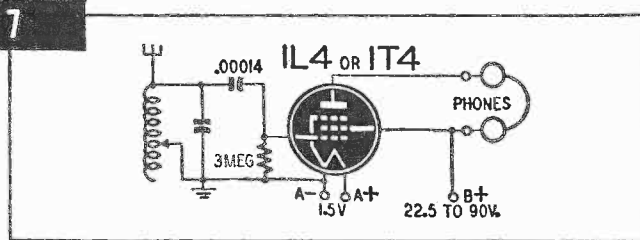
4. The Modern crystal receiver uses a 1N23 crystal. Coil is wound with No. 22 d.c.c. wire on a 2-inch form, tapped as shown. L2 is No. 34 d.c.c. on a 2-inch form.



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

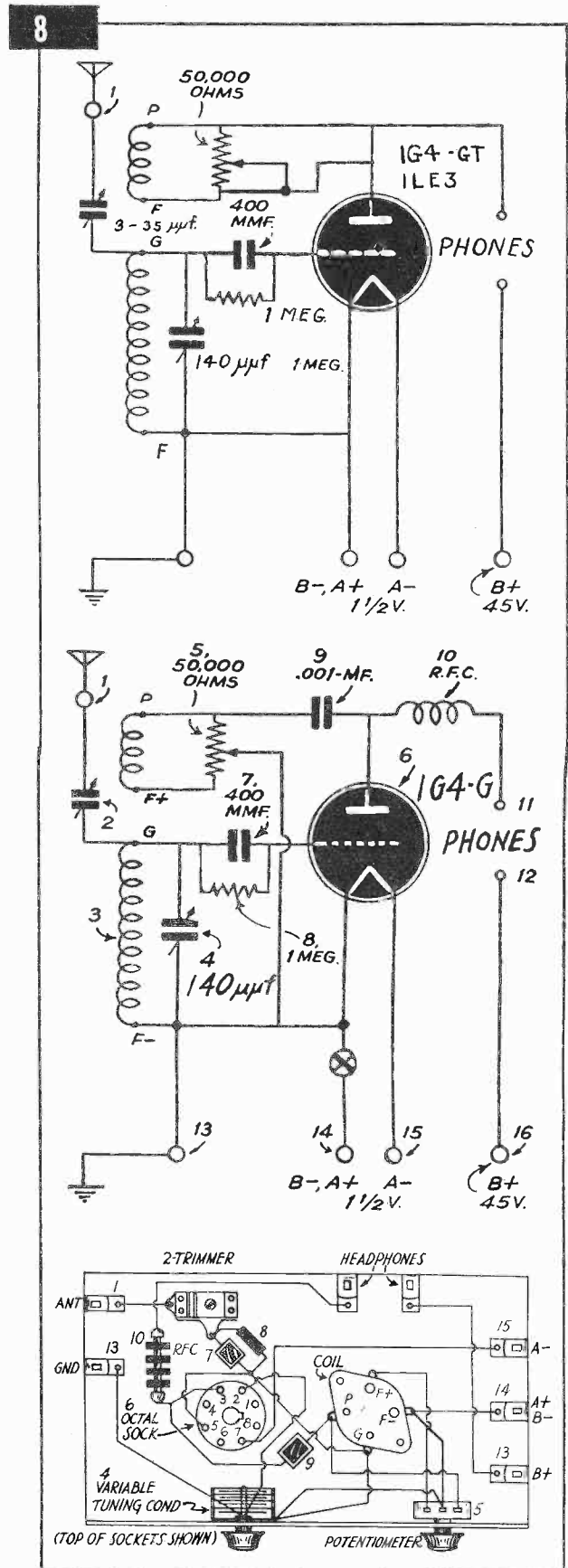


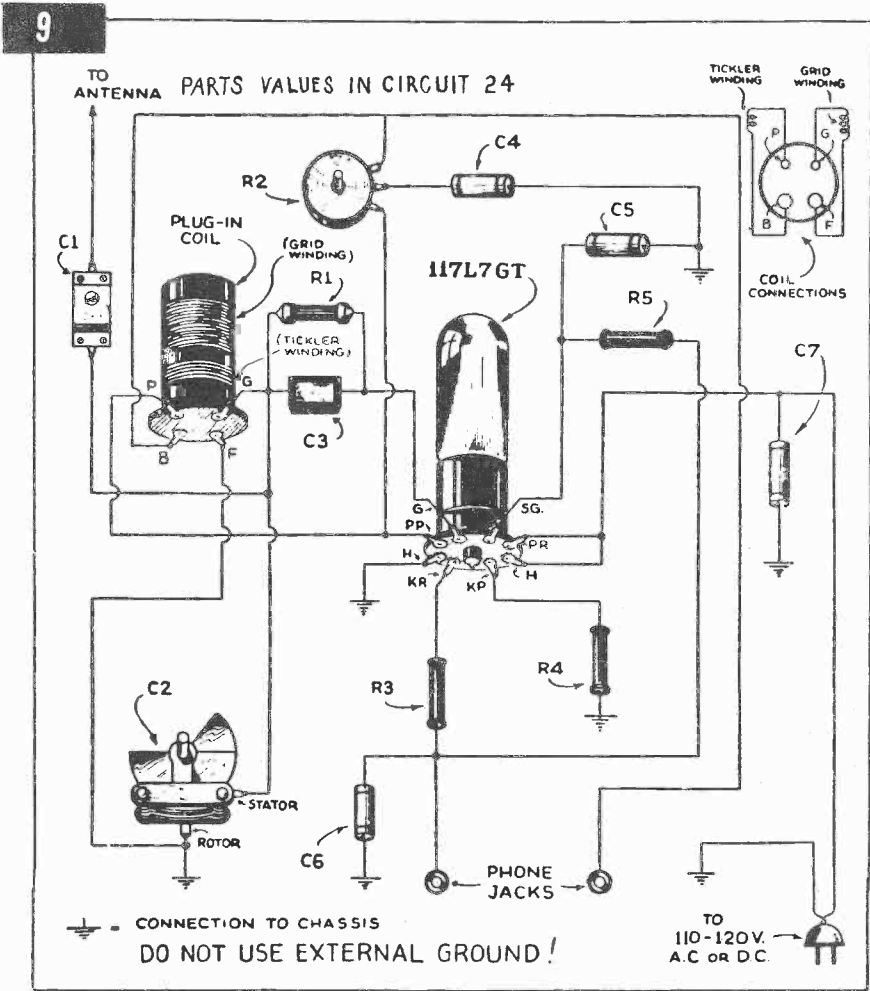
6. This is the simplest of all tube circuits, using only a diode-connected 1G4 and a tapped coil. A 6H6 may be used in this circuit if there is a.c. available for the filament. The capacitor C1 is not critical—may be .001 or .002 microfarad.



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.

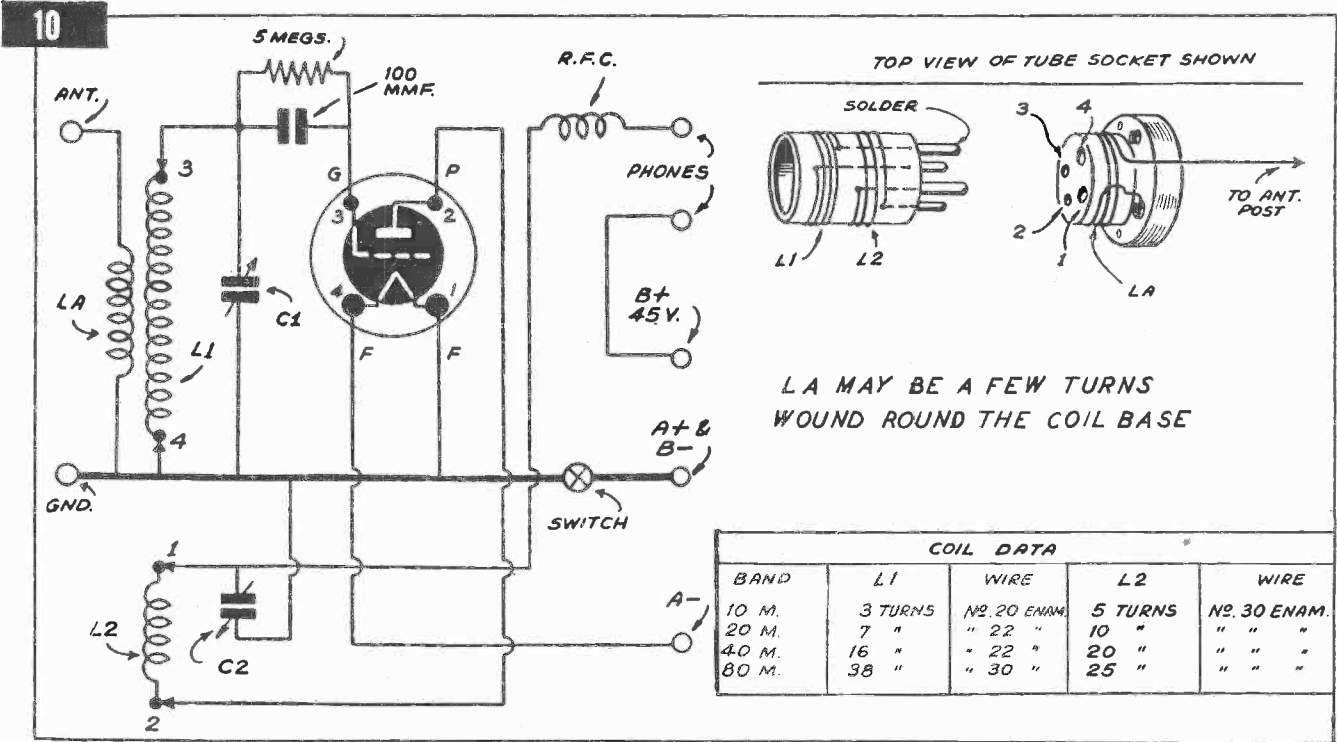
8. One of the simplest types of regenerative receiver. Two forms (series fed in the top figure and shunt fed in the bottom one) are shown. In the series fed circuit B-current passes through the tickler; in the shunt type it is supplied through an r.f. choke, the r.f. passing through the .001- μf capacitor 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.



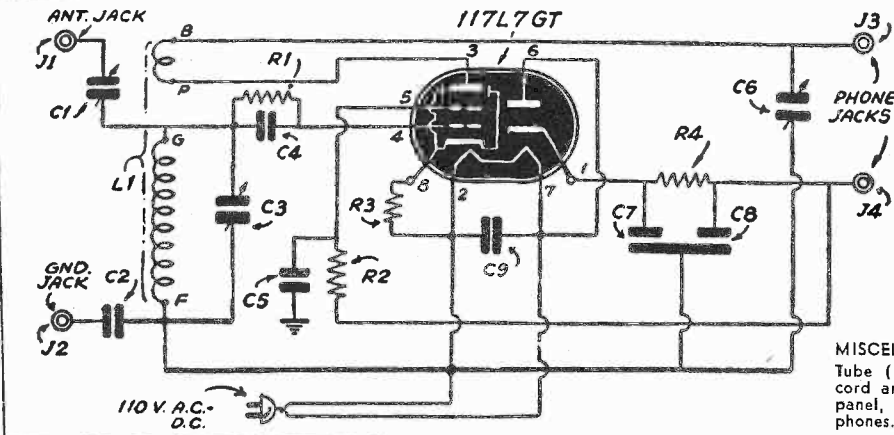


9. This 1-tube line-operated receiver is the famous Pigmy. Those who have any difficulty in following the pictorial diagram will find the schematic on page 15, in the 2-tube Pigmy circuit, shown in Circuit 24. Remember when following pictorials that not all plug-in coils are wound in the same way. Trace the coil terminals carefully and hook them up carefully so that, if the two coils are wound on the form in the same direction, the top lead is the grid, the bottom lead of the same coil, ground, the adjacent tickler lead, B-plus, and the other end the plate. If the coils are not so connected, the effect will be degenerative, not regenerative, and the set will be extremely insensitive.

10. One of the most famous of regenerators, this has been known under the various names of Hartley, Reinartz and Schnell, the names distinguishing very slight variations of the fundamental circuit. Regeneration in this circuit is controlled by a capacitor between the tickler (B-plus end) and ground. All r.f. flows through this capacitor, and by increasing its capacitance, the r.f. path is made easier and regeneration is increased. The radio-frequency choke (any size) prevents r.f. from flowing in any other circuit. A set of coil data is given, and the method of winding is shown very clearly. The original Reinartz attained great success with these windings on a spiderweb coil. An exactly opposite hook-up, the throttle circuit, with the variable capacitor connected between plate and ground, is also used.



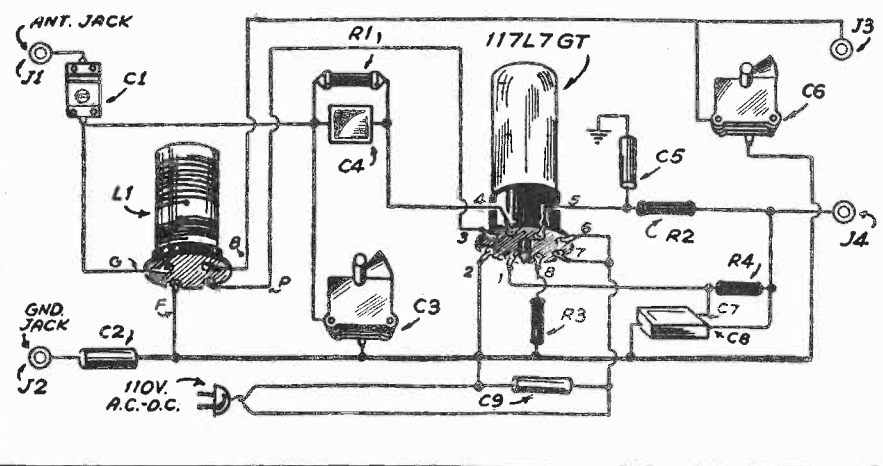
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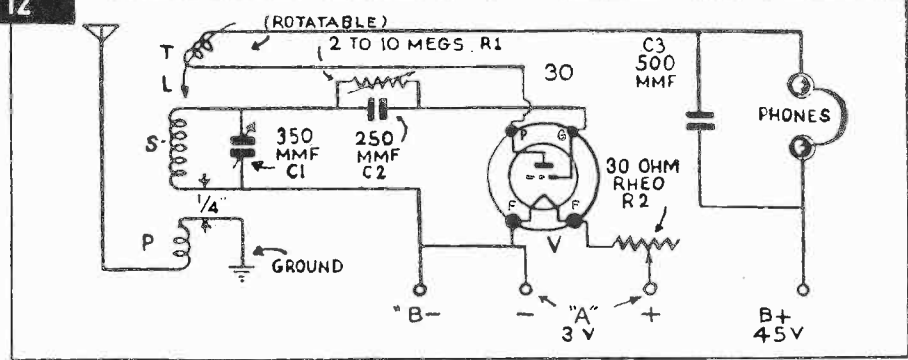
- PARTS LIST**
- RESISTORS**
 R1—2 meg, 1/2 watt
 R2—1 meg, 1/2 watt
 R3—150 ohms, 1 watt
 R4—10,000 ohms, 1 watt
- CAPACITORS**
 C1—Antenna trimmer, 3-30 μf
 C2, C5, C9—0.1 μf , 400 volts
 C3, C6—140 μf variable
 C4—250 μf mica
 C7—8 μf , 250 volts electrolytic
 C8—40 μf , 250 volts, electrolytic

MISCELLANEOUS
 Tube (117L7-GT) 4 pin jacks (J1, J2, J3, J4), line cord and plug, roll of hookup wire, 2 knobs, dial panel, octal socket, coil and plug-in socket, headphones.

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 μf instead of 140 μf 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.



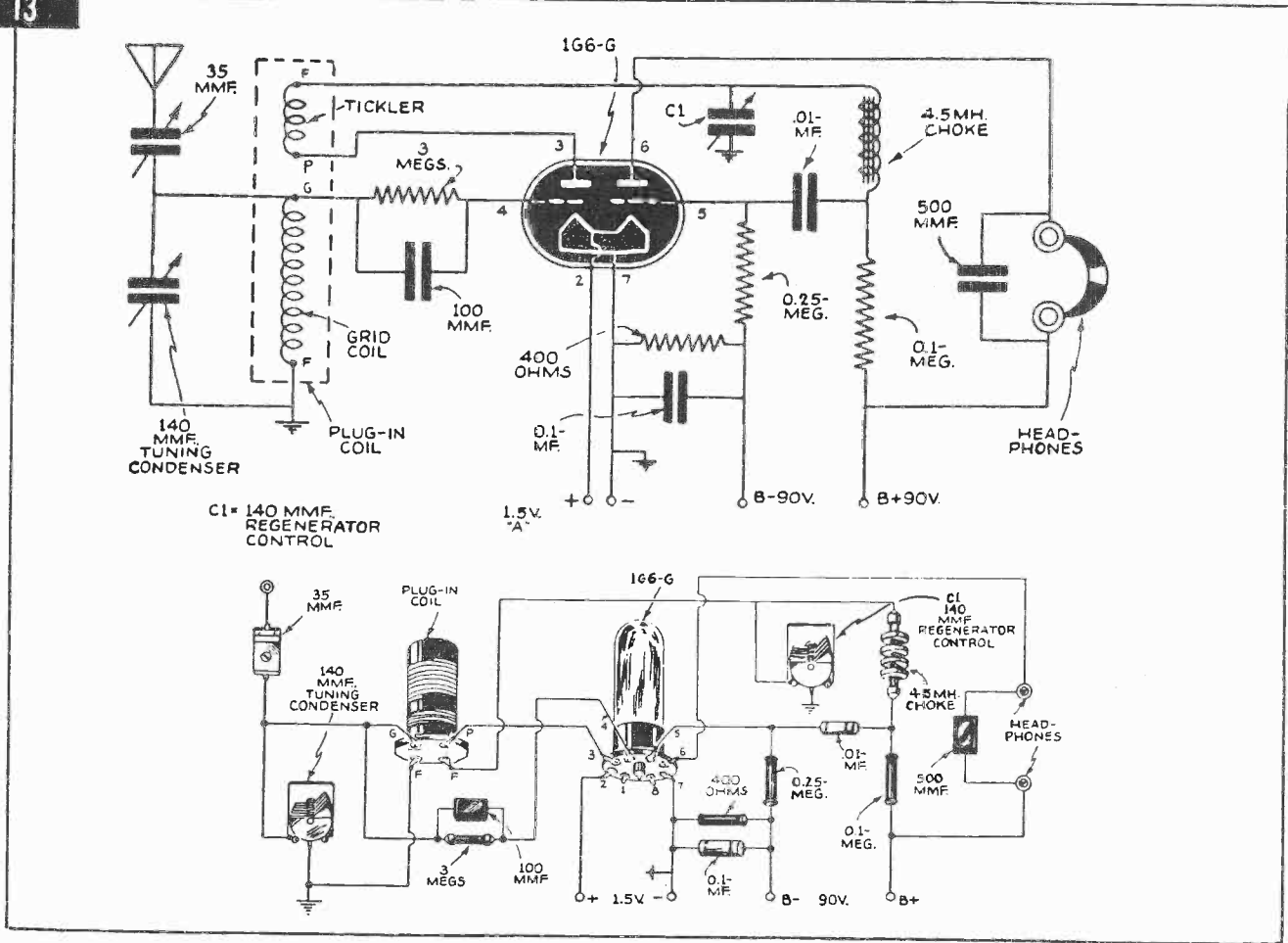
12



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,

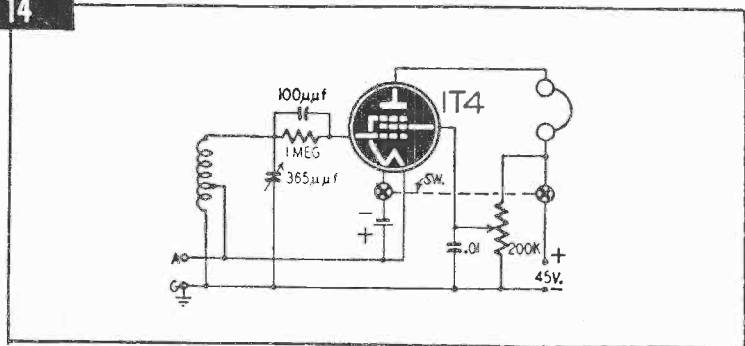
which has holes bored in it for the shaft. The large form is wound with about 40 turns of No. 24 wire. Enamel insulation may be used in all cases. The primary is a dozen turns of No. 28 wire wound about 1/8 inch away from the ground end of the grid winding. The tickler coil should fit snugly enough that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

13



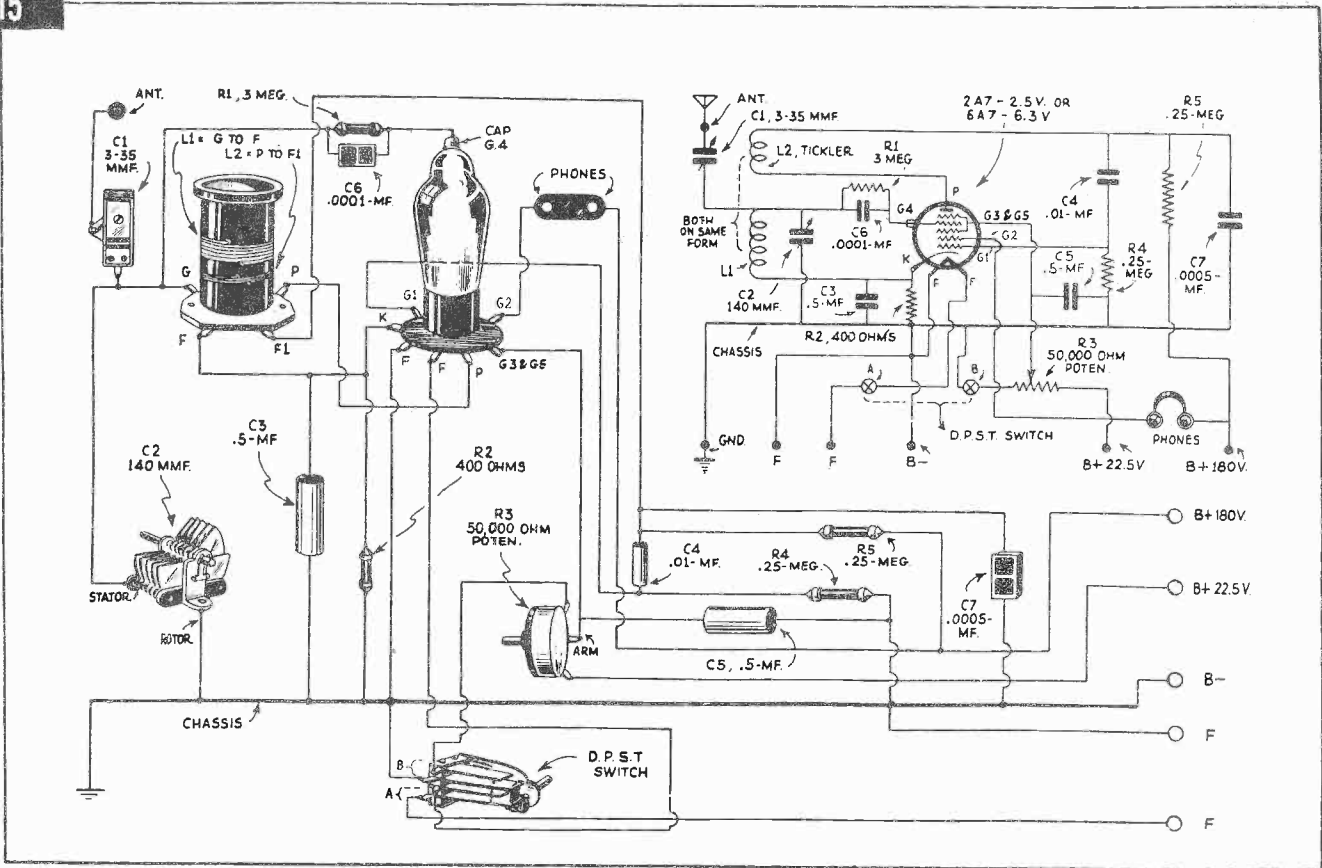
13. The Twinplex is a 2-tube set with one tube. The circuit has been described in numerous variations, some with 6-volt tubes operated by a.c. This is one of the simplest and most modern, using a 1G6-G, which draws 0.1 ampere at 1.4 volts. Any standard regenerative-receiver coils may be used. If the set is intended for broadcast only a 365- μf tuning capacitor may be used instead of the 140- μf shown. C1 may be either a 140- or 365- μf capacitor. Transformer coupling of the two sections of the tube has been used in some Twinplexes—the primary takes the place of the 0.1-meg plate resistor and the secondary that of the 0.25 meg leak. The Twinplex is a very convenient portable, and can be mounted inside a small carrying case, with plenty of room for extra coils. If these are of a low-loss type, excellent shortwave reception may be expected with this radio. A magnetic speaker may be used with this set on local stations. In that case the B-battery voltage may be run up to 110. The pictorial diagram shows the method of wiring and may prove helpful to the new constructor, though in a set of this size placement of parts is entirely uncritical. This receiver has appeared in a great number of modified forms, and works excellently as an a.c. receiver, using such tubes as the 6N7, 6C8, 7N7, 6J6, 12AU7, and equivalent types.

14



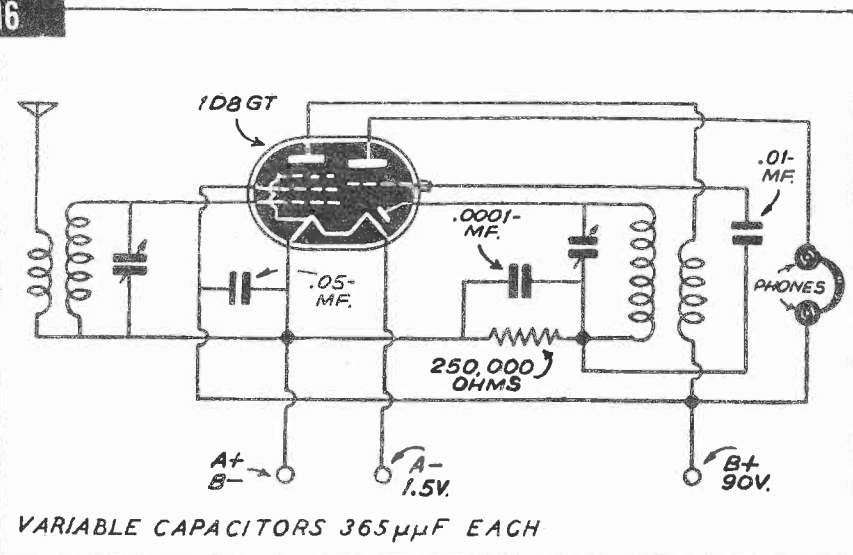
14. The electron-coupled circuit, new the most popular of shortwave regenerative hookups. The winding between the filament and ground is actually the tickler and the plate of the regenerative circuit is the screen grid, which is grounded at radio frequencies by the .01 capacitor. Regeneration is controlled by varying the voltage on the screen with the 200,000-ohm potentiometer. The capacity of the A battery to ground is across the "tickler" in this circuit, and therefore must be kept small. If the set is built on a metal chassis, it may be necessary to mount the battery clear of it on wooden blocks. A cathode-type tube works best, and the electron-coupled circuit is more often seen with an a.c. pentode like the 6SJ7. The antenna may be coupled as shown, attached to the grid end through a capacitor, or to a separate primary. With a stage of audio, it makes an excellent shortwave receiver.

15



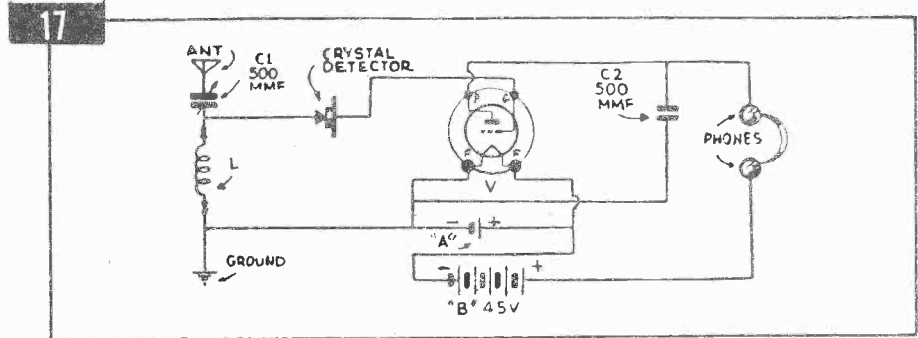
15. The Pentaflex, another of the two-in-one circuits. The signal is detected in the mixer circuit and amplified in the oscillator circuit of a standard converter tube. Though a 6A7 is shown, this hookup might work well with a 1R5. The signal comes in to grid 4 and is detected. Grids 3 and 5, acting 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- μ f 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.

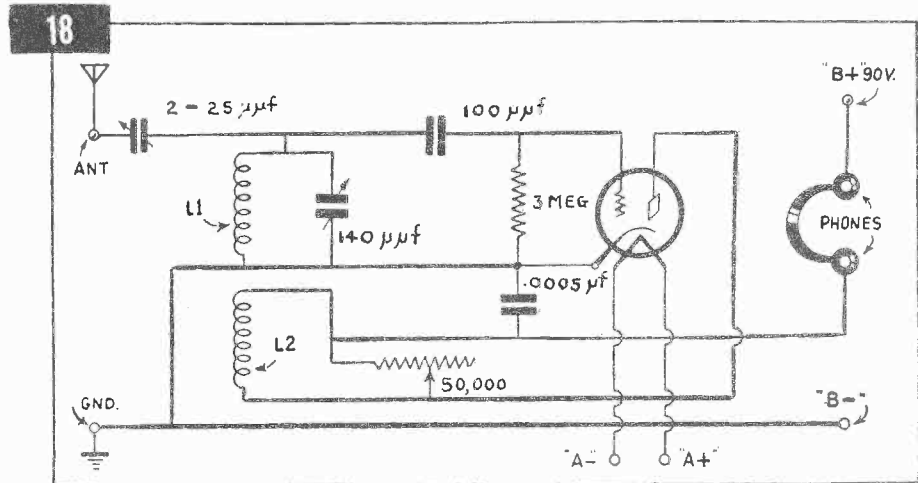
17. The Interflex, a crystal detector in the grid circuit of a 1-tube set, which then acts as an audio amplifier. Excellent reproduction is obtainable with this receiver, as the crystal detector is unsurpassed in fidelity. Sensitivity may be increased greatly by adding regeneration, which may be done 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.



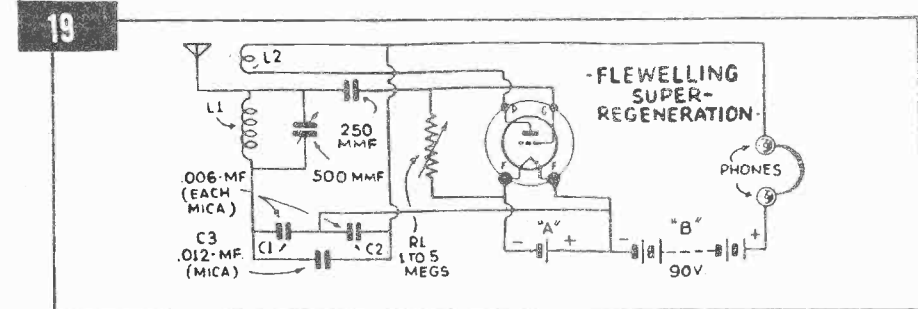
18. The Oscillodyne is a special type superregenerator. A large tickler coil is its secret. Coils are wound on 1½-inch diameter forms with No. 30 enamel wire, ⅛ inch in between the two windings, as follows:

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

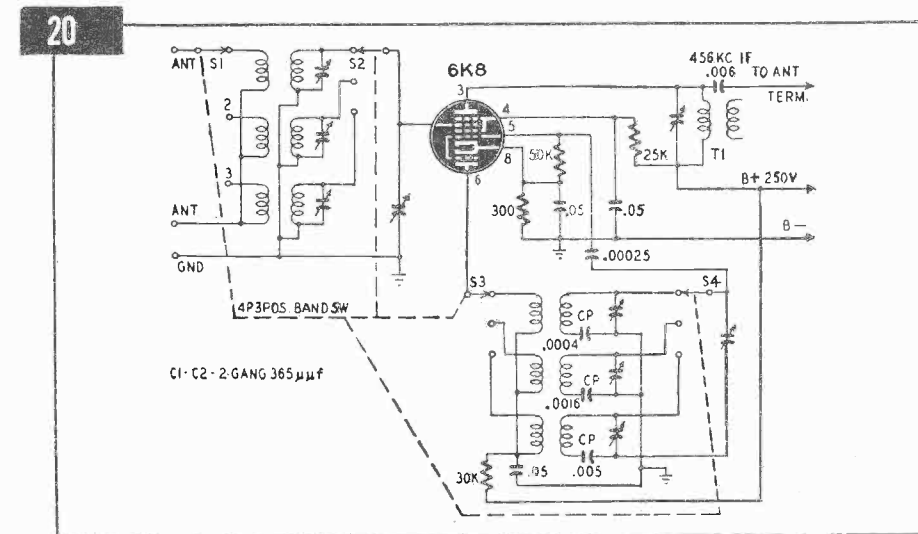
Space the higher-frequency coils to cover the desired band. For the broadcast band, a high-impedance antenna coil may be used, with the primary winding for the tickler. This set has made numerous dx records.



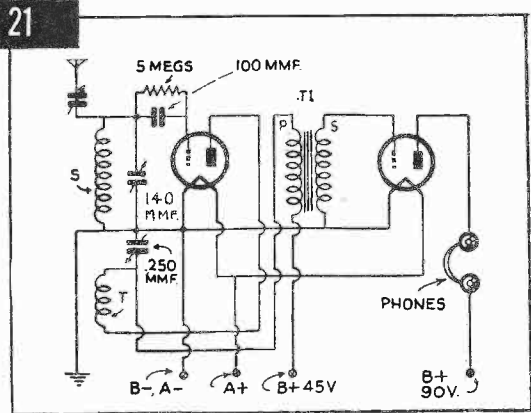
19. The Flewelling superregenerator, a set which depends on three large mica capacitors (C1, C2, C3) for the low-frequency oscillations that produce superregeneration. The tickler coil should be large; the data given for the Oscillodyne may be used for this receiver as well. This is one of the simplest 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 buy 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.



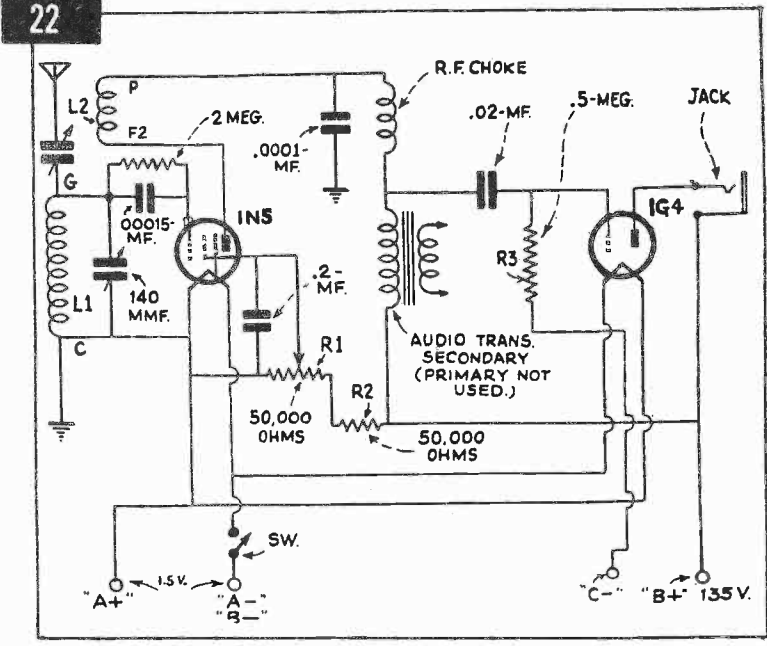
14 Two-Tube Circuits



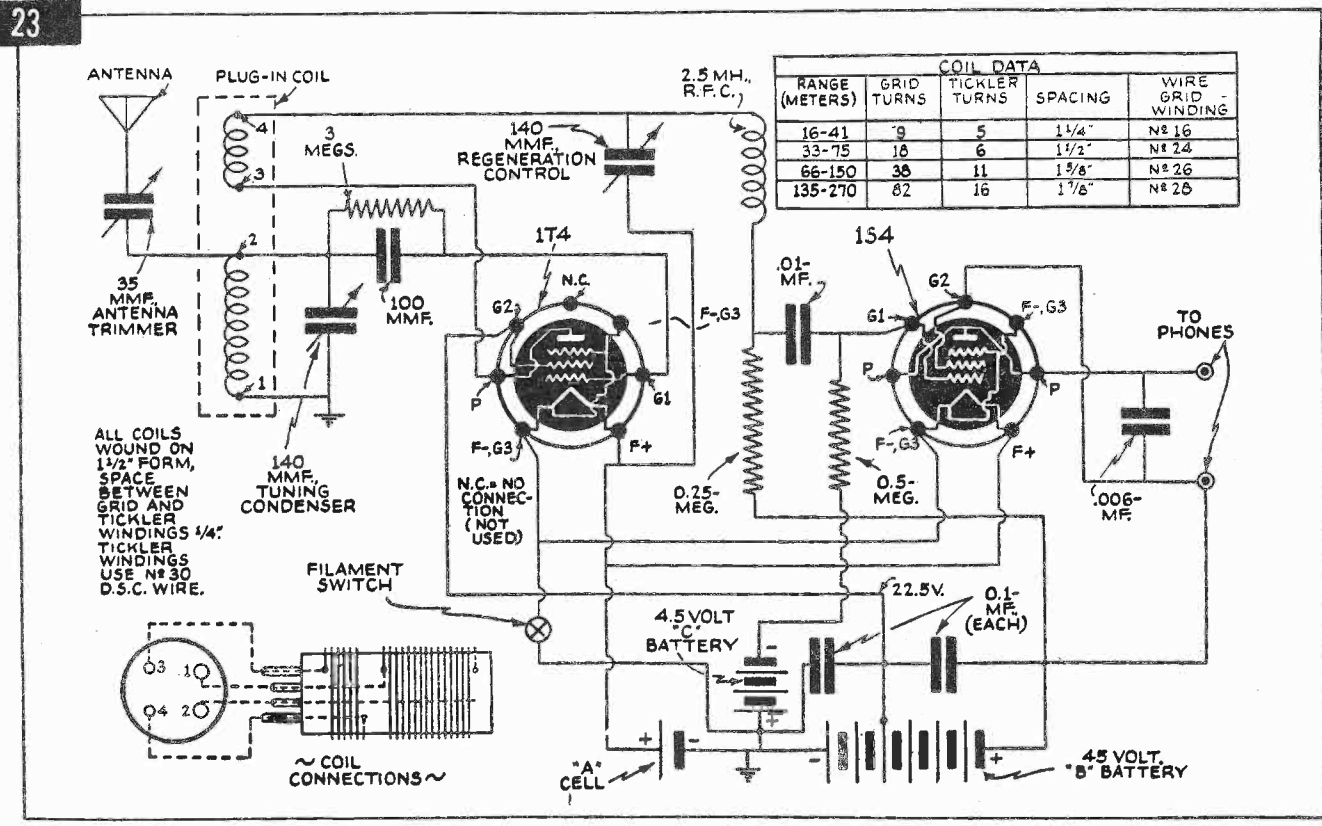
21. A regenerative triode with one stage of transformer-coupled amplification. This set is probably the easiest-constructed 2-tuber, and as the original Doerle receiver, had a reputation for distance-getting. Coil forms are UX tube bases on which the coils are wound with No. 24 enamelled copper wire,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



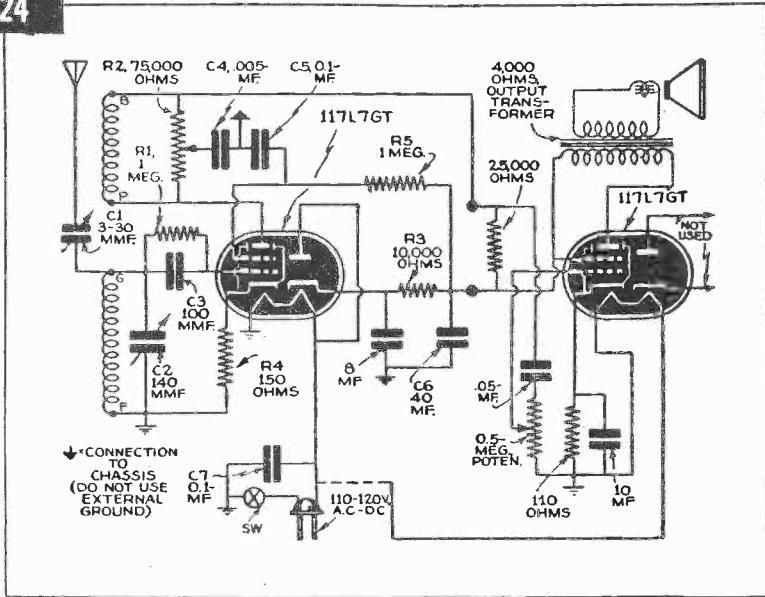
22. This circuit uses a screen-grid tube as detector. Regeneration is controlled by varying the screen potential. Impedance-coupling to the audio stage is used, any high-inductance choke such as the secondary of an audio transformer being suitable.



23. 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.

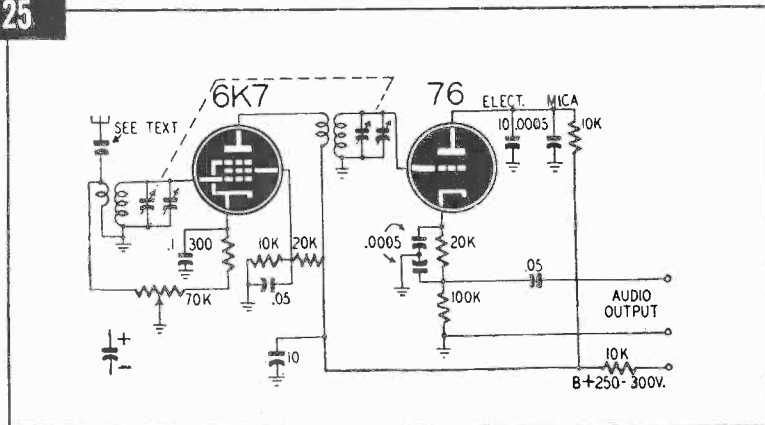


24



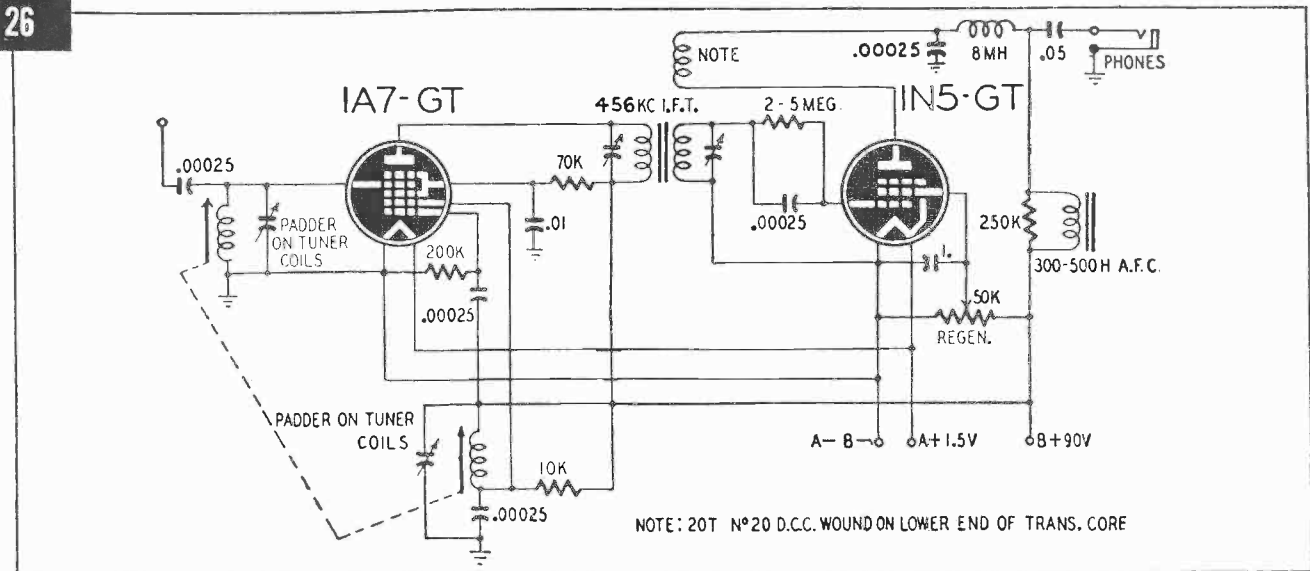
24. The Pygmy receiver of Circuit 9 has a stage of resistance-coupled amplification. This set can be built as a 1-tuber by omitting all parts beyond the two heavy dots.

25



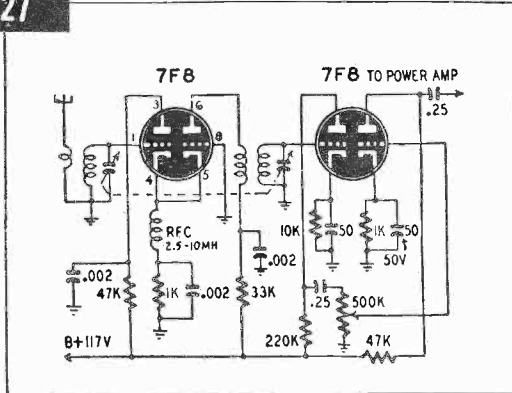
25. One stage of tuned r.f. followed by a plate detector with a cathode-follower output. This circuit was designed as a high-fidelity tuner to feed into an audio amplifier, but will work equally well as a head-phone receiver, though for that purpose a stage of audio would help it greatly. As a high-fidelity 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.

26



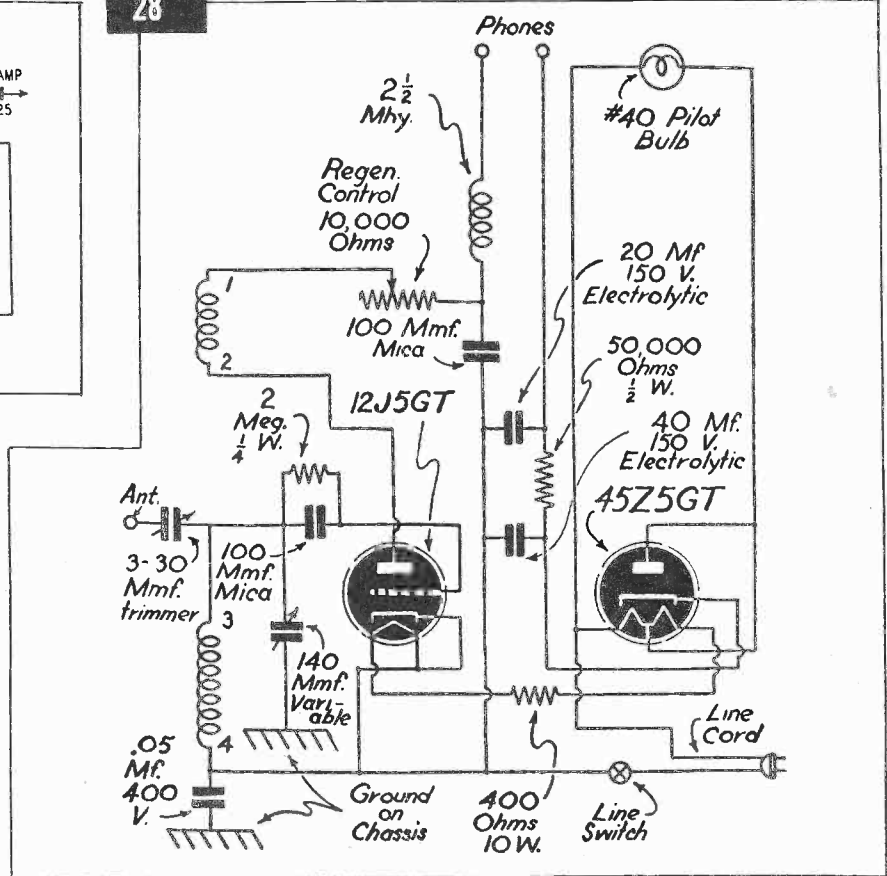
26. A regenerative superheterodyne using only two tubes. While not greatly more sensitive than other 2-tube receivers, this radio is more selective and has the great advantage that once the regeneration is set, it may be left undisturbed while tuning in nearby stations. This feature is particularly valuable 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.

27



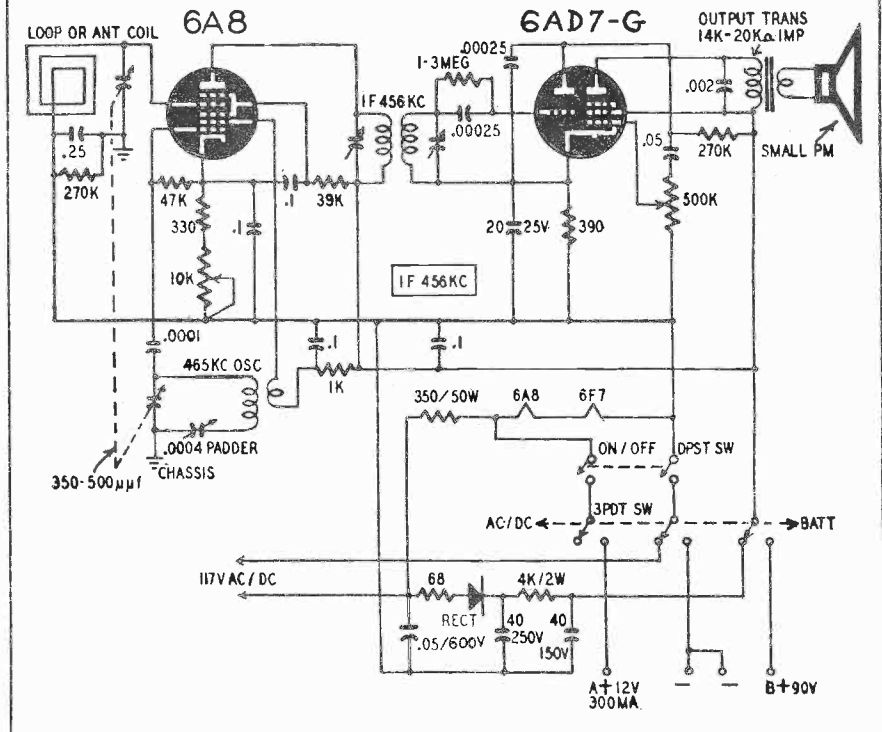
27. One of the many Four-in-Two circuits, where two twin triodes give the results of a 4-tube set. Actually the first tube in this receiver—due to its grounded-grid circuit—does not give the full amplification of two triodes. The circuit is extremely stable. The first section of the second triode is a plate detector and the second an audio amplifier. This is an excellent little receiver for head-phone reception. The B-voltage, shown as 117, may be increased to 250 for sensitivity.

28



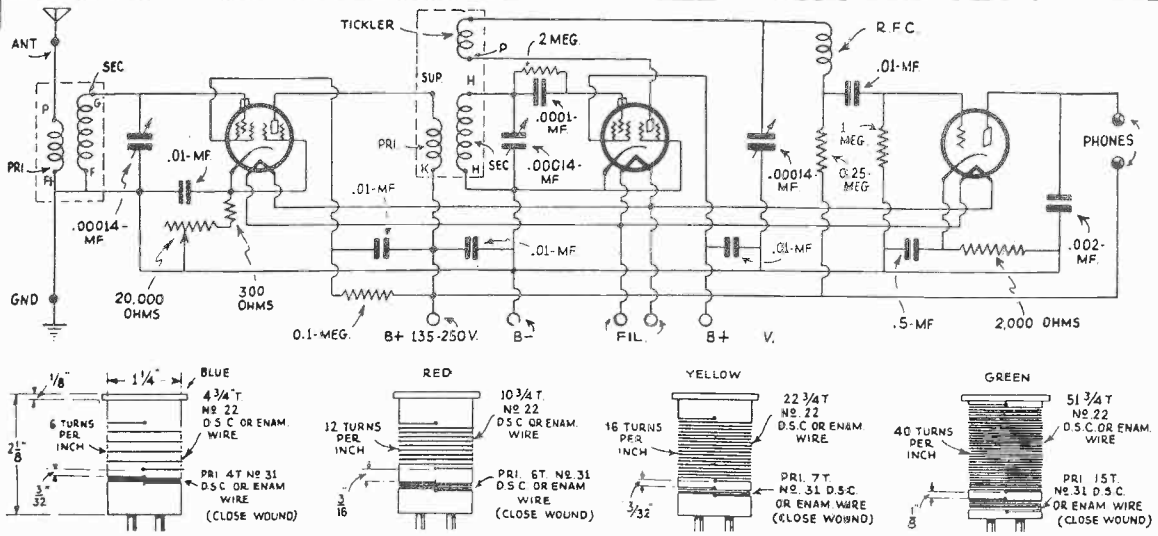
28. First half of the Progressive receiver, a set which can be expanded from a 2- to a 4-tuber, as is shown in Circuit 41. The 2-tuber is a 1-tuber in effect, as the other tube is a rectifier, used only to supply power to the receiver. Regeneration is controlled with a 10,000-ohm variable resistor in 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.

29



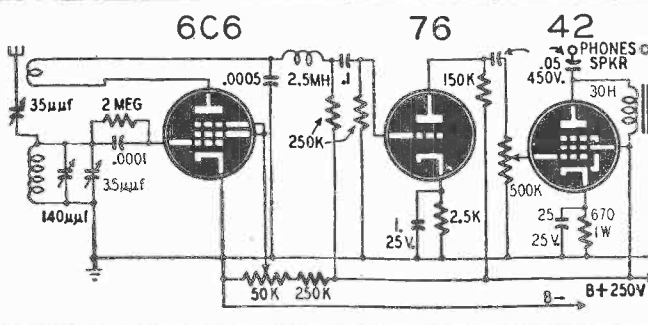
29. Another 2-tube super. This one has a selenium rectifier and operates from the power lines, driving a loudspeaker on powerful local stations. The first tube is a standard 6A8 converter, which produces the intermediate-frequency signal. The second tube is two tubes in one, a triode detector and pentode amplifier. Grid-leak detection is employed for greater sensitivity, and the output is resistance-coupled to the pentode section of the 6AD7. No regeneration is used in this circuit, which may therefore not be as sensitive to distant stations as the 2-tube dry-cell superhet just described. The loop antenna is also a factor in reducing sensitivity, and if reception over a considerable range is expected, should be replaced with a good antenna coil.

30



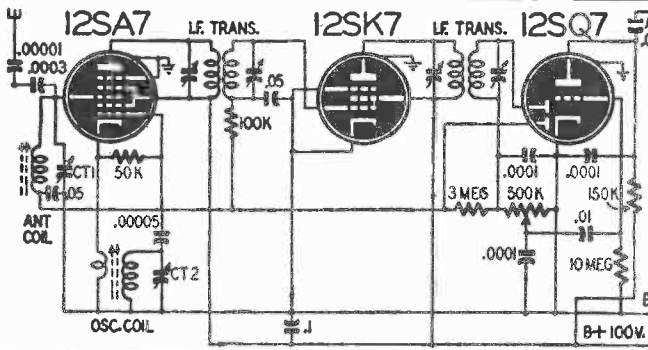
30. The old Doerle 3-tube Signal Gripper, one of the all-time record holders. It has an r.f. amplifier, regenerative detector and one-stage audio amplifier. Regeneration is by the Reinartz method. Coils shown will tune from below 15 to above 100 meters, and the tuning ranges may be extended with other coils.

31



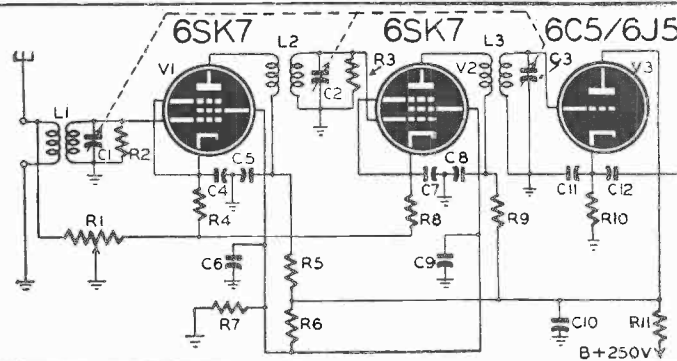
31. A regenerative detector with two stages of audio. Regeneration is controlled by varying the voltage on the connected screen and suppressor grids. An output transformer may be used instead of the choke-capacitor output shown. For phones it should have an output winding of 500 ohms or higher.

32



32. A 3-tube tuner or receiver. If used for direct phone reception, the detector may be a 12SR7, with phones inserted in the plate lead. The 150,000-ohm plate resistor would not then be used.

33



33. A high-fidelity broadcast tuner, with infinite-impedance detector. The swamping resistors across the coils may be omitted for greater sensitivity though fidelity will of course drop accordingly.

Parts List

RESISTORS

- R1—110,000-ohm potentiometer
- R2, R3—100,000 ohms
- R4—400 ohms
- R5—10,000 ohms
- R6—50,000 ohms
- R7—60,000 ohms
- R8—400 ohms
- R9—10,000 ohms
- R10—60,000 ohms
- R11—5,000 ohms 10 watts (optional if power supply is well filtered)

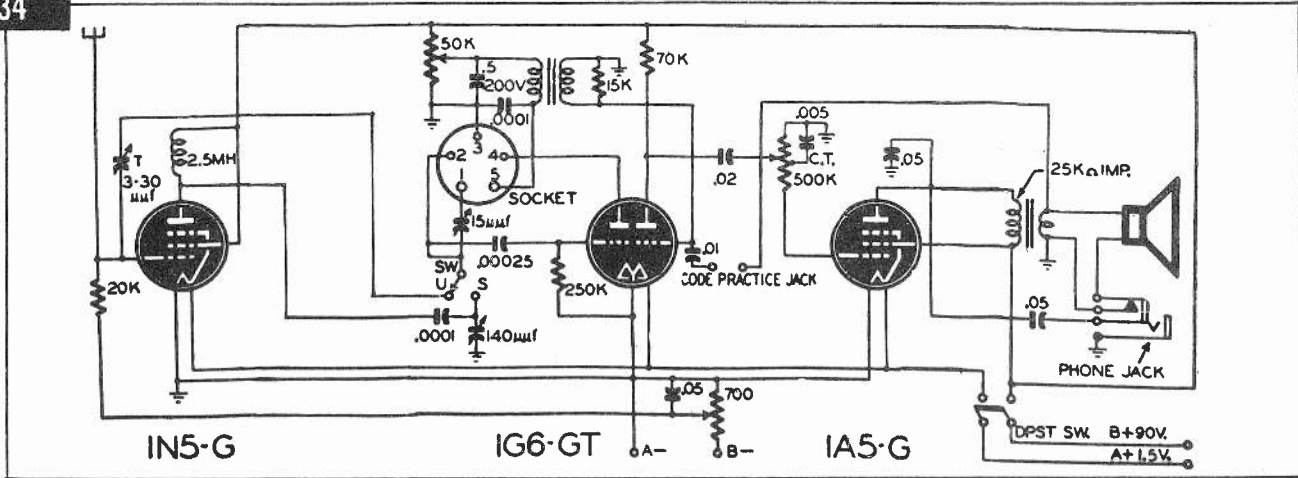
CONDENSERS

- C1, C2, C3—gang condenser, .00036
- C4, C5, C6, C7, C8, C9—1 µf
- C10—8 µf, 450 volt electrolytic
- C11—.0001 µf mica
- C12—1 µf, 600 volt, tubular

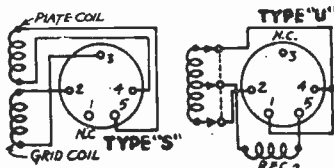
MISCELLANEOUS

- L1—14-7413 Meissner Iron Core shielded coils
- L2—14-7558 Meissner Iron Core shielded coils
- L3—14-7558 Meissner Iron Core shielded coils

34



34. The All-Wave Explorer, a set for the all-round experimenter. With the switch in position S the set tunes from the broadcast band to 28 mc. For higher frequencies, switch is thrown to position U, cutting the 140-μf capacitor out of circuit and connecting the detector direct to the antenna. By inserting a key in the CODE PRACTICE JACK, the set becomes a code oscillator. Coil values are given in the table, and details below. Note that some coils are simply one or part of a turn of wire, centertapped.



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.

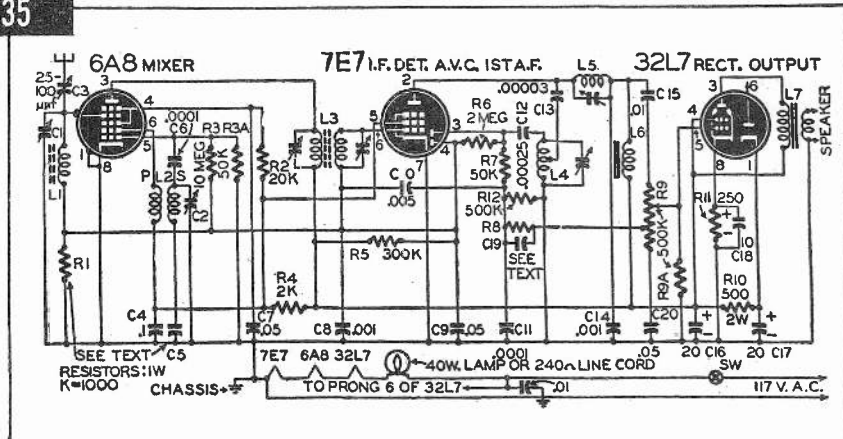
35. The Super-Reflex, another Conntatser circuit in which the 7E7 is i.f. and a.f. amplifier as well as detector. Coils L4 and L5 are i.f.t. replacement windings, or may be taken from i.f. transformers on hand. L1 and L2 may be standard antenna and oscillator coils, though the designer used an antenna 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.

PLUG-IN COIL DATA TABLE

All windings wound in same direction.
All "S" series coils on 1/2-inch forms.

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

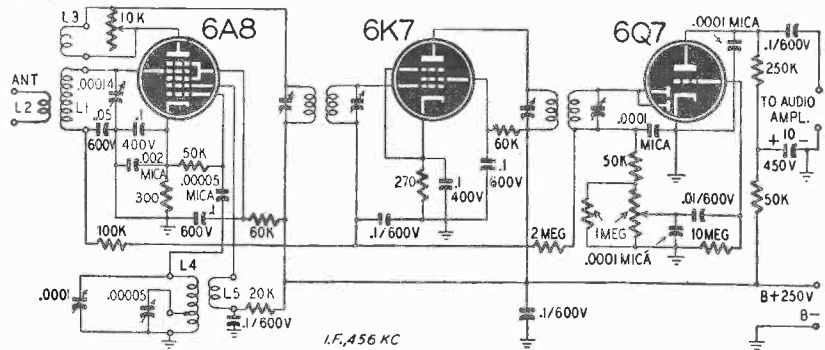
35



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.

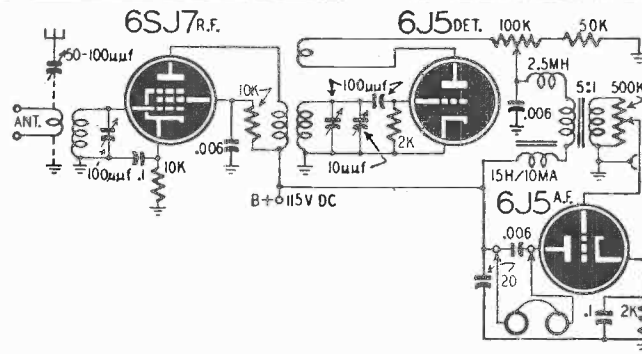
36



RANGE	L1		L2		L3		L4		L5		L4 TAP TURNS FROM BOTTOM TO TAP
	TURNS	WIRE SIZE	TURNS	WIRE SIZE	TURNS	WIRE SIZE	TURNS	WIRE SIZE	TURNS	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

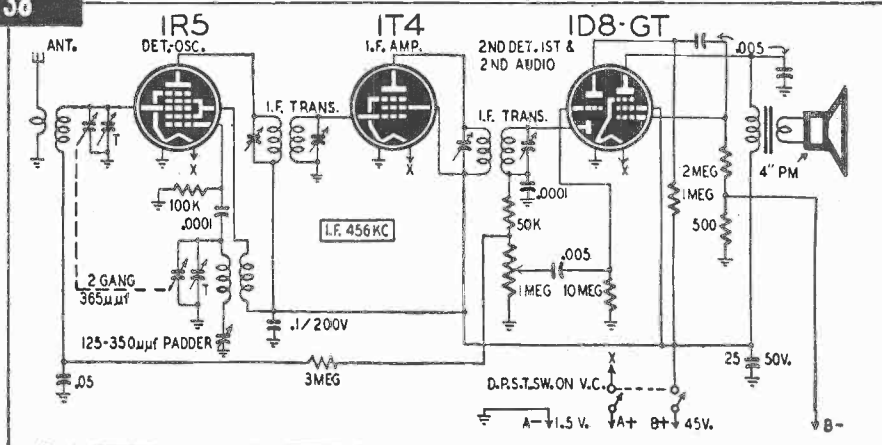
37. A 3-tube receiver for d.c. areas or 110-120-volt shipboard use. The filaments may be supplied from the line through a 280- to 300-ohm dropping resistor, or from a 6-volt battery. Either a single conductor to the wall receptacle (and a good ground on the receiver) or a double conductor with one wire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

37

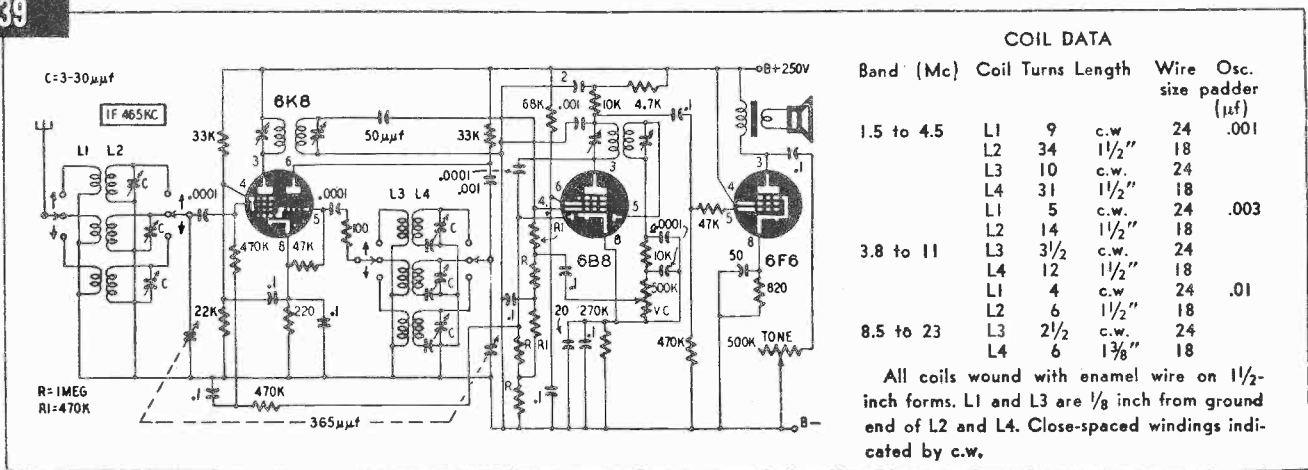


38. This 3-tube superhet actually has five stages, the 1D8 acting as detector and two stages of audio amplification. Since it will operate on 45 volts, it should be an excellent circuit for a super-compact portable for vacation use. For greater sensitivity the plate voltage may be increased to 90. The 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

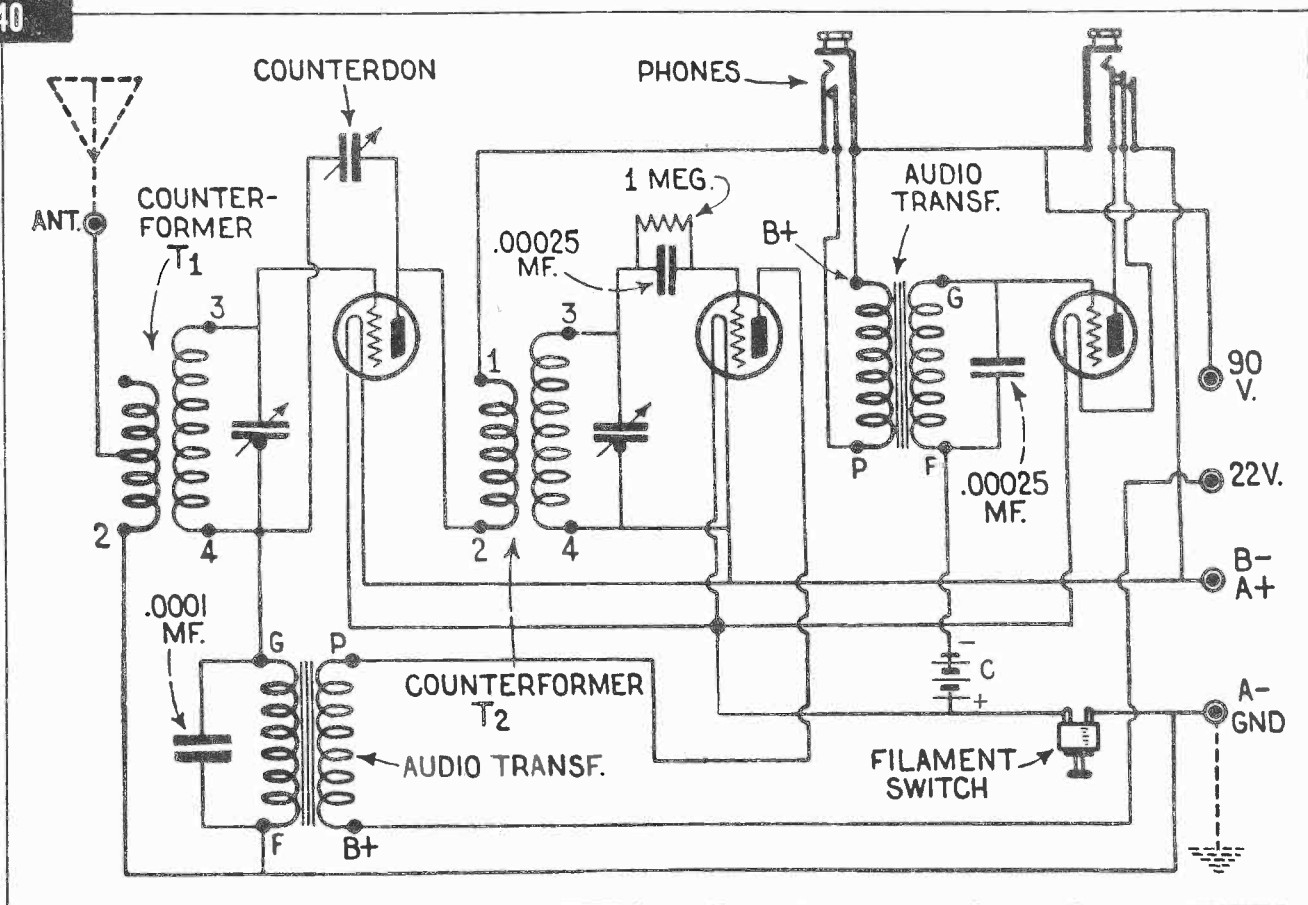


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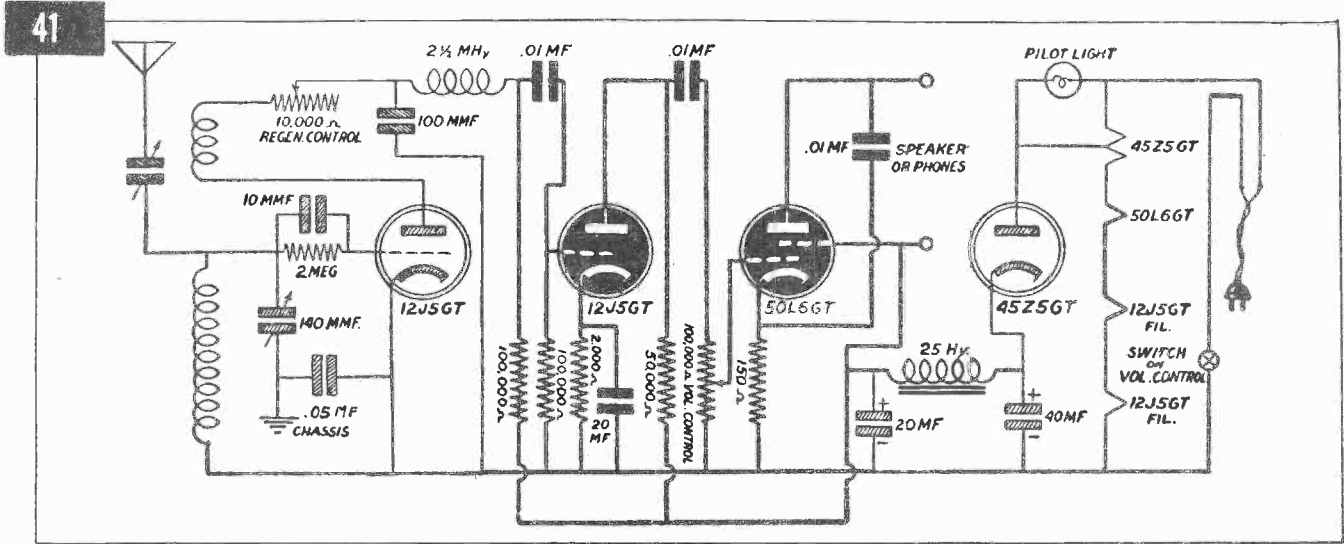


39. A 4-tube reflex superheterodyne with only three tubes, this English circuit is more sensitive than the standard 3-tube super. The signal is first converted to the intermediate frequency by the 6K8 converter, amplified at the i.f. by the pentode section of the 6B8, and detected by its diode section. 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.

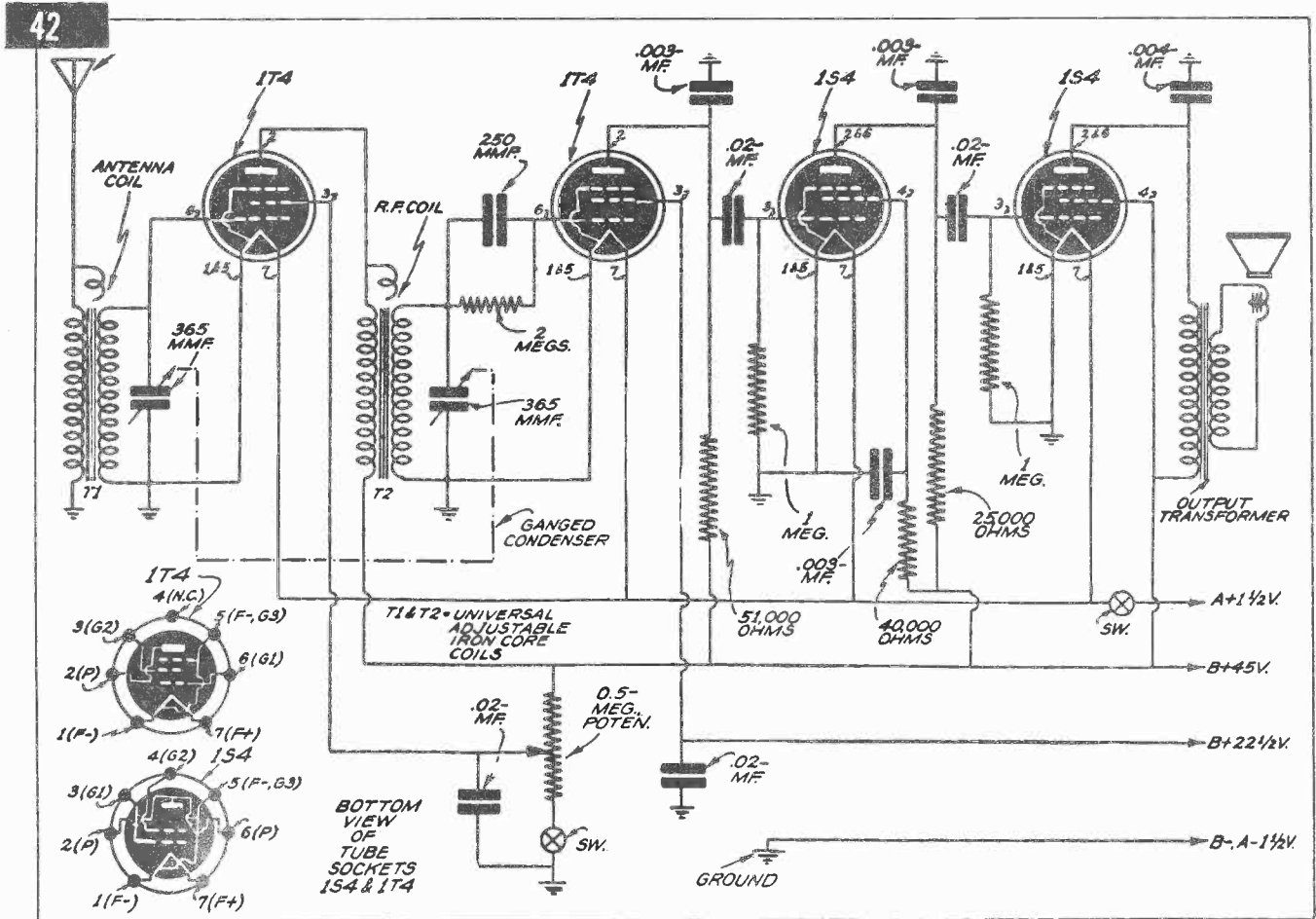
40



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.

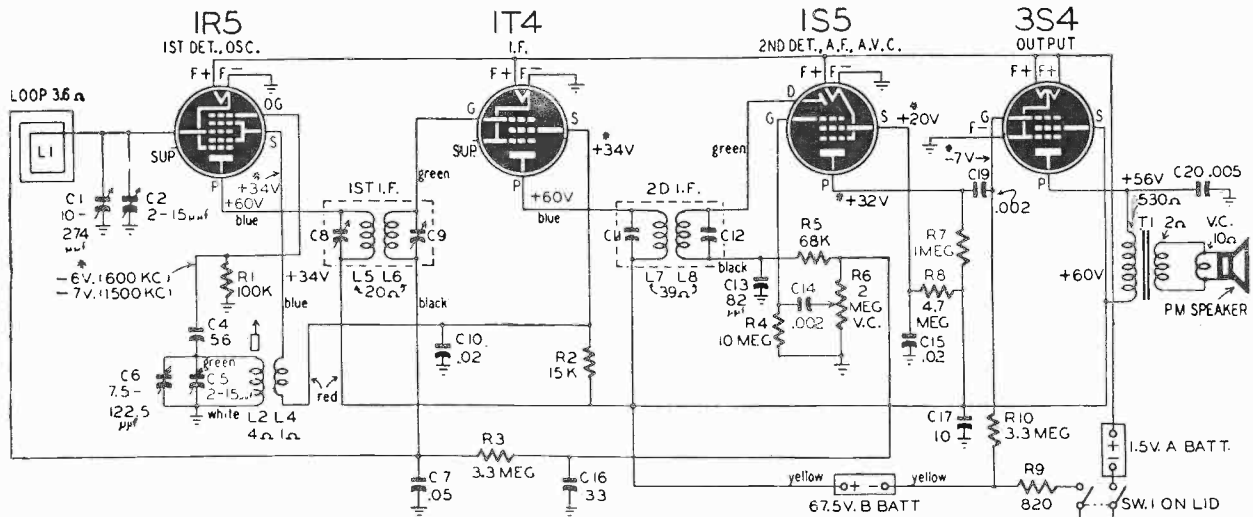


41. Second half of the 2-4 tube Progressive receiver whose first section was illustrated in Circuit 28. The two stages of audio should make loudspeaker reception practicable on local and medium-distance stations, especially if the receiver is used on a good antenna. Inverse feedback is provided by the unbiased cathode resistor of the 50L6. If more volume is required, this resistor may be by-passed by a 5- μ f or bigger capacitor.



42. The 4-tube Ultra midget, one of the first of the small portables. Built on a chassis 1 x 2 1/4 x 4 inches, it can easily be held in the palm of the hand. In the original model, a miniature-type variable 2-gang capacitor occupied one end of the chassis and the four tubes were set in a square at the other end. The set is a t.r.f. and has an excellent record of dx loudspeaker reception. T1 and T2 should be high-class powdered-iron-core types.

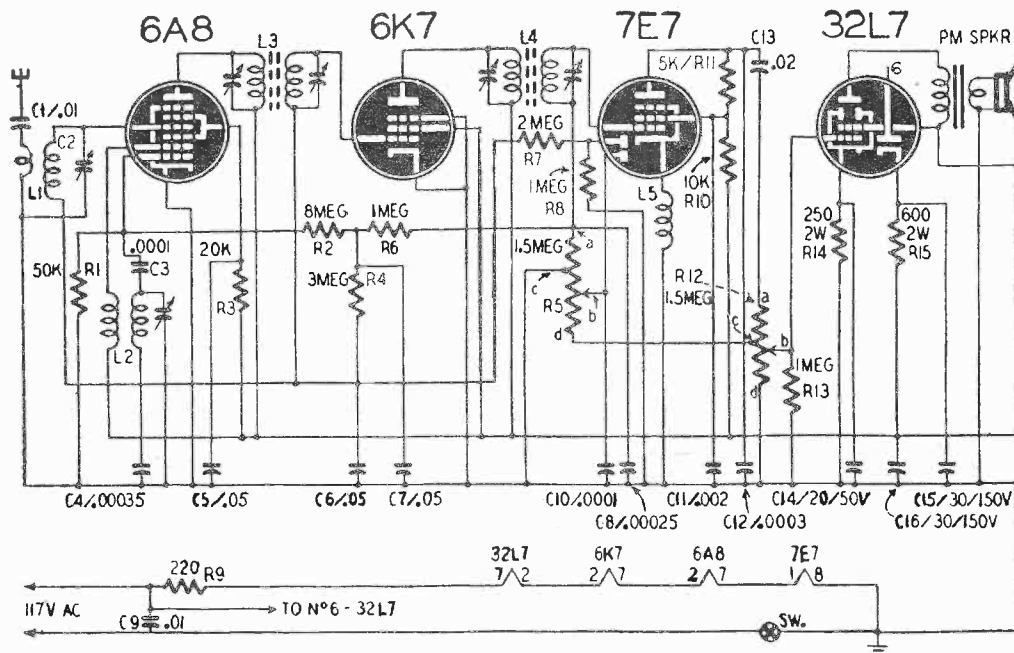
43



BATT. VOLTAGES SHOULD HOLD WITHIN $\pm 20\%$. *MEASURED WITH CHANALYST OR VOLTOHMST. VOLTAGES MEASURED WITH RESPECT TO CHASSIS GROUND.

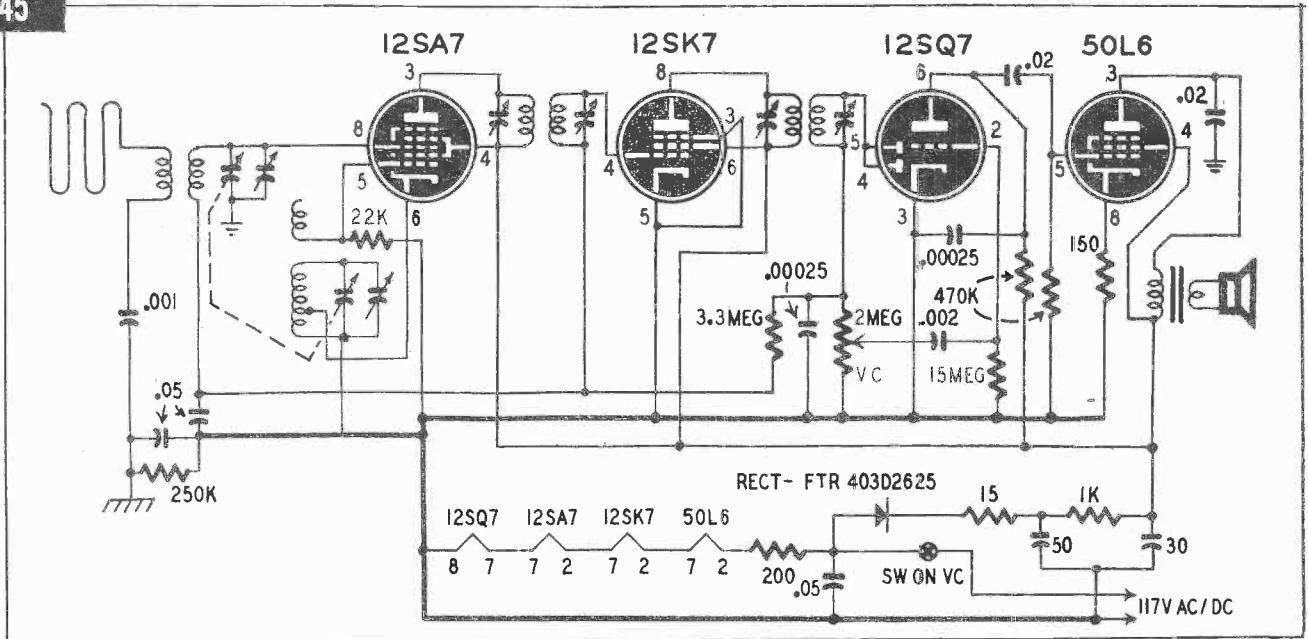
43. The RCA Victor 54B1 etc., one of the standard camera-type portables. A very simple and straightforward little superheterodyne, it is an excellent model for portable-radio builders to use as a basis for their designs. Components of the 54B series were specially-built midget types. The i.f. is the 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



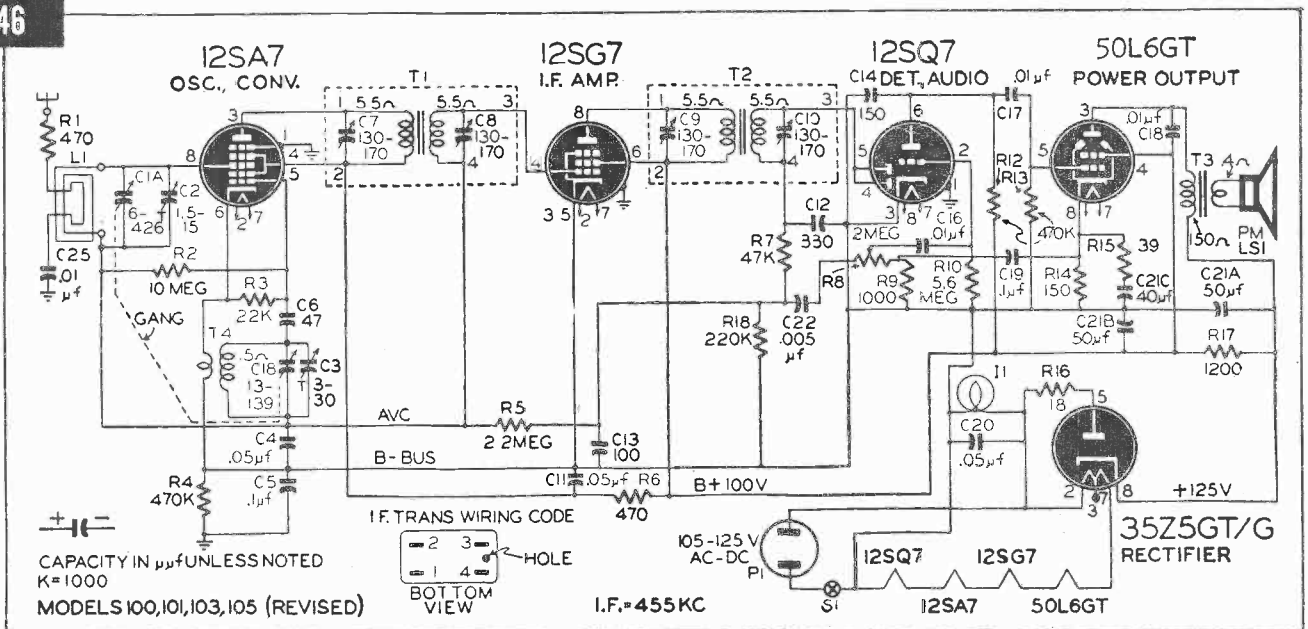
44. The Connatser reflexed 4-tuber. The unorthodox detector circuit is explained by the choke in the cathode of the 7E7, which causes its voltage to ground to vary with the signal, while that of the diodes remains essentially constant. The reflex circuit may be cut in and out at will with R5. With *b* 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



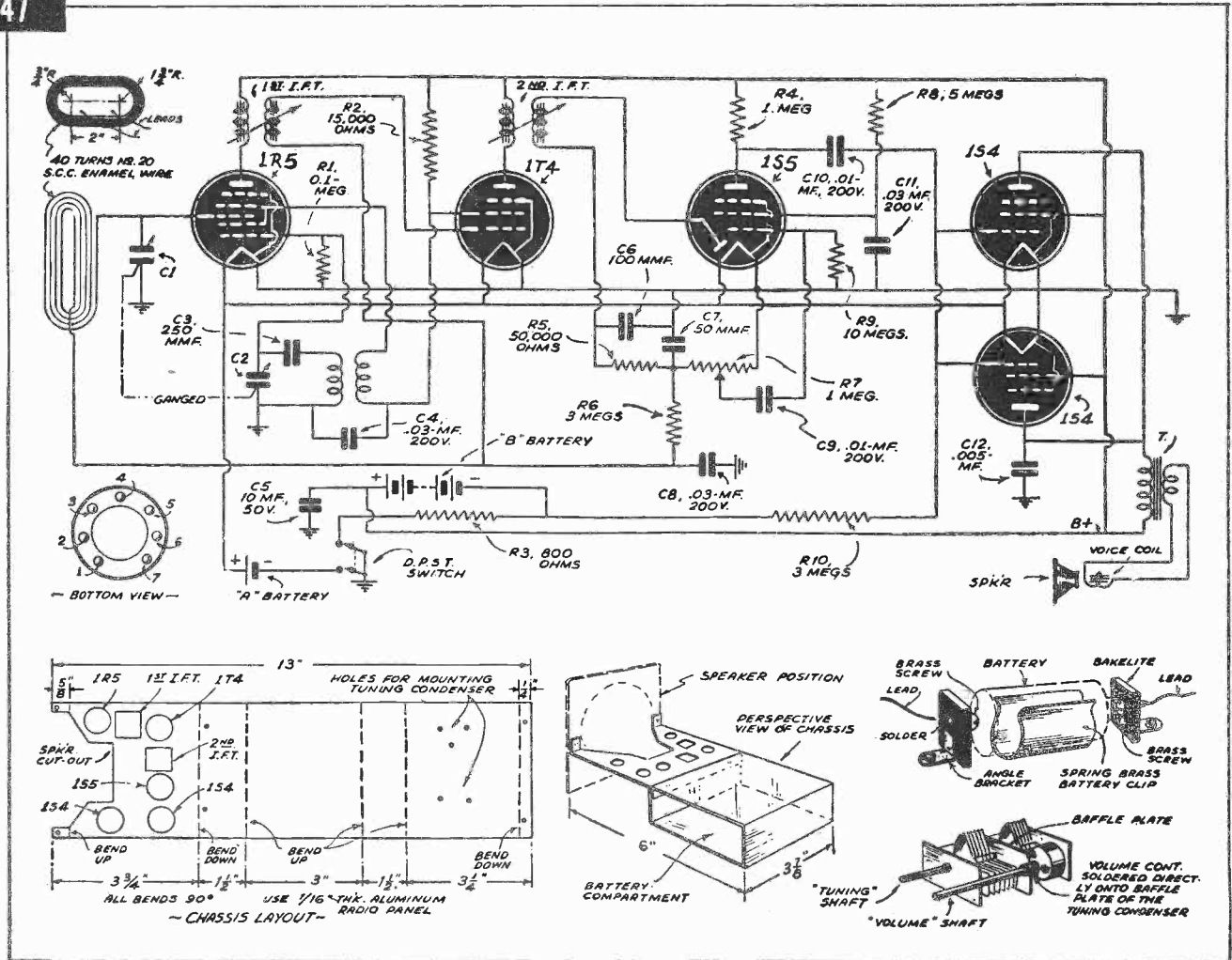
45. A modern commercial superheterodyne with a selenium rectifier and resistance-capacity filter. The 15-ohm resistor before the first filter capacitor prevents heavy surges from damaging it. In some receivers, the plate lead of the output tube is taken off before the 1,000-ohm filter resistor, which 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.

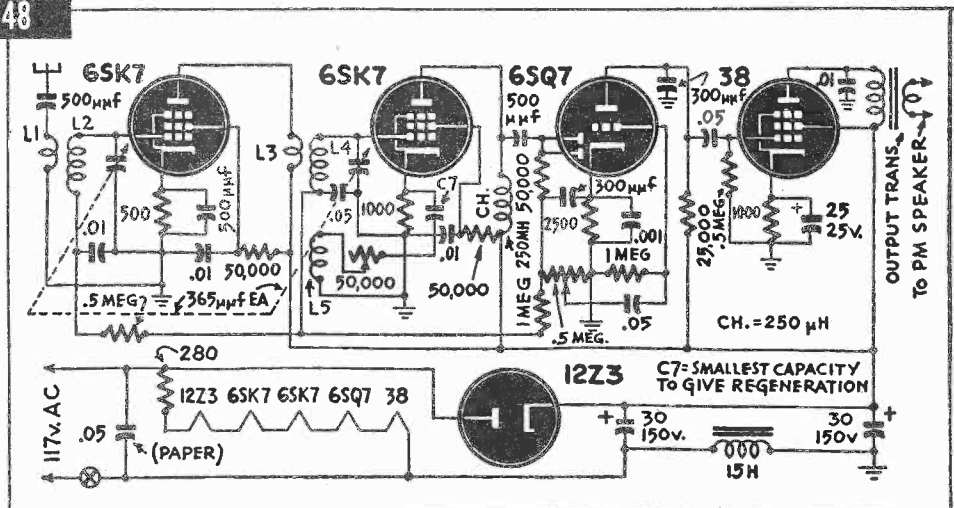
47



47. The Miniport is a very-small-space superheterodyne. In spite of its compactness, it has considerable power, employing two 154'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.

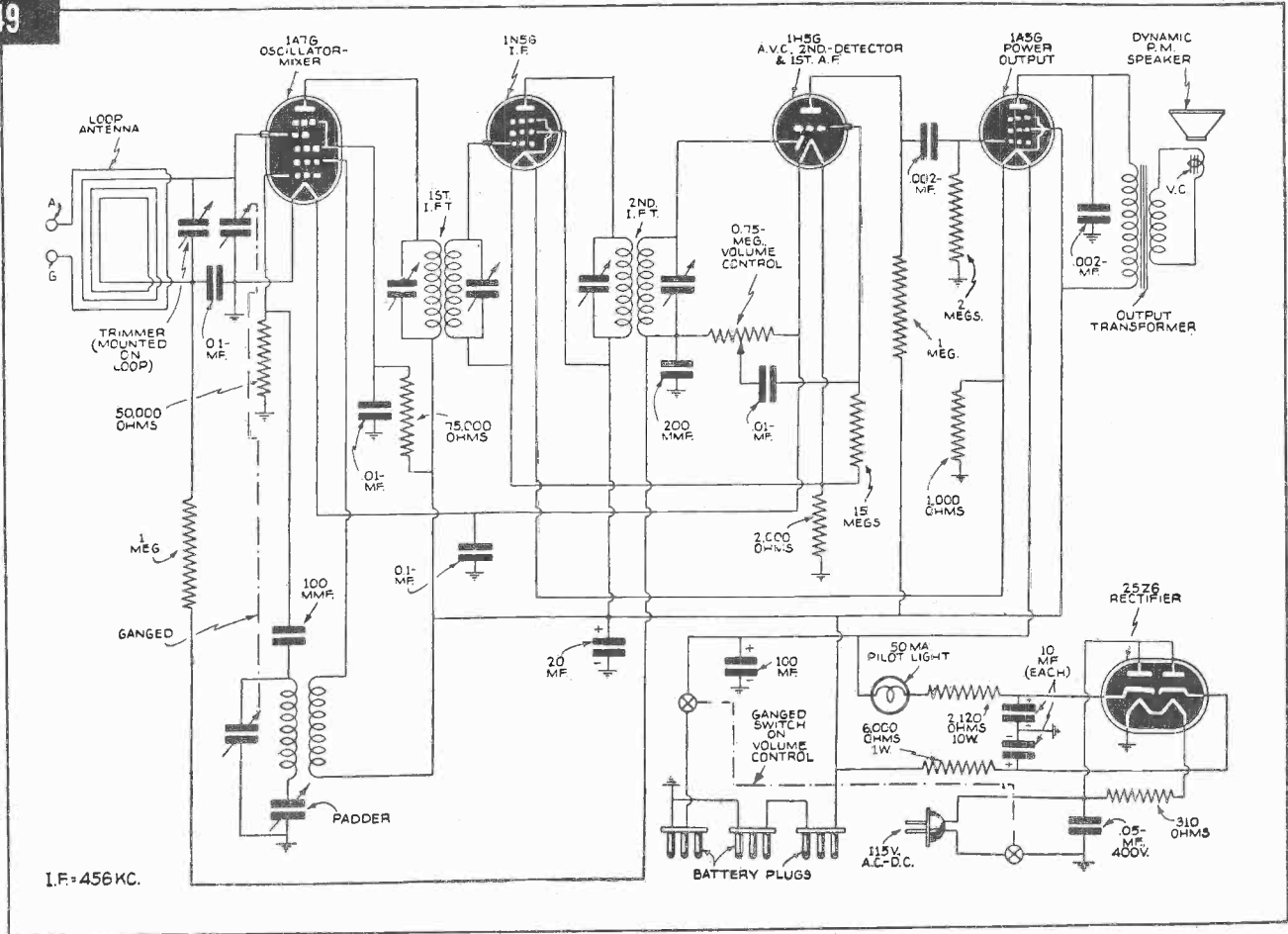
48. This 5-tube t.r.f. with regeneration should be a good distance-getter. Vary C7, using the smallest capacity that permits oscillation over the whole dial. Coils L1 to L4 may be standard t.r.f. type radio-frequency transformers, and L5 may be wound on the end of one of the forms with 15-20 turns of 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



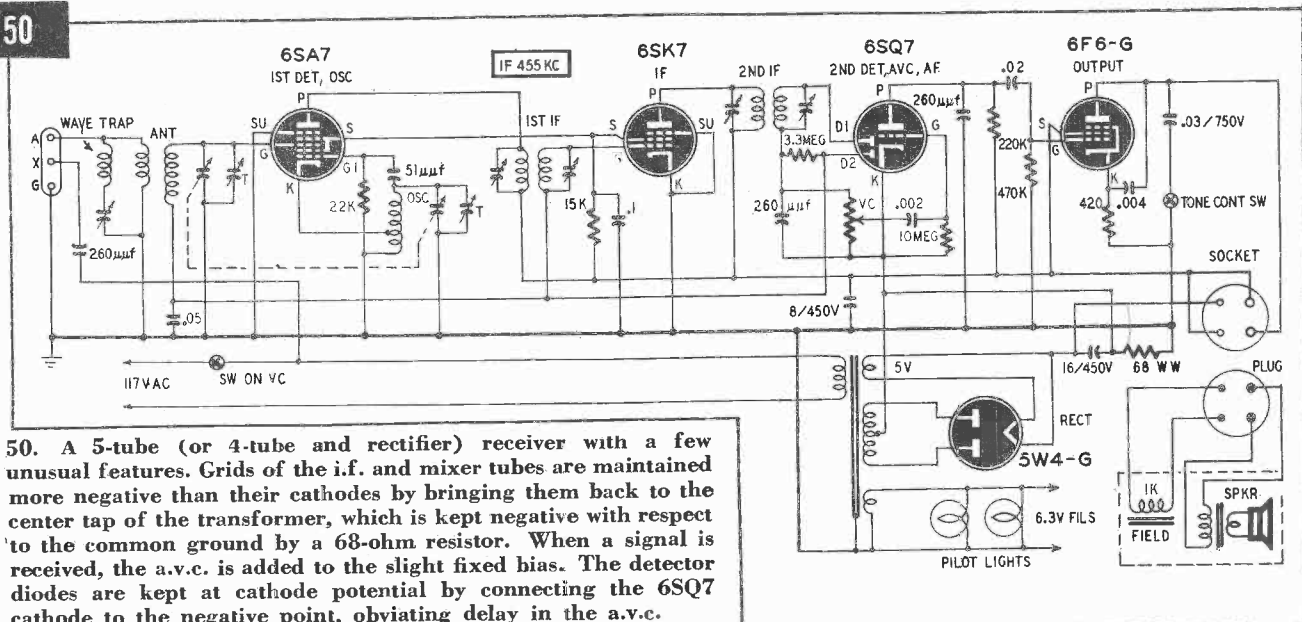


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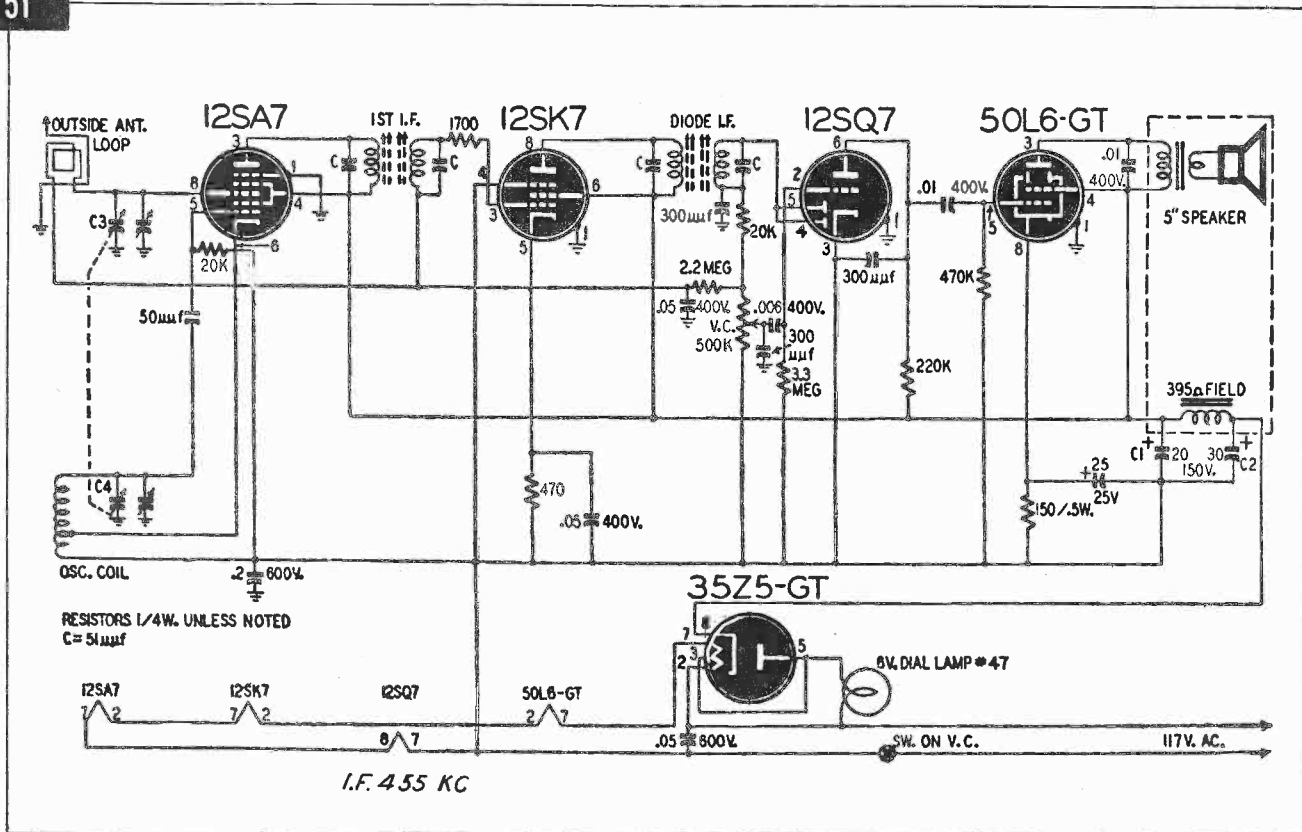
49. The Automatic 3-in-1, an a.c.-d.c. battery receiver of novel design. There are no switches, the batteries floating on the line when the set is used as an electric receiver. The manufacturer believed this "charged" the dry cells and thereby prolonged battery life. In any case, the batteries tend to act as an excellent addition to the filter circuit. The set starts to play immediately it is switched on, changing from battery to line operation as the 25Z5 cathode heats up.

50



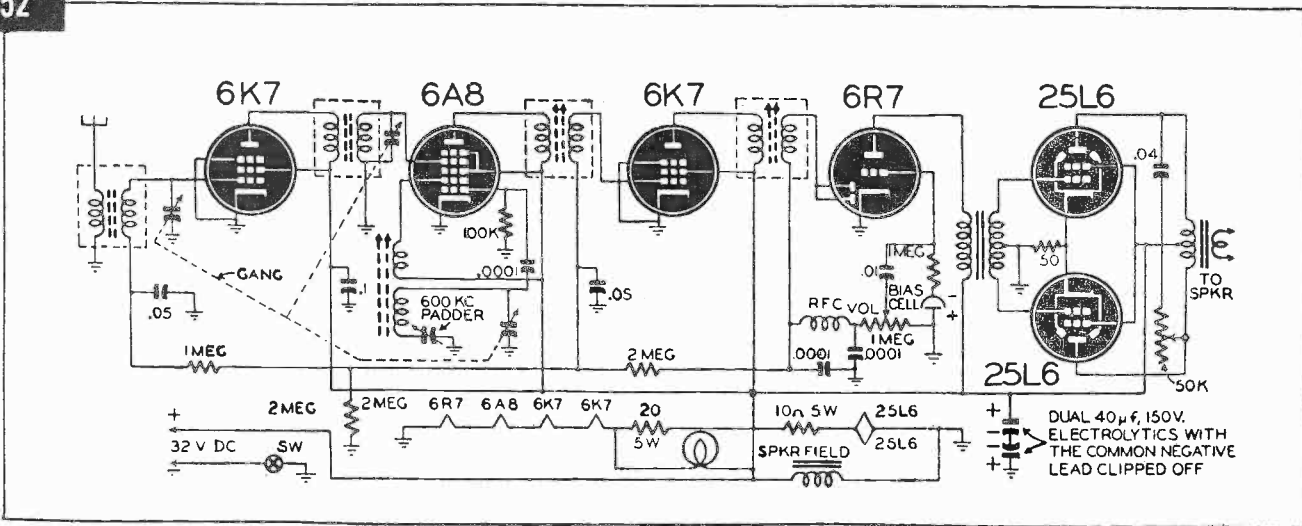
50. A 5-tube (or 4-tube and rectifier) receiver with a few unusual features. Grids of the i.f. and mixer tubes are maintained more negative than their cathodes by bringing them back to the center tap of the transformer, which is kept negative with respect to the common ground by a 68-ohm resistor. When a signal is received, the a.v.c. is added to the slight fixed bias. The detector diodes are kept at cathode potential by connecting the 6SQ7 cathode to the negative point, obviating delay in the a.v.c.

51



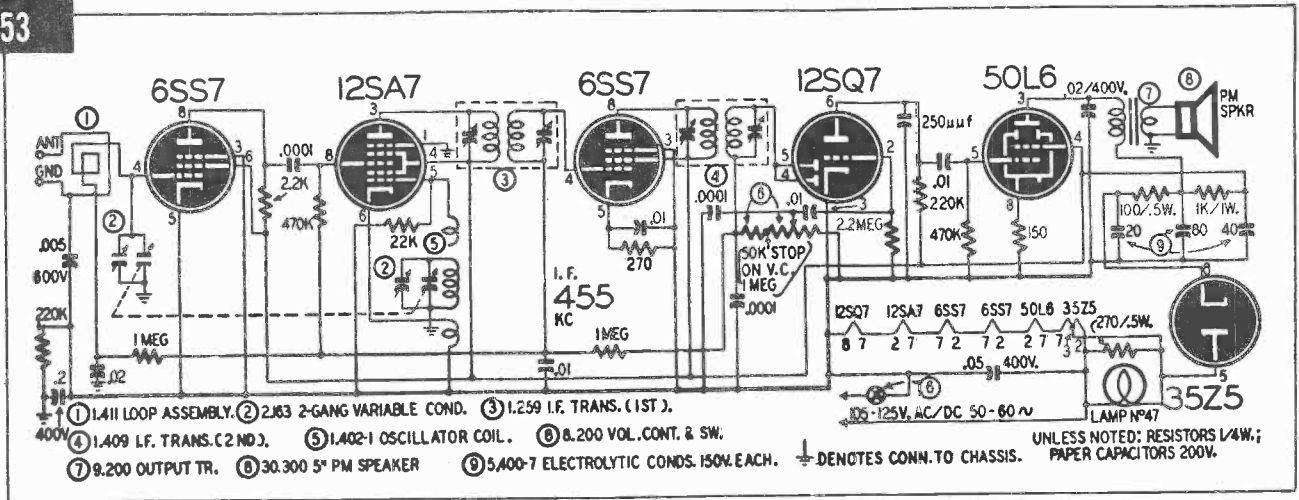
51. The Howard 901, a good example of a medium-quality small 5-tube (or 4-tube and rectifier) receiver. It uses the so-called "All-American" standard tube lineup, with a 12SA7 converter in an electron-coupled circuit, a 35Z5-GT rectifier and a 50L6 output tube. Unlike many of the small receivers, which use an a.c.-d.c. choke and a permanent-magnet speaker, the Howard has an electrodynamic speaker, the field of which acts as the choke in the filter system.

52



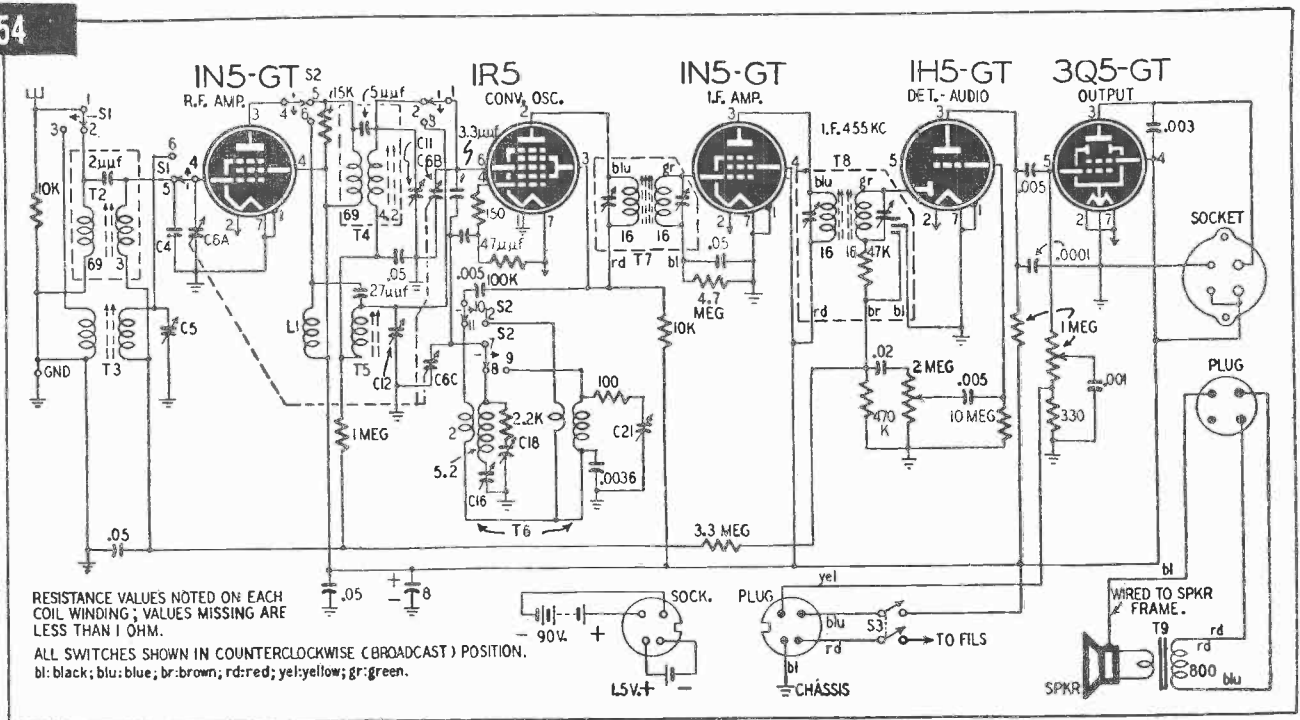
52. Many farms and even some small villages depend on 32-volt lighting plants for their electricity, but few commercial receivers are adapted to work at this voltage. This circuit is the result of a long series of experiments to determine the best tubes and circuits for the low voltage. All components are standard, though some of the circuits are somewhat unconventional. Note particularly the r.f. choke in the diode circuit, and the double filament string. The r.f. stage was found useful to cut down the hiss, and low-resistance speaker field (450 ohms) worked well at 32 volts.

53

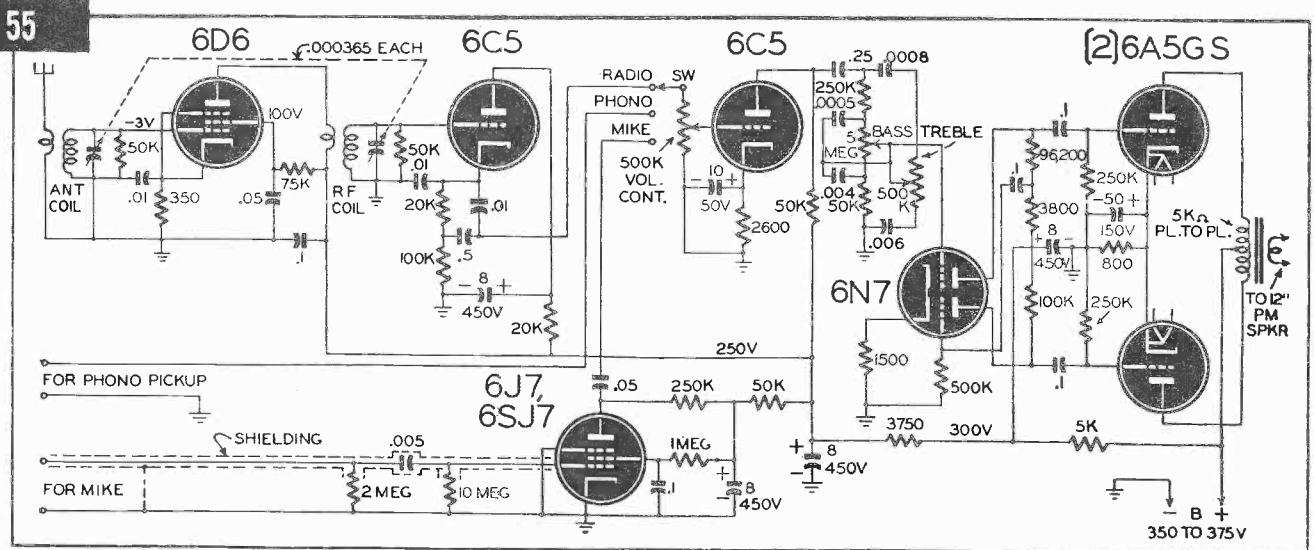


53. A high-class a.c.-d.c. receiver with a stage of resistance-coupled radio-frequency amplification, this set (the Garod 6AU-1) otherwise resembles the smaller a.c.-d.c. receivers already illustrated. The mixture of 6-volt and 12-volt tubes looks strange at first, but the 6SS7 is a 0.15-ampere tube like the others in the filament string. The volume control has a stop 50,000 ohms from its high end which, together with the .0001 capacitors from that end and the arm, assure that r.f. is filtered out before it enters the audio circuits. The oscillator circuit uses the cathode tickler, and a few turns of wire act as the grid capacitor. The r.f. stage, while not contributing greatly to gain, isolates the oscillator from the antenna circuit and compensates for loading effects of outside antenna systems, should such be used. The double-section resistance-capacitance filter circuit with its high capacities is also worthy of study.

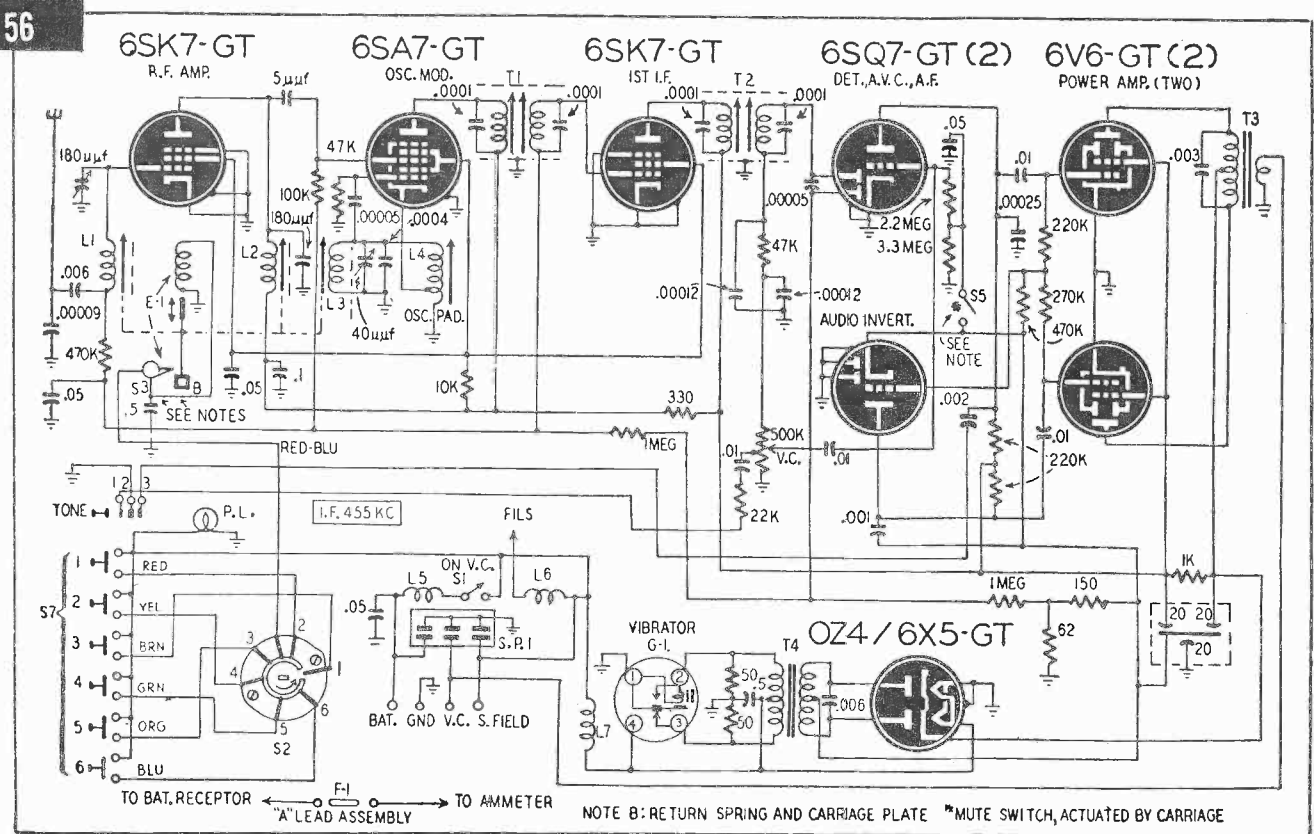
54



54. Farm radios are of two general types—those which operate with dry-cell tubes and A- and B-batteries, and those which use a 6-volt storage battery and 6.3-volt tubes, with a vibrator pack for the high voltages. Each type has its own advantages and disadvantages. This set is a typical example of the dry-cell battery type. Because of the need for greater amplification in rural areas far removed from broadcast stations, the set is provided with an r.f. stage. The shortwave band is also more useful in farm areas, where there is likely to be less interference from man-made static, and where reception on the broadcast band may be poor at times. The r.f. stage is tuned on both broadcast and shortwave bands, and trimmers are provided for exact adjustment on all circuits except the broadly-tuned broadcast r.f. Iron-core high-gain coils are used throughout. Power of the set is limited by the dry-cell output tube, and is listed as about a quarter watt maximum, or 0.15 watt undistorted. This is quite enough for a quiet living room. Where louder signals are required, receivers with the 6.3-volt type tubes will provide more output.

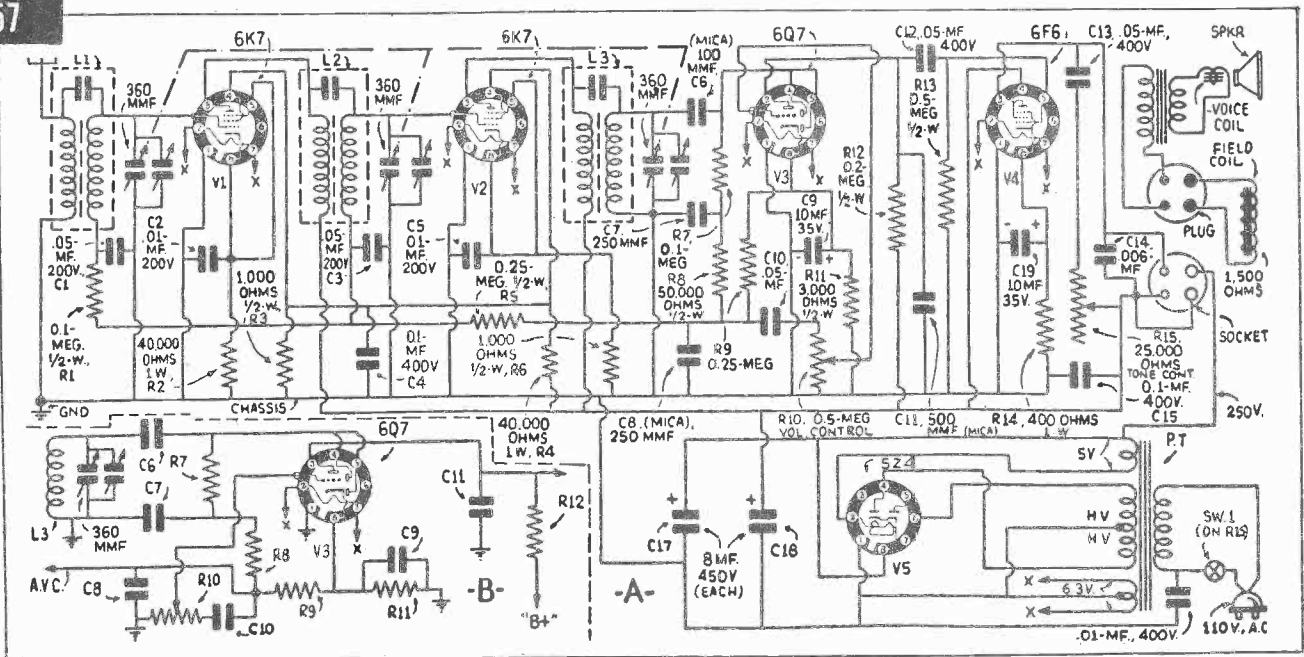


55. A high-fidelity radio receiver, consisting of an r.f. tuner with broad-response coils, an infinite-impedance detector and a bass- and treble-compensated amplifier. No negative feedback is used in the amplifier, as the output tubes are triodes. If 6A5's are unavailable, 6B4's or other available triodes may be used. The 6D6 r.f. could also be replaced with the more modern 6SK7, or postwar miniature tubes could be substituted. A separate input is provided for microphones or low-sensitivity pickups, and another for high-level crystal pickups. This type of receiver is bound to tune broadly, and may not be satisfactory in congested localities where a loud undesired station may be within a few channels of desired stations. In such cases, adding another stage or r.f. may provide sufficient extra selectivity.



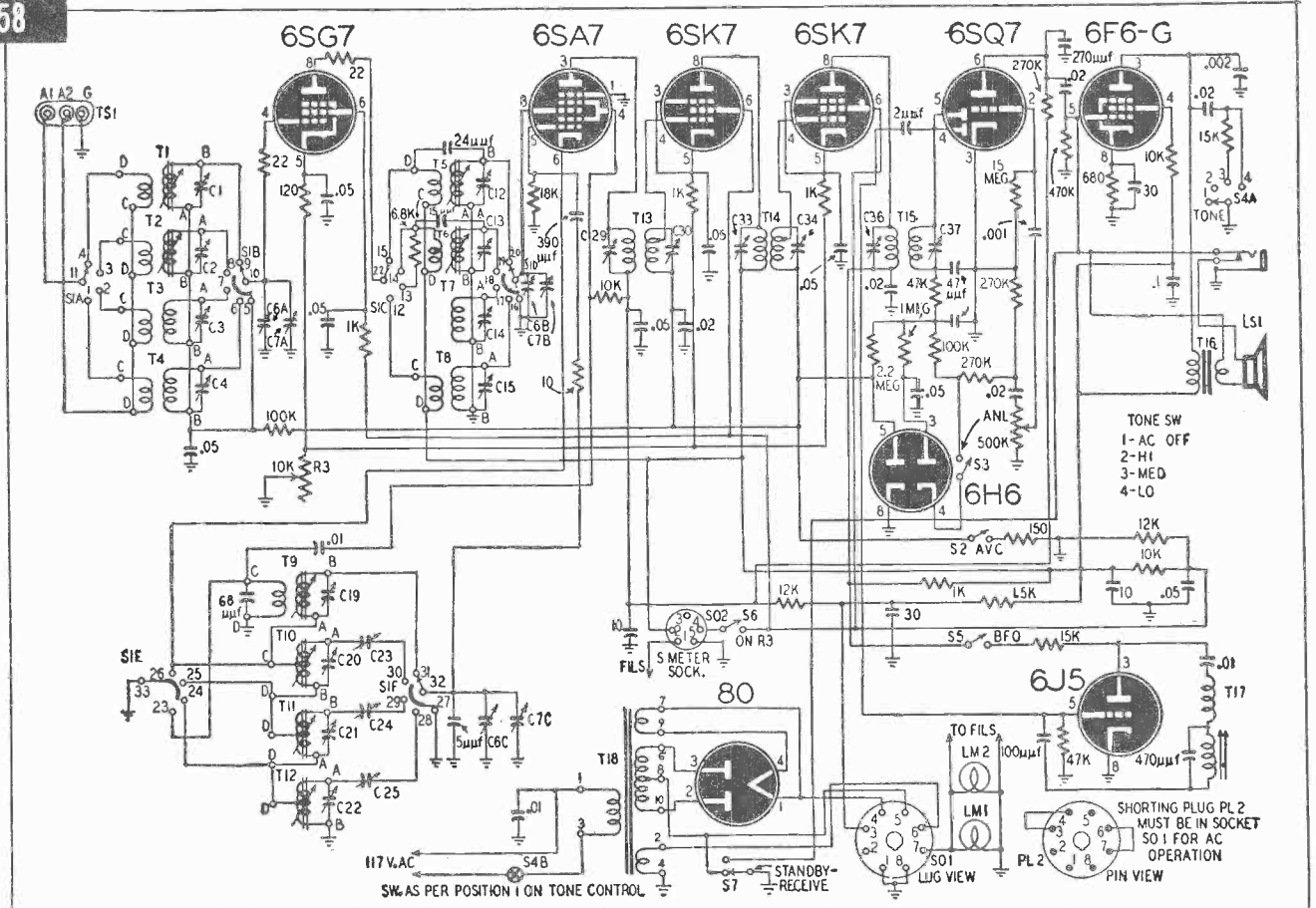
56. A typical large automobile receiver, the Motorola CR6. It has eight tubes including rectifier, and has a maximum power output of 9 watts from the two 6V6's, which are operated with fixed bias. Automatic tuning is by a tuning motor, the iron cores being moved out by the cam arrangement of S3. Receiver is silenced between stations. One diode of the 6SQ7 detector is used for rectification, the other to provide a.v.c. The inverter is of the self-balancing type, but connections look complicated because of the biasing system. The tone control system is exceptionally interesting. If desired, an OZ4 filamentless rectifier tube may be used in place of the 6X5-GT shown.

57



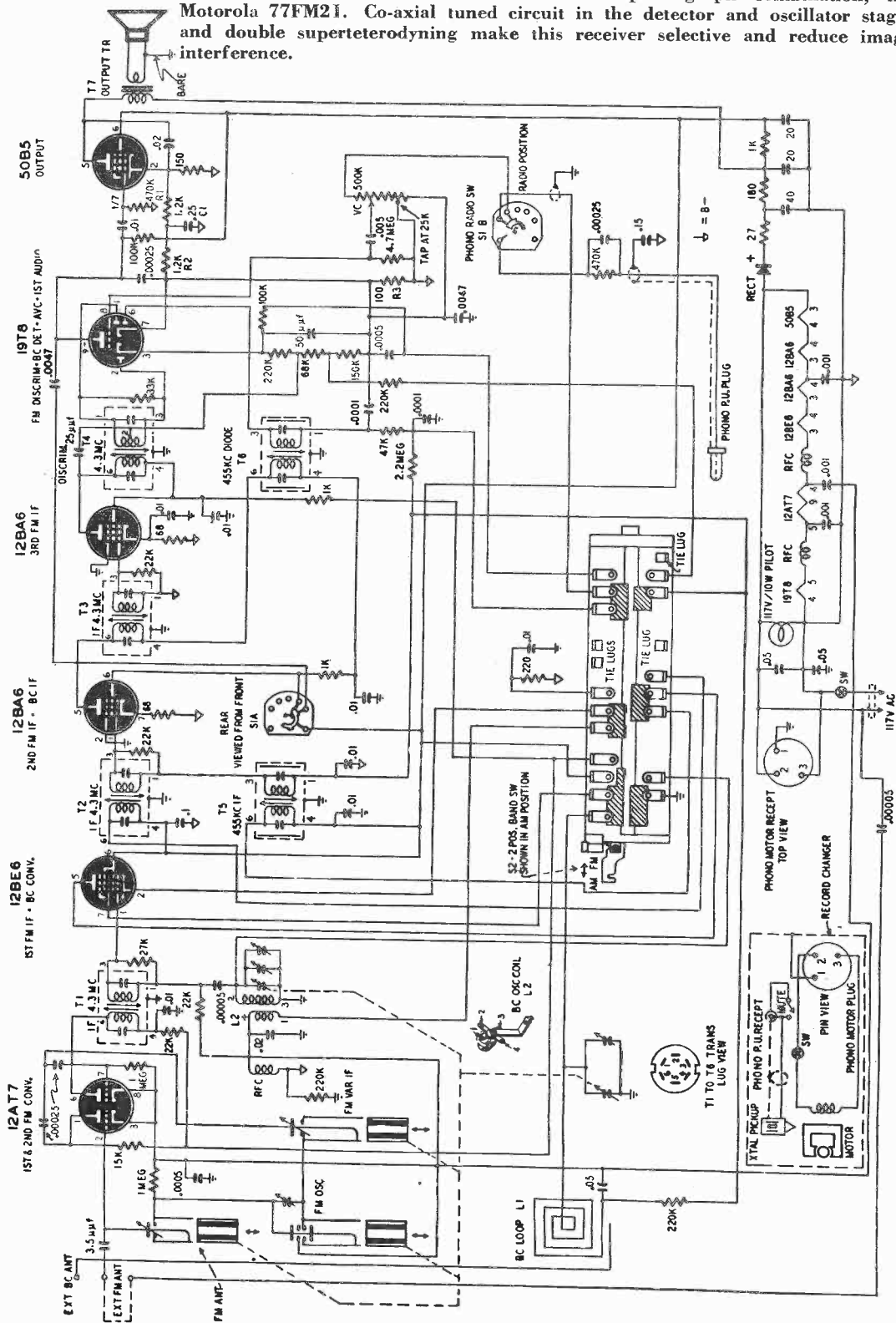
57. The Denton t.r.f., which uses a simple method of applying a.v.c. to a tuned radio frequency circuit. The a.v.c. system is detailed in the lower left-hand corner. This receiver combines sensitivity and selectivity in a t.r.f.

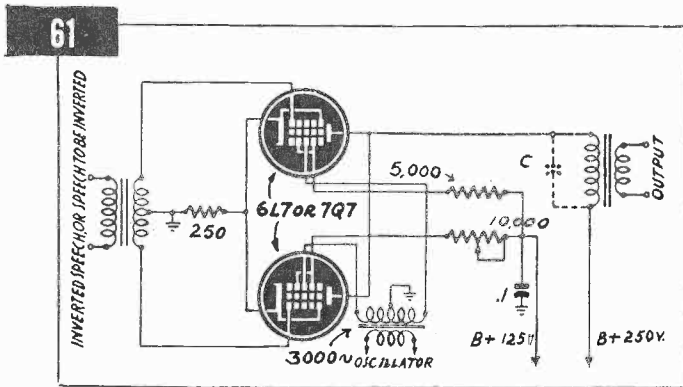
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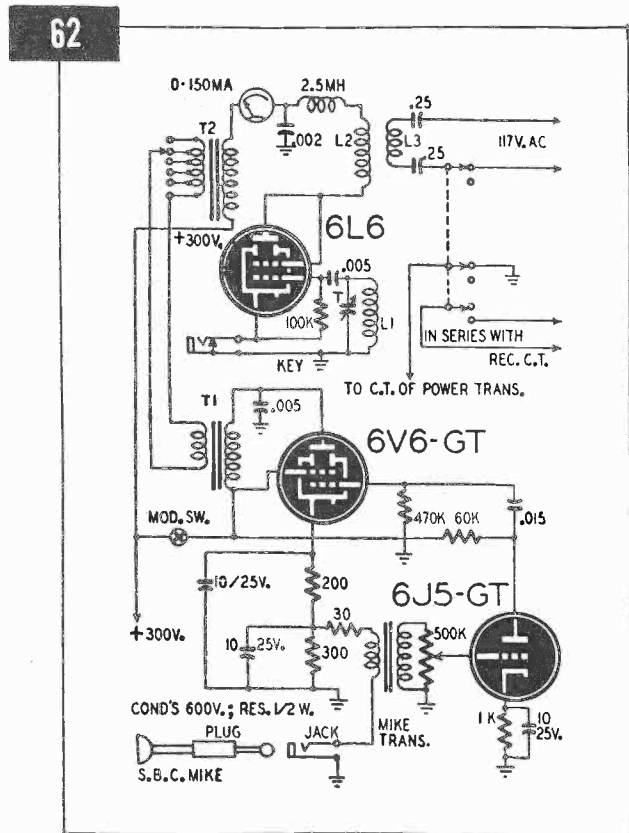
58. A modern communications receiver, the Hallcrafters S-40 ranges from 540 kc to 43 mc. Some tubes have special functions. Half the 6H6 is a gas gate and the other a noise limiter. The 6J5 is a beat-frequency oscillator.

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.

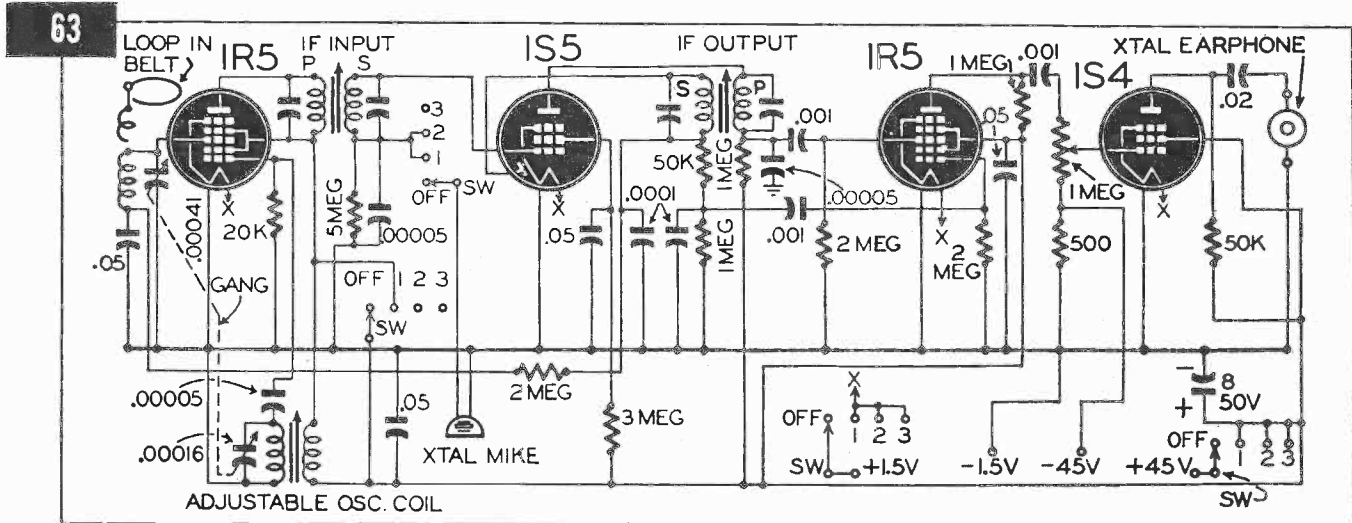




61. This is a speech scrambler or unscrambler circuit. It consists of a balanced modulator with push-pull input and parallel output. The speech to be inverted is filtered to remove components above 2,500 cycles, after standard telephone practice, and a carrier of a little higher frequency is beat against the speech signals. This frequency, commonly about 3,000 cycles, is supplied by an external oscillator. The output is the beat or difference frequency. Thus a 50-cycle note appears in the output as 2,950 cycles, and a 2,500-cycle note appears as 500 cycles. Inverted speech fed to the input will therefore appear in its original form at the output, so the circuit can be used either to invert ordinary speech or to receive and unscramble inverted speech. The output of the speech scrambler can be transmitted over wire lines to its destination or used to modulate a radio carrier (or recorded and later unscrambled with a microphone and amplifier.)



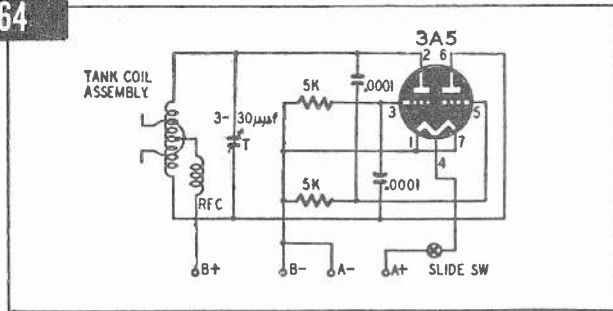
62. A carrier intercommunicator for operation on the electric light line. A 6J5 speech amplifier feeds a 6V6 modulator, and the oscillator is a 6L6. Thus a considerable amount of well-modulated power is produced. The grid coil, L1, is one of the windings of an old low-resistance 175-kc i.f. transformer. L2 is 75 to 100 turns of No. 28 or 30 d.c.c. wire scramble-wound close to L1 on the same dowel. L3 consists of a few (8-12) turns of No. 24 or bigger d.c.c. wire wound over the tickler. The two 0.25- μ f capacitors should be 1,000-volt mica type and the line should be fused to prevent damage in case of possible breakdown. The frequency is set by tuning the i.f. trimmer T. In the hookup shown, two output transformers back-to-back were used instead of a modulation transformer, and the taps on T2 were changed till results were judged best at the receiver. The three-pole, single-throw switch connects the output to the line, opens the center tap of the receiver's power-supply transformer and closes that of the transmitter power supply. Any 175-kc supers may be used as receivers, with signal input to the first i.f. through a coil like L3, with coupling capacitors of .005- μ f or less.



63. A pocket radio set which is also a hearing aid and may be both at the same time. The IS5 acts as i.f., detector and one stage of a.f. When the 4-pole, 4-throw miniature gang switch is at 1, oscillator coil is shorted and the IS5 amplifies at a.f. only. In position 2, the oscillator is in circuit and the set acts as a radio and hearing aid. The microphone is cut out of the circuit in position 3, and the set becomes a simple and very portable radio receiver.

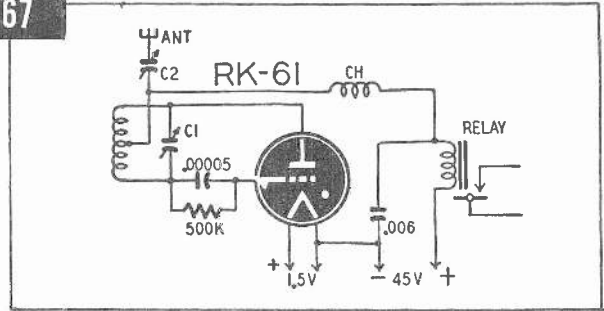


64



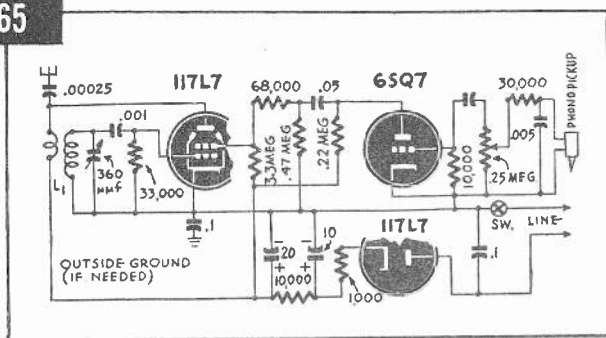
64. A high-frequency transmitter for low-power control purposes. Used with the receiver of Circuit 67, it gave excellent results over a distance of several yards. The 3A5 is used as a push-pull oscillator feeding a tank which consists of eight turns of bare copper wire, spaced to one inch, and a small 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



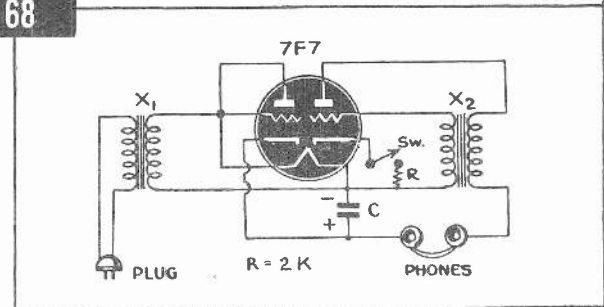
67. A receiver for the transmitter of Circuit 64; a superregenerator with an RK-61 subminiature thyatron. Coil is 14 turns of No. 14 tinned copper wire, one-half inch inside diameter and spaced to $1\frac{1}{8}$ inches. Antenna is two feet of copper wire. C1 and C2 are 3-30- μ f ceramic trimmer capacitors, 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



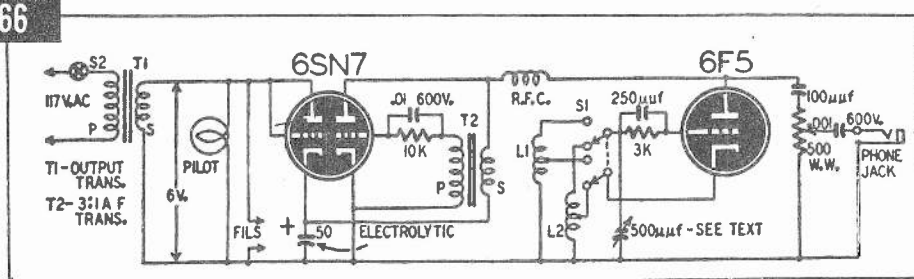
65. A phono oscillator with considerable gain, suitable for use with many magnetic pickups and high-sensitivity microphones as well as crystal pickups. The 6SQ7 speech amplifier screen-modulates the I17L7 oscillator. A volume control cuts down excessive input signal, reducing oscillator loading and distortion. 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

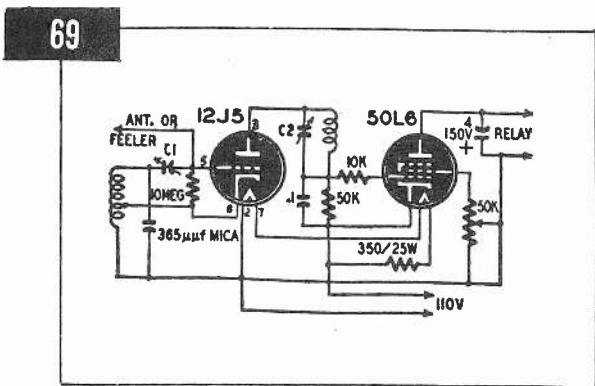


68. A simple and excellent code oscillator which can be built from a minimum of parts. X1 is a filament transformer (or old output transformer whose secondary will supply 5-8 volts with the primary connected across the 117-volt line). X2 can be an old audio transformer (any ratio). A small replacement 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.

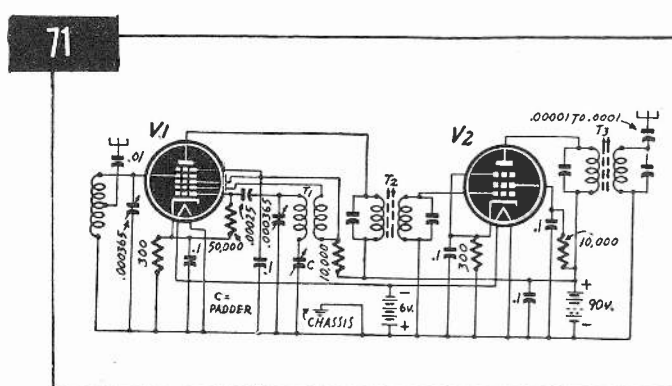
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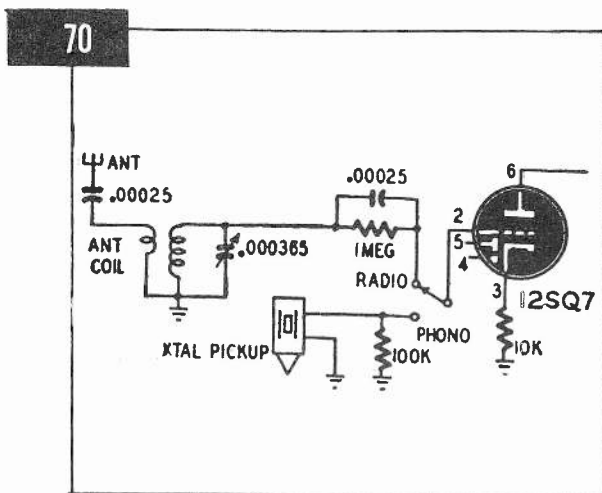
66. An interesting combination unit which can be used as a code oscillator which transmits to a nearby radio, or as a signal generator. For use as a signal generator, output is taken from the phone jack as shown. A double-pole, double-throw switch permits changing from one of the two Hartley oscillator coils to the other. Thus the generator can be used for broadcast and i.f. bands. The two coils are wound on $1\frac{1}{2}$ -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.



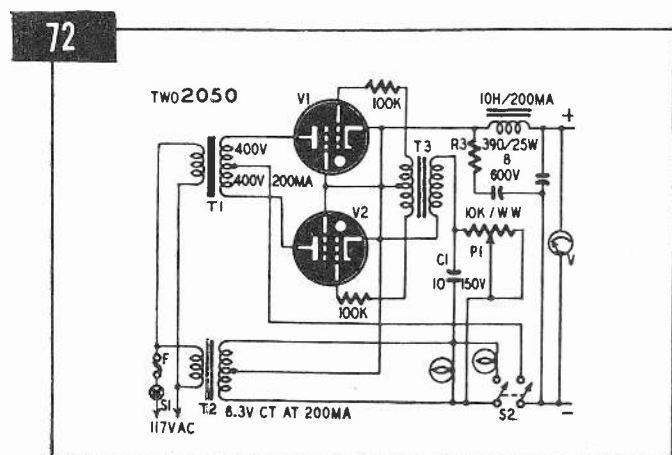
69. A capacity-operated relay or intruder alarm. Coils are standard broadcast oscillator (6SA7 type) and secondary of an antenna coil. Tune to about 550 kc with large-capacity trimmers across the 365- μ f mica capacitor, and with C2 (mica fixed and trimmer capacitors to about 650- μ f). The "feeler" 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. 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.

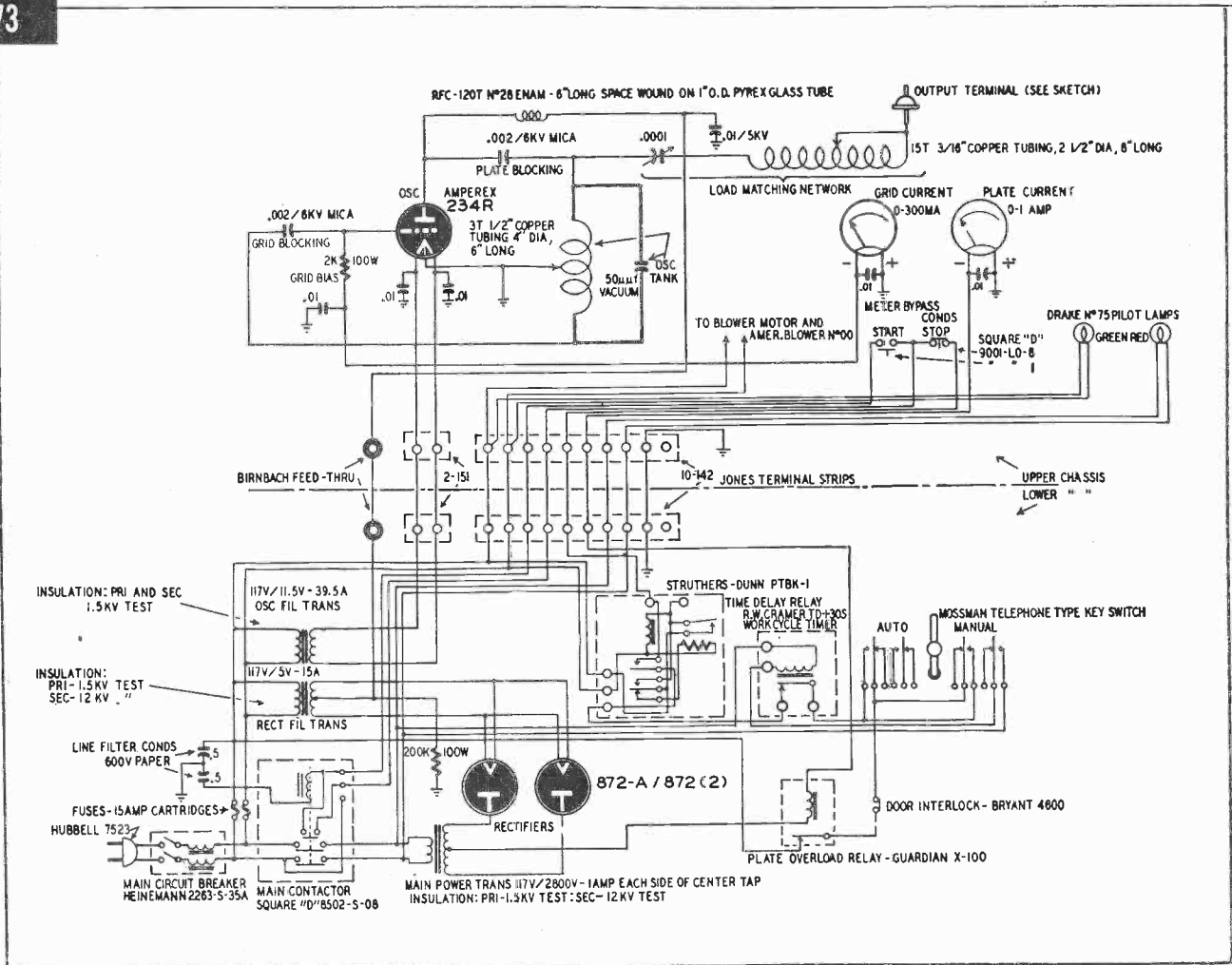


70. Radio tuner for phonograph amplifier. The equipment represented by the 12SQ7 may be the input of any amplifier. A standard broadcast antenna coil with a 365- μ f variable capacitor is the tuner. The 1-megohm resistor and the 250- μ f capacitor cause the tube to detect the radio signals. A single-pole 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.



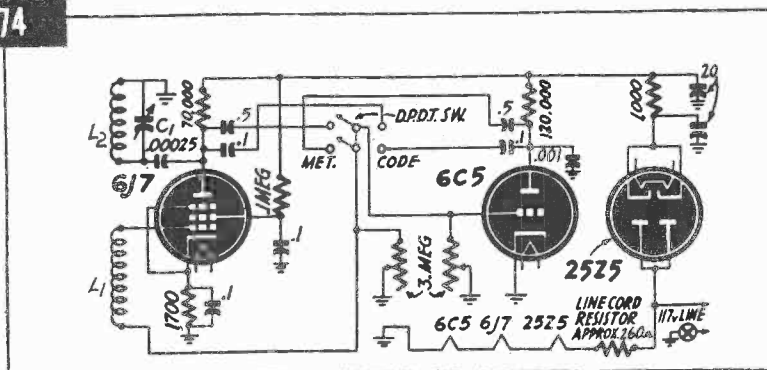
72. A variable voltage supply using thyratrons, which can be regulated smoothly from zero voltage to full output. Since the thyatron operates by so biasing the grid that plate current can be made to flow through all, part, or none of the a.c. cycle, output can be controlled without dissipating unwanted 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



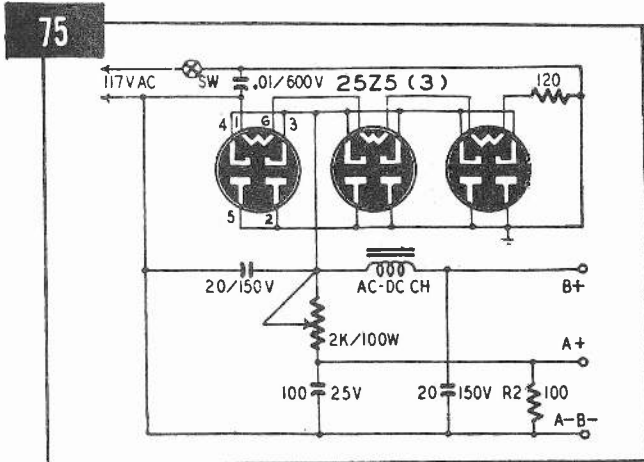
73. An experimental 1-kilowatt radio-frequency dielectric heater or diathermy unit. While a low-power unit for most r.f. heating jobs, it has a wide range of application for small work. It is usable only for heating non-conductors or imperfect conductors—the induction heater must be used for metals. 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. 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.

74

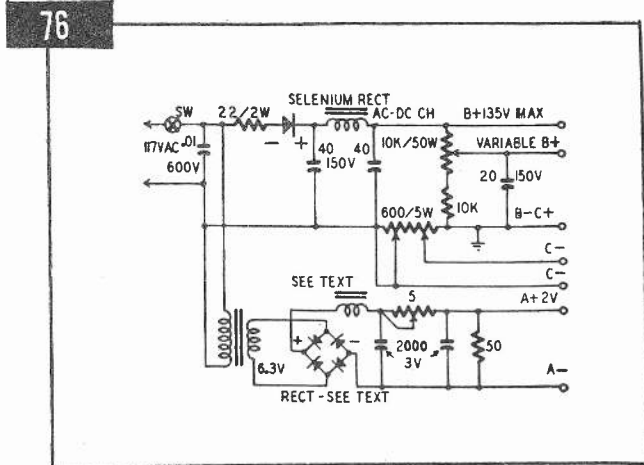


74. An electronic metronome, which can also be used as a code oscillator. It operates and is adjusted like a wireless phonograph oscillator. L1, L2, are a low-impedance broadcast antenna coil, L2 being the secondary. It is tuned with a 365- μ f variable capacitor, or a couple of mica trimmers in parallel.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

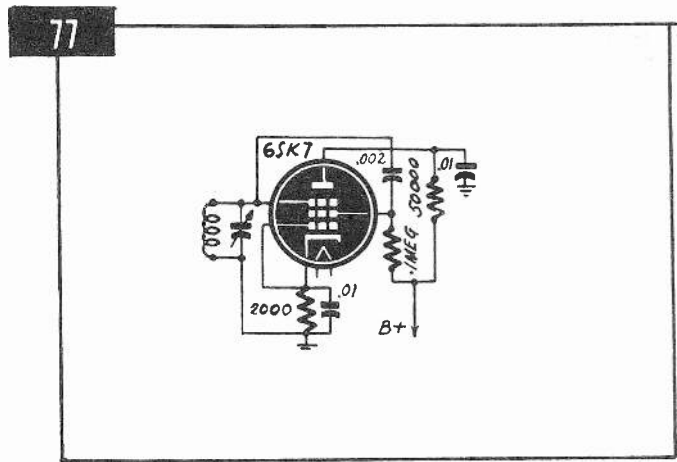
Power is applied and the tuning capacitor rotated till the plate meter reads about 0.6 ampere, which is full power. If it is impossible to reach a point near 0.6 ampere the match to the load is probably poor. Move the tap on the load-matching coil to another point and retune. As a first approximation, 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.



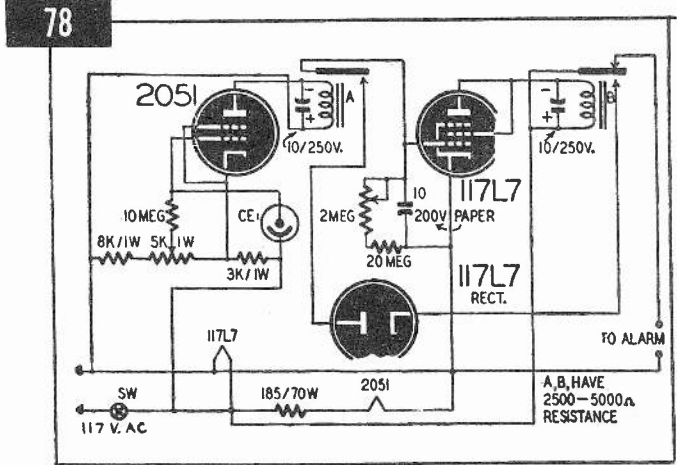
75. A universal power pack for portable receivers. Designed for the service bench rather than the individual set owner, it can be adjusted for sets of widely different filament currents and voltages. Maximum filament current may be 0.45 ampere, more than enough for practically all portables. The filament 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. 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.

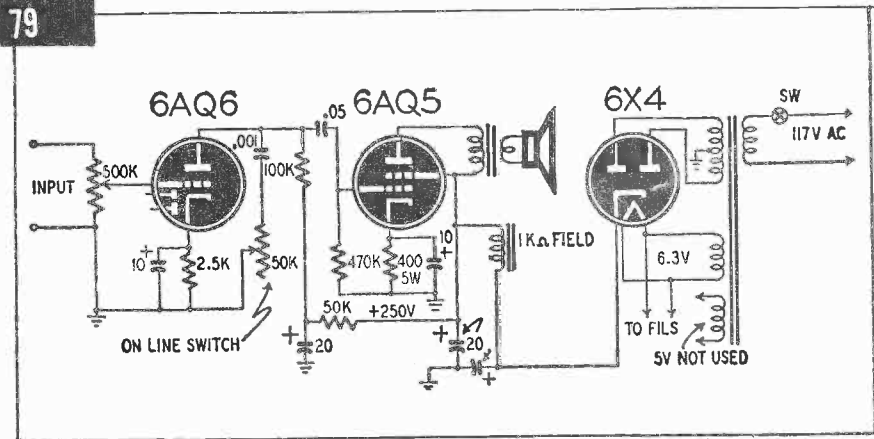


77. The Transiron oscillator circuit. Operating on a different principle from most oscillating circuits, it uses a single two-terminal coil. By varying the size of this coil and its tuning capacitor, it can be made to operate at frequencies above 100 mc to below audio. The circuit shown is applicable 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 transiron 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.

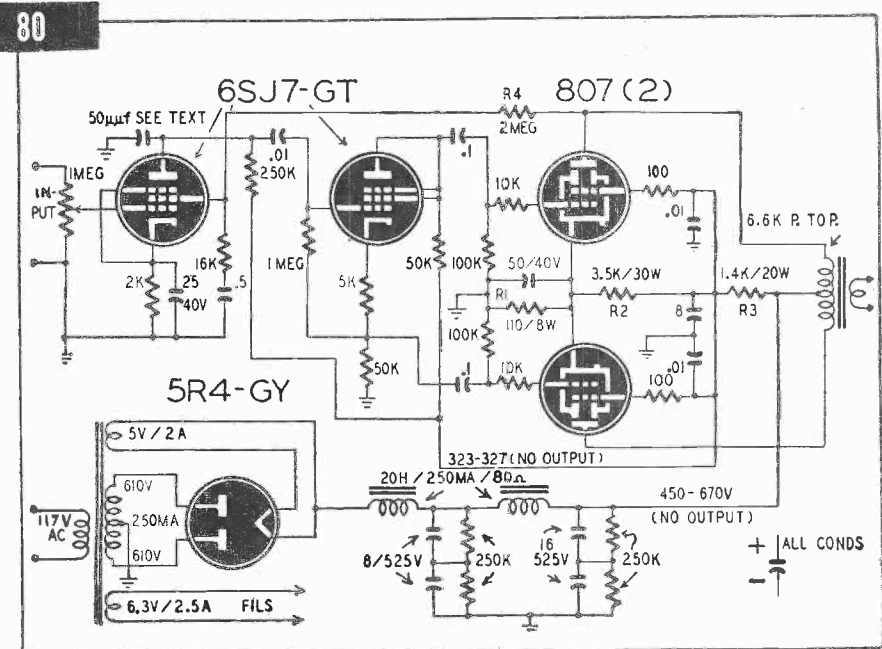


78. A photocell alarm which operates whenever a beam of light is broken. While light shines on the photo-tube the grid is practically shorted to the negative end of the bleeder, and the grid remains sufficiently negative to prevent the 2051 from firing. When the light beam is broken, the photo-tube becomes 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- μ f 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.

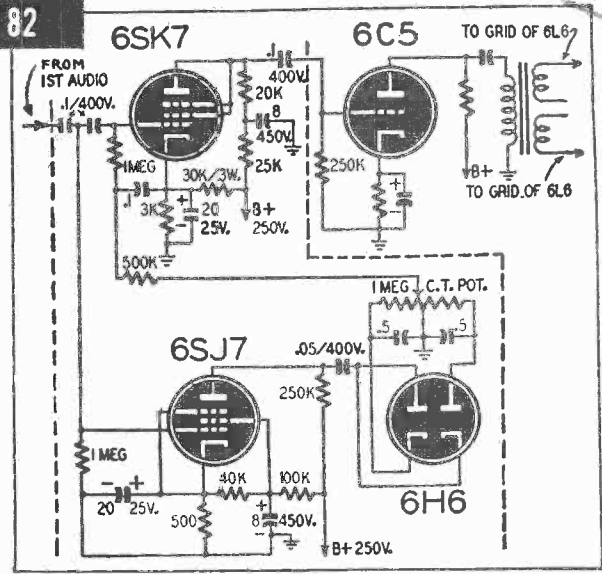
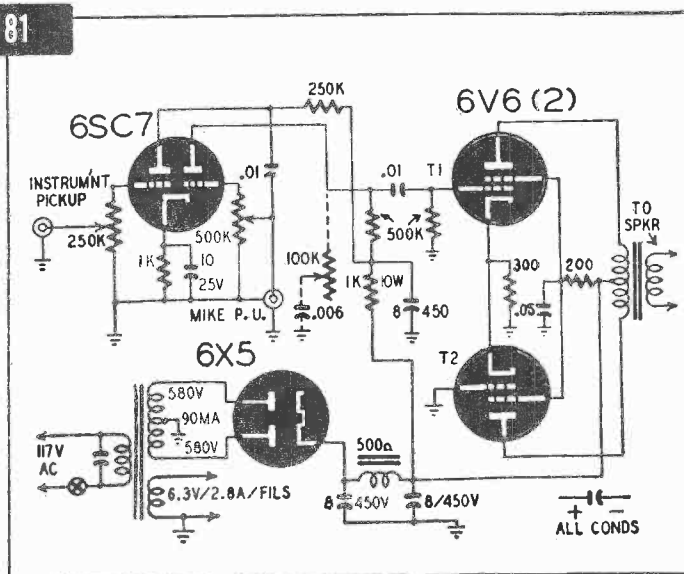


80. A 30-45-watt amplifier, designed by the Australian associate of RCA. With the component values given, it is a 30-watt amplifier. With a plate transformer having an 850-850-volt secondary and an output transformer with a minimum rating of 45 watts (10,000 ohms plate-to-plate) it becomes a 45-watt 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.

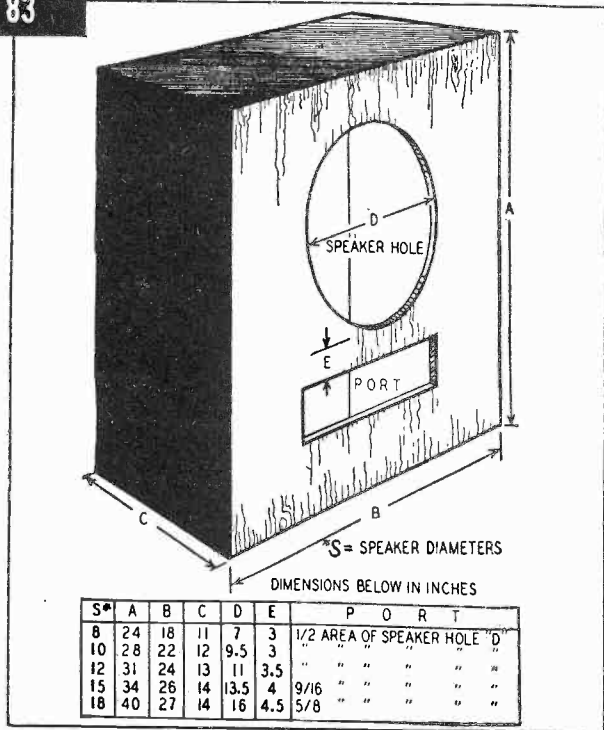


81. A small amplifier with considerable gain, used originally for a musical instrument. It could be made even more compact by using new miniature tubes (6AQ5 for 6V6, 6AX7 for 6SC7, etc).

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.



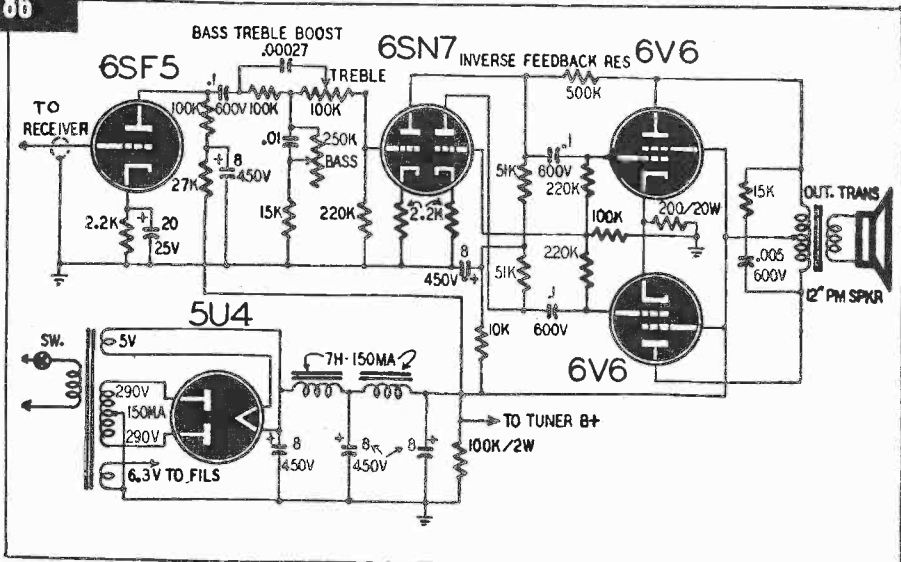
83



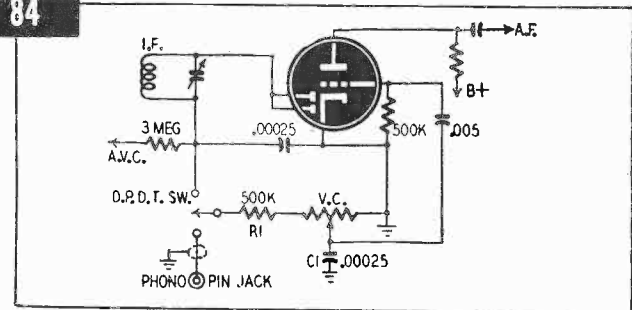
83. A reflex speaker enclosure. Dimensions are given for various speaker sizes. The enclosure is made of heavy wood or building board, with a solid back. If the box is made of light material it is likely to vibrate and add its own resonances to the program. With certain loudspeakers a larger or smaller 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

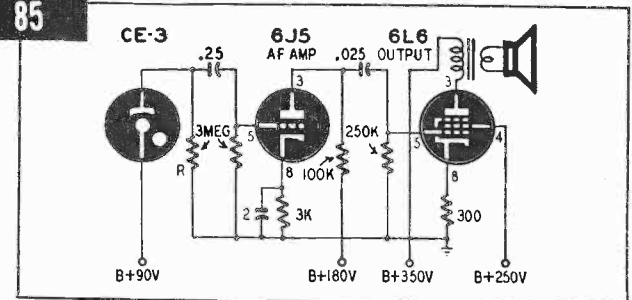


84



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.

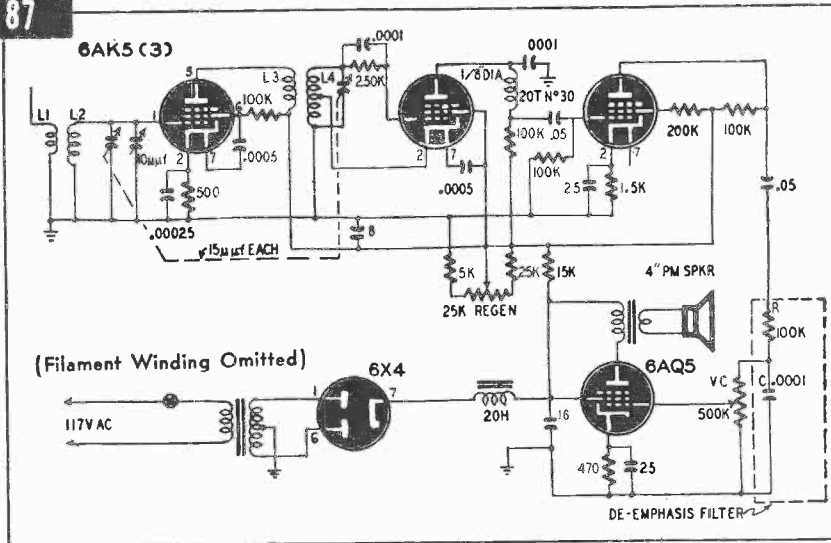
85



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



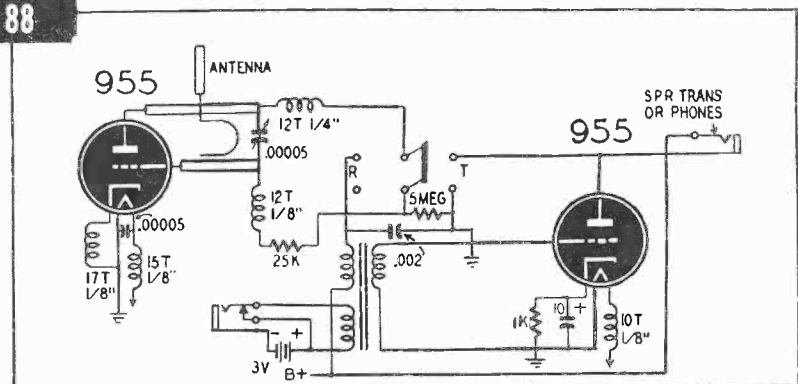
All coils wound with No. 22 enameled wire—detector secondaries are center-tapped—

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

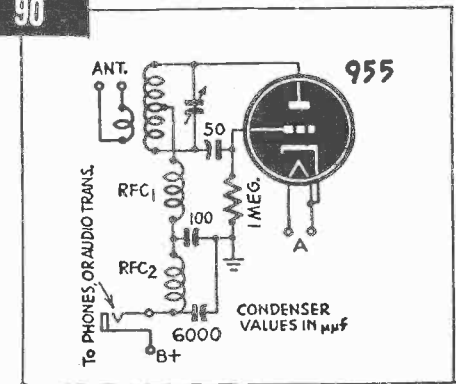
* ¼-inch diameter coils placed within coil forms—all others are wound outside the ¼-inch forms.

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 ¼-inch polystyrene of a type suitable for winding high-frequency inductors.

88

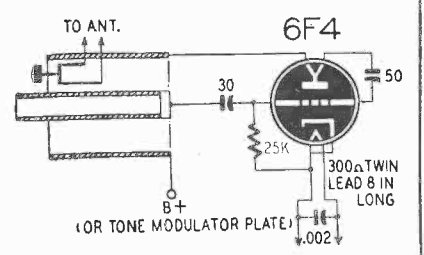
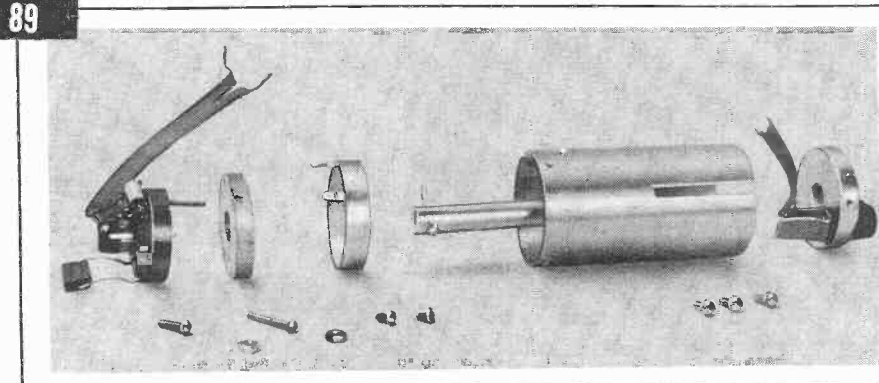


90



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.

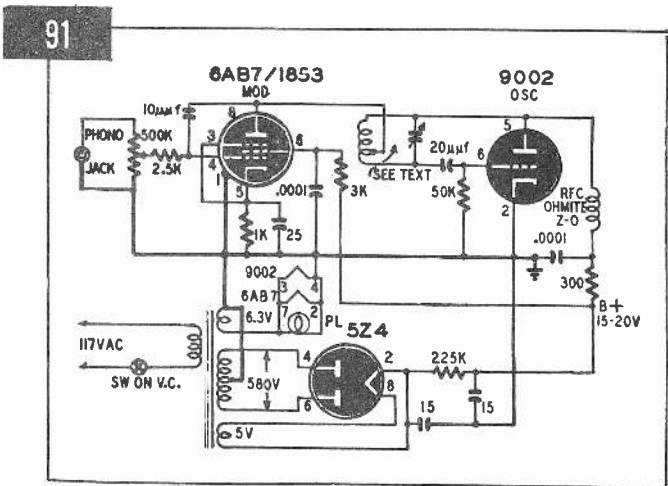
Taps on coils may find themselves in queer positions. A tap indicated as one turn from ground may work better exactly at the ground terminal, or even a fraction of an inch out on the ground lead. Such is the tuning effect of connecting leads.

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

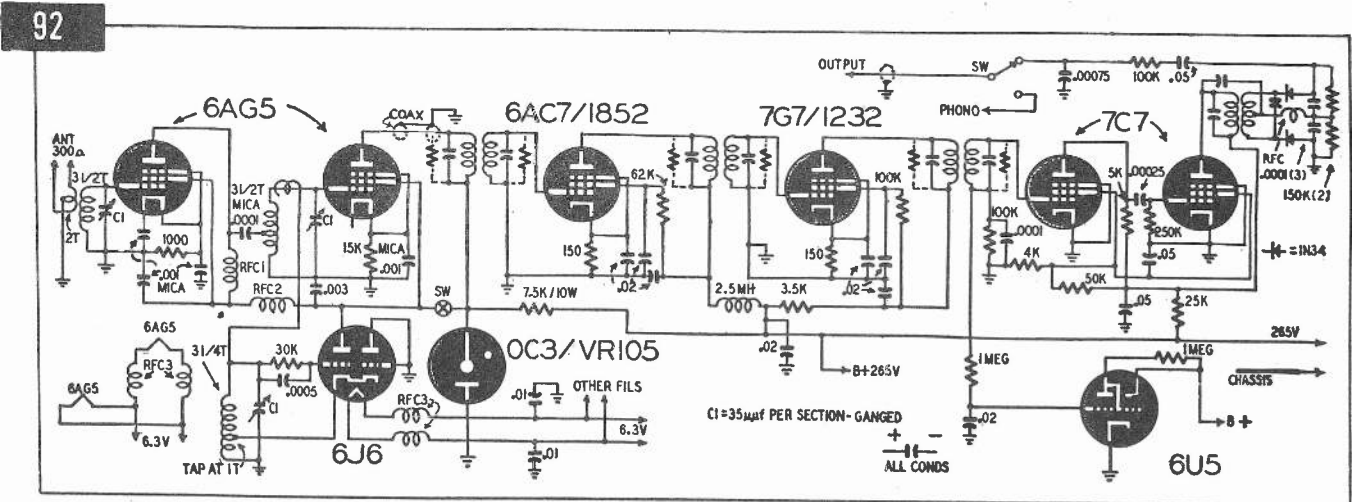
turns of No. 16 or 18 wire on a quarter-inch dowel, spacing turns very slightly.

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.

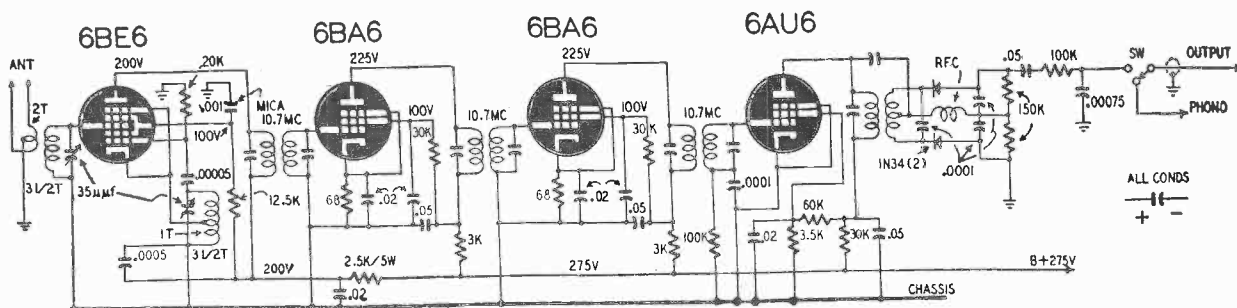


91. A phonograph oscillator built to work with an ordinary FM radio receiver. The coil consists of three turns of No. 12 or 14 copper or silver-plated wire, three-quarters inch inside diameter and spaced out to one inch. The tap is one-half turn from the grid end.



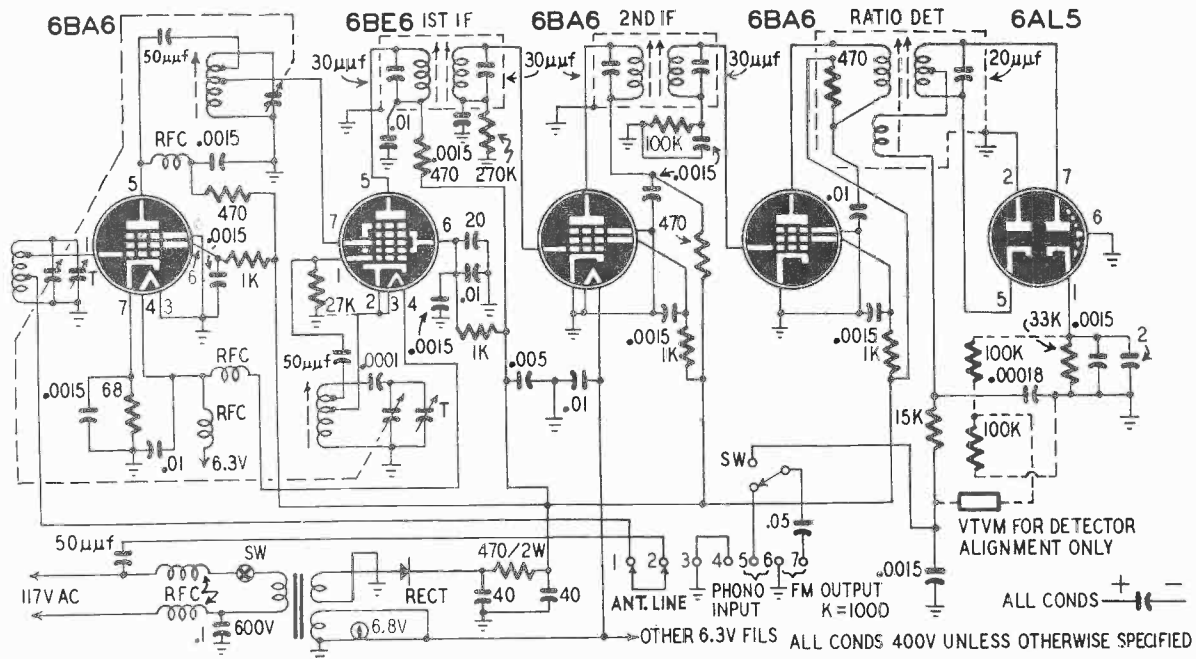
92. A complete FM tuner, with voltage regulator and electron-ray indicator. Constructed for use in fringe areas, it has an r.f. and two i.f. stages. Two limiter stages suppress interference. The coils are of No. 12 wire, one-quarter inch in diameter and three-quarters inch long. Grid coils are all of 3 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.

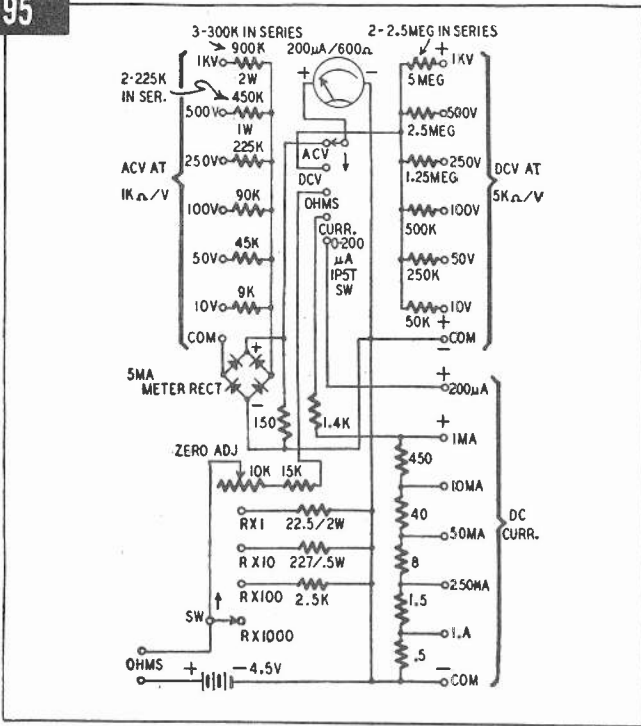
94



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.



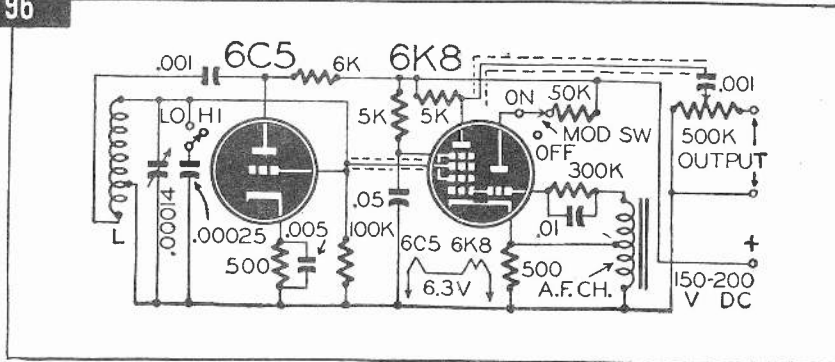
95



95. Most necessary of all instruments is the common multimeter. This instrument uses a 200-µa meter, but meters ranging from 50 µa 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 µa, and each multiplier resistor for this meter is 5,000 times the voltage measured by it. For a 50-µa 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.

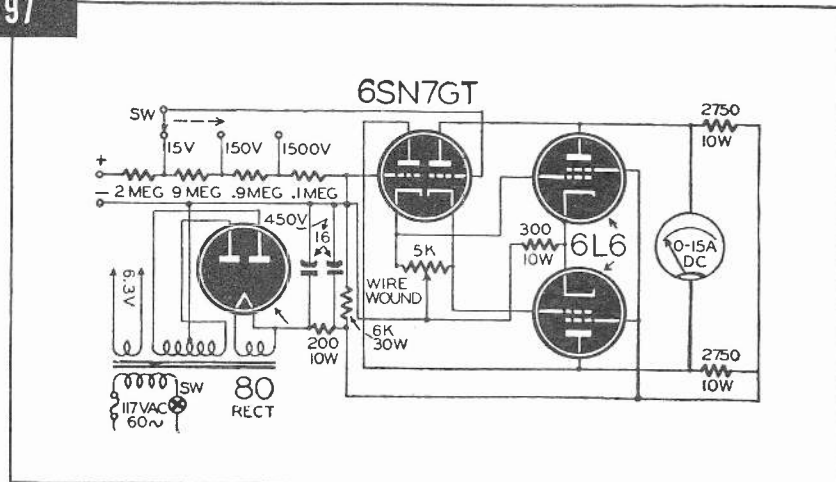
Milliammeter ranges depend on the internal resistance of the meter. To multiply the range by any figure, put across the meter a shunt which will reduce the total resistance of meter and shunt by that figure. Thus, a 27-ohm, 1-ma meter will read 10 ma when shunted by 3 ohms (one-ninth the resistance of 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-µa 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



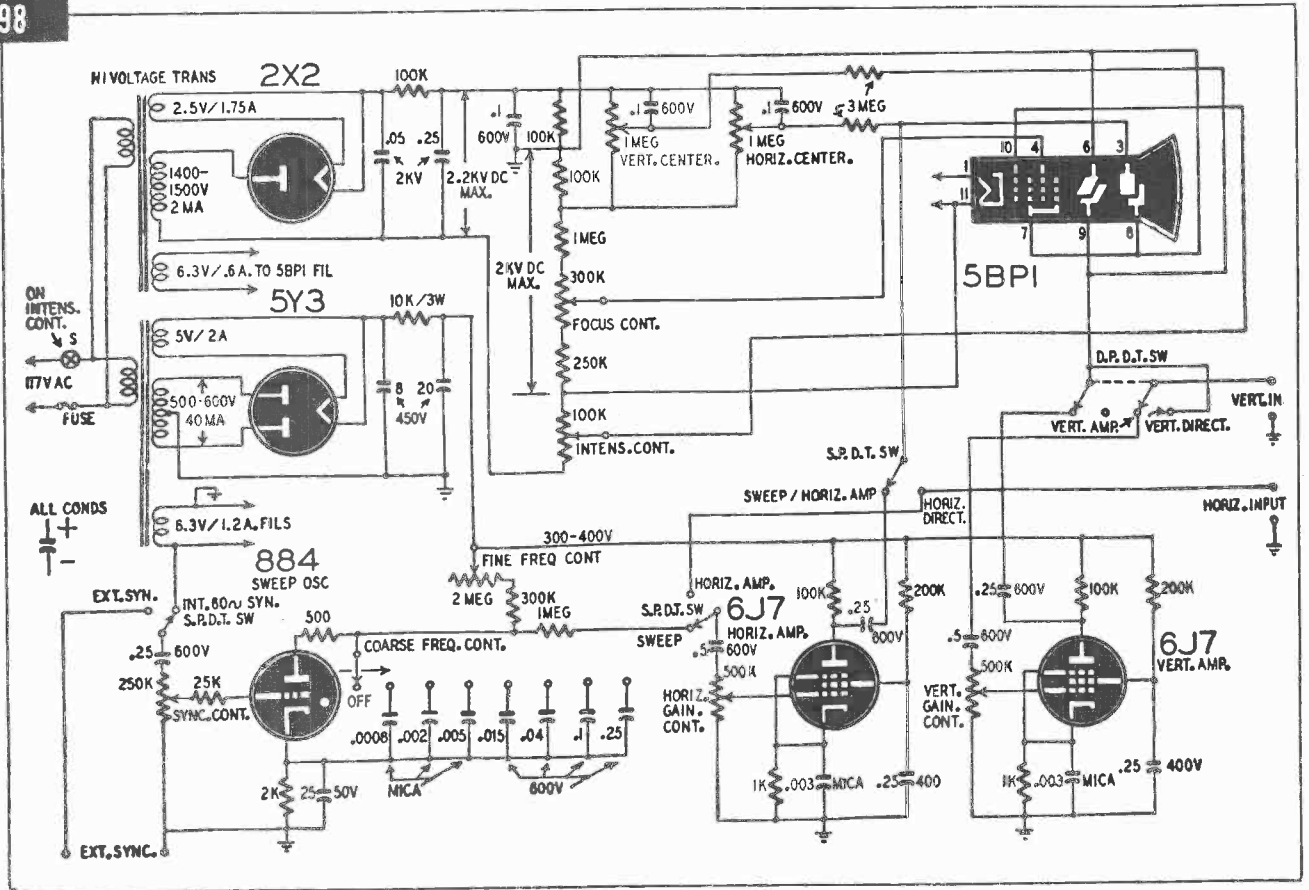
96. A signal generator constructed to cover either the 425-525 kc i.f. range or the broadcast band. The coil is 130 turns of No. 32 enamel-covered wire tapped about 30 turns from the bottom. If the rather odd-sized capacitances in the original circuit are not available, a pair of 365-µmf capacitors may 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



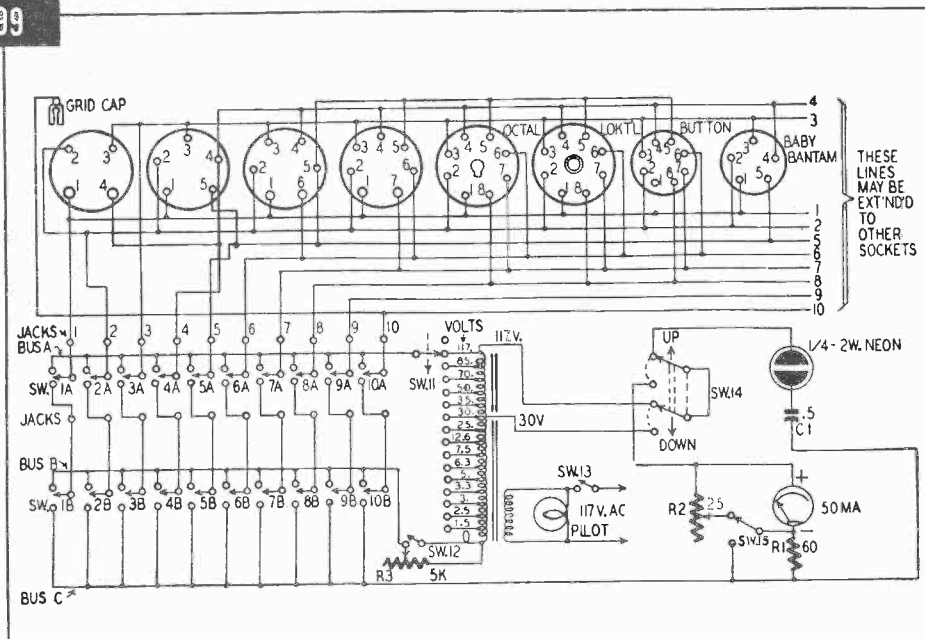
97. A simple vacuum-tube voltmeter built out of surplus equipment. The meter is an old ammeter from which the shunt has been removed, leaving a movement with a range in the order of two to three milliamperes. Any low-range milliammeter may be used in this circuit. The meter is balanced by shorting the 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



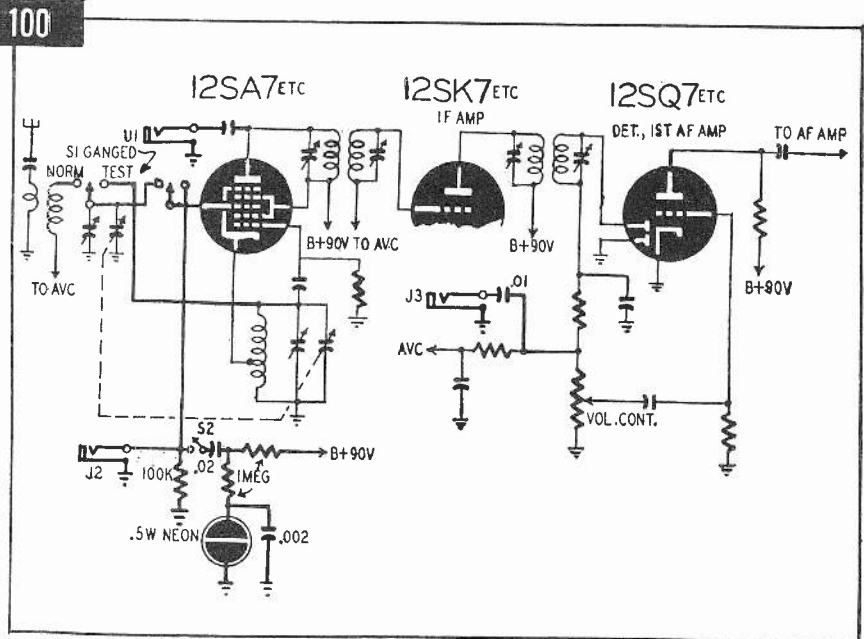
99. Tube checkers are not easily constructed, because of their numerous soldered connections, and need calibration with a known good tube of every type to be tested. Therefore tube testers are not popular with constructors. This is one of the simplest circuits. Filaments are connected to busses A and 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.

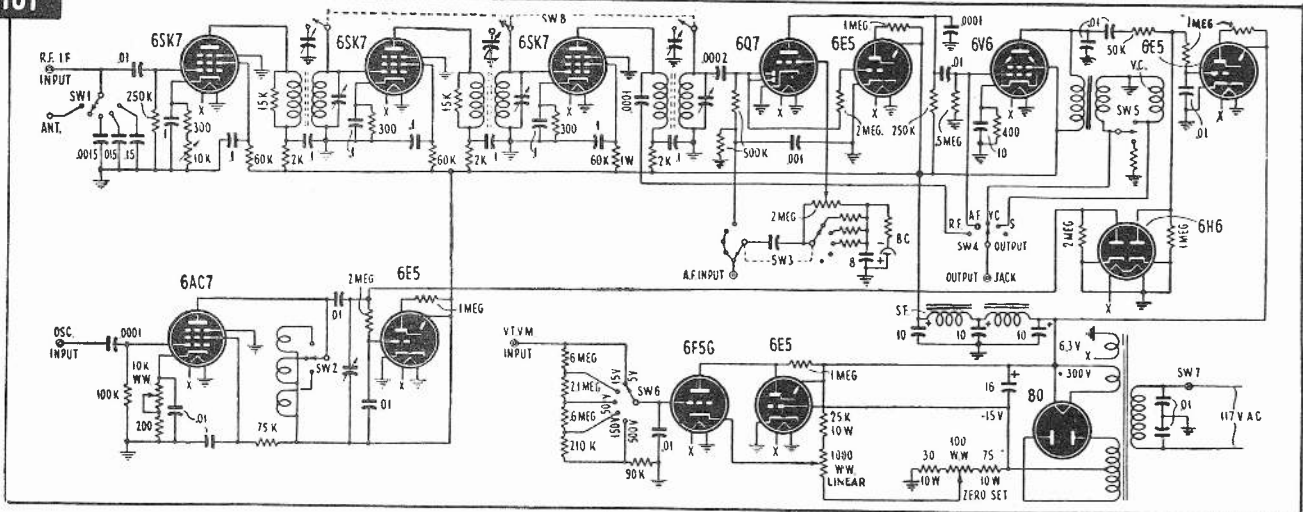
Audio signals may be traced by inserting the plug in J3, tuning the tester to a clear channel with switch at NORMAL.

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



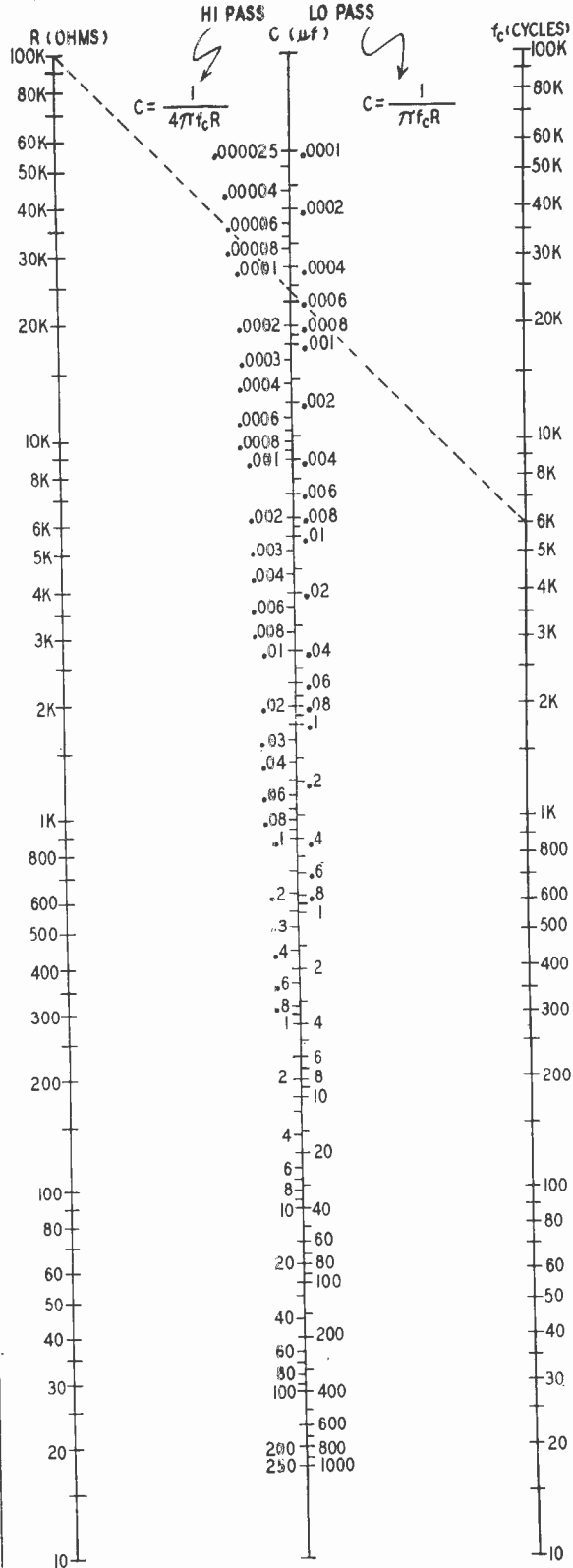
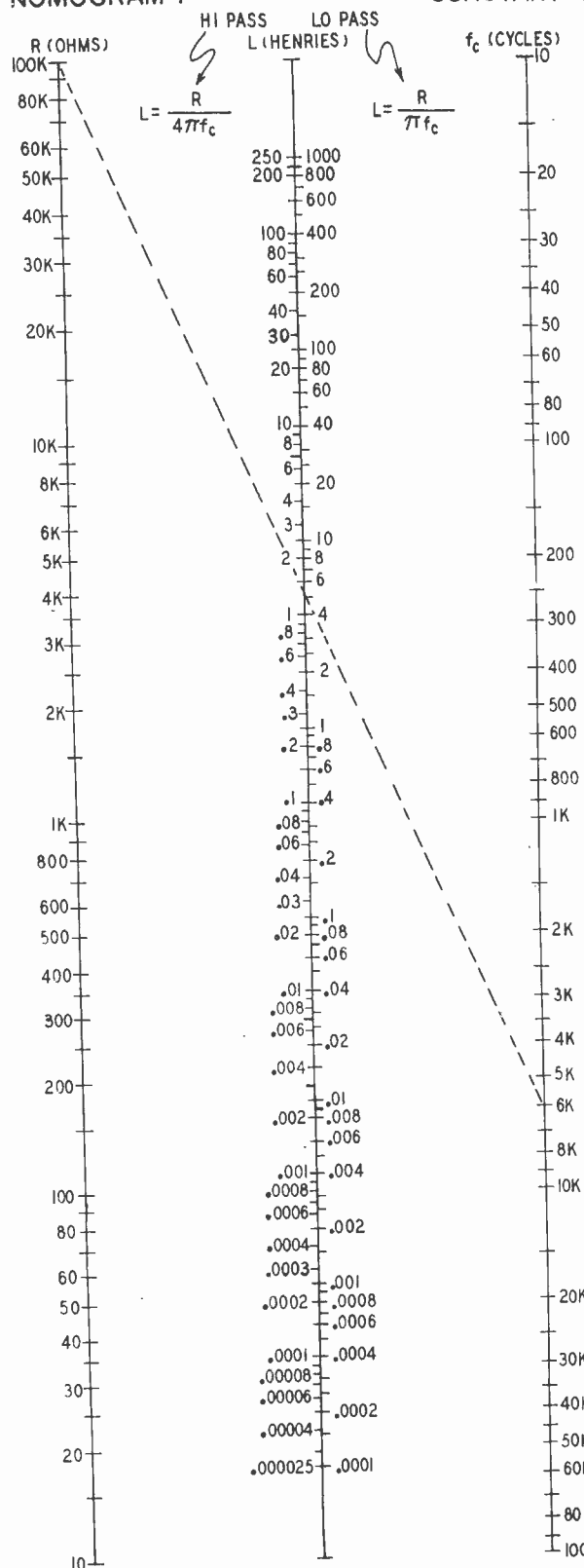
101. The ordinary signal tracer is too insensitive for servicemen far from broadcast stations. This job was built by a Canadian who needed plenty of sensitivity. Three tuned r.f. stages are used to tune over the broadcast band. By switching in the three trimmers, the set covers intermediate frequencies 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.

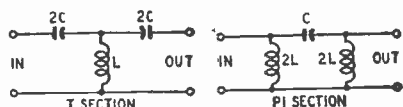
NOMOGRAM 1

— CONSTANT-K FILTERS —

NOMOGRAM 2

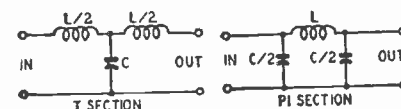


Hi-Pass



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 Receiver		Feb. 48	48
Switchless		June 48	62
Tubeless		Apr. 48	44
Wireless		Nov. 47	56
Intermittent Checker		Sept. 48	74
Ionosphere experiments, 3.6 mc		July 48	33
Isolation Transformers (See Transformers)			
	- J -	Jan. 48	32
Jenkins, C.F.			
	- K -	Sept. 48	22
Kiss Meter			
	- L -	June 48	67
Labels, Panel		July 48	42
Langevin 122 Amplifier		Aug. 48	69
Latin American Radio		Aug. 48	23
Light Magnifier		Aug. 48	60
Lightning Arrester with T-R Tubes		May 48	50
Line Cord Anchoring			
Litz Wire (See Wire)			
Loudspeakers		Apr. 48	50
Cleaning		June 48	67
Cleaning		Mar. 48	42
Repairing		Jan. 48	53
Test, Universal		Aug. 48	58
Grill Cloth, Tightening			
	- M -	Mar. 48	42
Magazines, Binding		Oct. 47	26
Magnetism		Sept. 48	41
Maico Hearing Aid			
Medical Electronics		Mar. 48	28
Part I		Sept. 48	28
Part II		Sept. 48	28
Metal Locator, compact		Sept. 48	79
Meters		Sept. 48	45
Amperes, AC, Servicing Uses		Oct. 47	22
Field Strength		Oct. 47	46
Field Strength		Sept. 48	22
Kiss		Jan. 48	70
Milliamperes, for Servicing		June 48	66
Multirange		June 48	80
Multirange		July 40	56
Output, Crystal-Rectifier		Feb. 48	50
Recording-Level		Nov. 47	56
Shunts		Mar. 48	60
Shunts		Aug. 48	59
Shunts, Mounting		Mar. 48	66
Viscosity		May 48	22
Visibility		Aug. 48	26
Volt, Vacuum-Tube		July 48	56
Volt, Vacuum-Tube		July 48	28
Volt, Vacuum-Tube, Double-Bridge		Aug. 48	63
Watt, a.c.			
Microphones		Jan. 48	80
Carbon, repairing		Nov. 47	62
Case		Mar. 48	26
Contact		Aug. 48	60
Contact		Nov. 47	38
Oscillator		July 48	48
Mirror, Dental		Mar. 48	54
Mixers, a.f., Vacuum-Tube		July 48	66
Mobile B'dc'st Relay in Denmark		Aug. 48	58
Modulator, Flea-Power		July 48	32
Motion Picture Amplifier		July 48	48
Motorboating, Curing			
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
	- N -	Oct. 47	32
National NC-173 Receiver		Aug. 48	52
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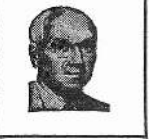
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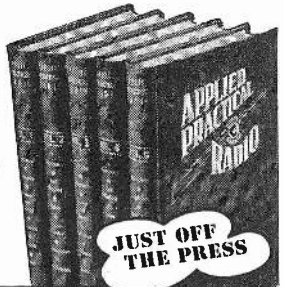
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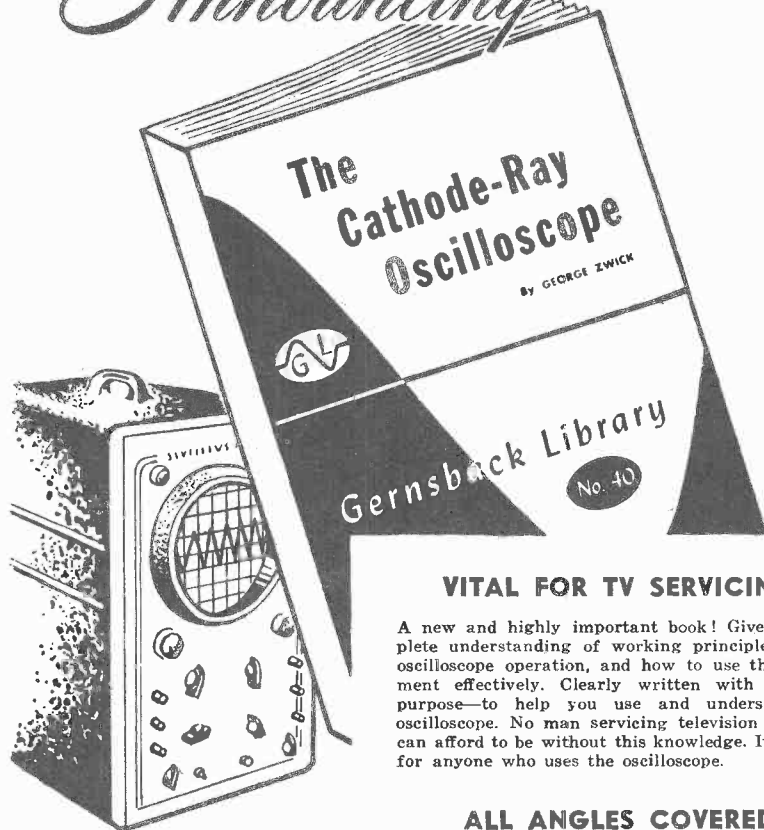
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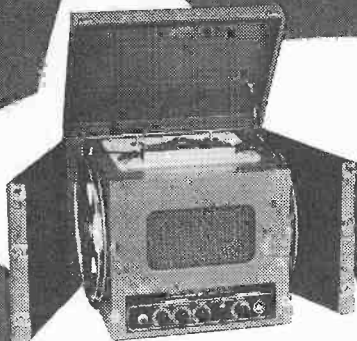
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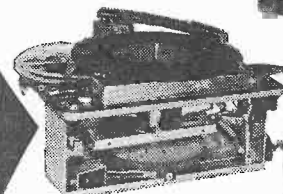
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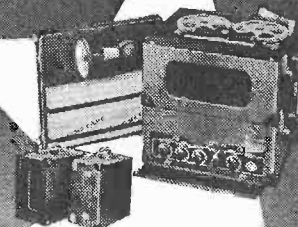


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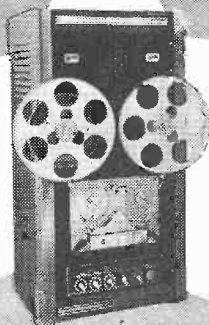


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