2JU SPECIAL SIX

amateur receiver

Here is a receiver specially designed for amateur use, which will give you a genuine eight-valve performance from six. Several constructional and circuit features are included which make it unique, not only in its design, but also in its construction. Such things as a simply hand-calibrated dial will allow you to find your frequency at a glance. Bandspread gives you six or seven inches of scale on each band. The new 6K8G converter and the 6C8G second detector and beat-oscillator save you two valves without efficiency loss. Vernier band-setting allows quick and sure adjustment when changing coils . . . . and can she go!

receivers using a valve such as the 6A8. If you disagree you will have to convince us that you have a better laboratory to check your results than has the best of the commercial labs. in question, and that you have the knowledge and ability to adjust the circuit in your receiver as well as the men in such a laboratory. If you can produce your figures on grid current at various frequencies, conversion gain, noise level ratios and the like, we will humbly apologise.

The fact of the matter is, of course, that we amateurs, who only slap on the number of turns which seems to work out the best, can not hope to compete with a laboratory for such accuracy. So that the majority of our case for using separate oscillators and so on falls to the ground, and rests on such things as a bit better freedom from interlocking, etc., than we can get with a single converter valve.

That's one point to be considered—that it's easier to talk about our efficient separate oscillator circuits than it is to get the efficiency, so's you'd notice much difference.

THE 6K8G

This brings us to the consideration of a new valve which has lately come to the fore—the 6K8G. This is a converter valve, which has been constructed with a very much improved plan, allowing most of the disadvantages of the older 6A7's and 6A8's to be overcome. It isn't yet a perfect valve, but its's a darned good one. We had hoped to have a series of figures run off for this issue, showing just how it compares with the 6L7 and separate oscillator, and also with its newcomer friend, the 6J8G, because there's so little difference between them, that the amateur constructor is not likely to tell the difference. We will go further than this—having been a very keen user of the 6L7 and every other type of converter we could lay hands on, we'll wager that two identical sets, placed side by side, using the two valves, would, to the amateur ear, sound exactly the same. We just could not tell the difference, and neither could you.

The 6L7 combination was reputed to be quite free from any pulling between oscillator and mixer. As a matter of fact, it wasn't free from this fault, which existed to a very small degree, and we haven't used a converter valve that was. There is just a tiny bit of it apparent with the 6K8, but not a skerrick more than with the 6L7. Noise level isn't any higher, sensitivity may be down a trifle, owing to the lower plate resistance, but this isn't important.

NOT CRITICAL

What is important is that the 6K8 is a valve which, as far as the oscillator characteristics are concerned, isn't a bit critical, and the same cannot be said of all other types. It can't be said of the 6J8G, which, according to laboratory experience, shows a big change in efficiency with a few volts difference in the injection. Its plate resistance is higher than the 6K8G, which may be why some have preferred it. You will remember, by the way, that this valve isn't the same as the 6K8G, being actually a 6L7 type, with the oscillator in the same envelope. However, to make the use of this high plate resistance, one should by rights use a high-impedance intermediate transformer, otherwise in practice there isn't much use to it.

Why we like the 6K8G is that the average amateur, who sometimes hasn't facilities for measuring the oscillator grid current, has every chance, if he follows the coil data given, of obtaining optimum working conditions with it, without worrying whether it may be a bit above or below the 150 microamperes which is recommended. All the coils detailed here have been worked out to supply a grid current at least equal to this 150 microamperes, and even if this is exceeded by 100 microamperes no harmful results will occur or any noticeable change in sensitivity.

Summing it up, we have proved to our satisfaction that there just isn't anything in this prejudice against the single converter valve such as the 6K8G, and we are quite satisfied that in including it in our circuit we have thrown nothing whatever away. Quite a number of amateurs whose experience demands respect have tried out this receiver for themselves, and they have all remarked on its low noise level and freedom from pulling at maximum gain.

As a matter of fact, the 6K8G is reputed to be slightly regenerative anyhow, about 20 metres, which is just where the average valve tends to drop off. No, sirs, in many ways, the electron-coupled mixer is the ideal valve for converter service, and there are plenty of clever men who share this opinion.

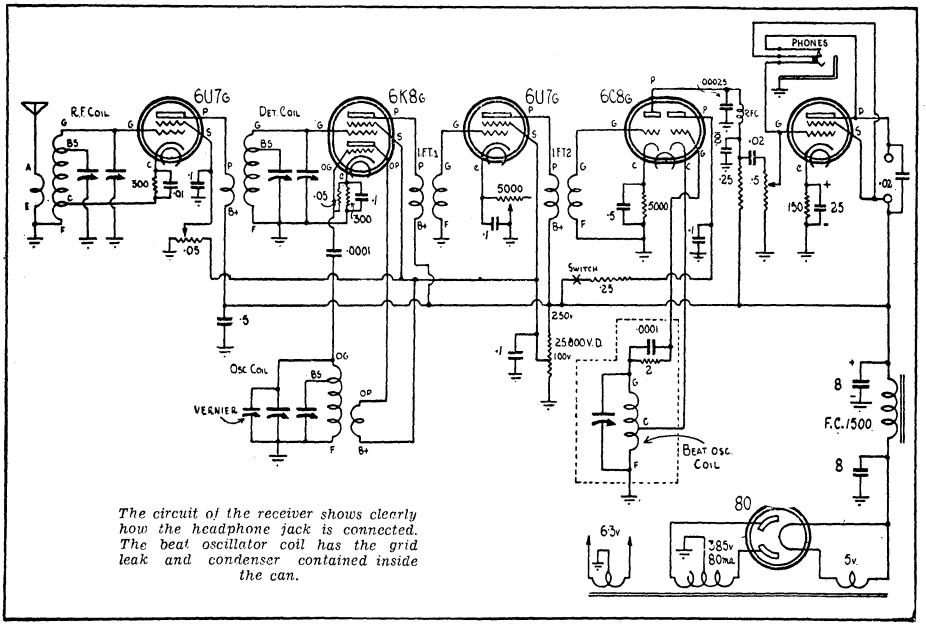
It is scarcely necessary to point out that this valve simplifies the construction of the set quite a bit, and saves the cost of the extra valve.

THE 6C8G

Turning now to the beat oscillator circuit, we set out to find a circuit which would be just as good as that using a

PARTS LIST

1 Chassis, 14 x 12 x 3½.
1 Panel, 16 x 12.
2 Shields, 3½ x 6.
1 Tuning dial.
6 Midget condensers (see article).
4 Flexible couplers.
2 High-gain intermediates.
1 Beat oscillator coil.
1 Power transformer, 385-0-385 at 80 mills., 6.3 mills. at 3 amps., 5v. at 2 amps.
1 5000 ohms potentiometer.
1 50,000 ohms potentiometer.
1 .5 meg. potentiometer.
1 Switch.
2 8 mfds. electrolytic condensers.
1 25 mfds. electrolytic condenser.
2 .5 mfd. tubular condensers.
6 .1 mfd. tubular condensers.
1 .0001 mfd. mica condenser.
2 .02 mfds. mica condensers.
1 .01 mica condenser.
1 .001 mica condenser.
1 .00025 mica condenser.
1 50,000 ohms resistor.
1 5000 ohms resistor.
1 25,000 ohms divider.
2 .25 meg. resistors.
1 300 ohms resistor.
1 150 ohms resistor.
5 Octal sockets—2 5-pin, 16-pin, 14-pin.
Valves—6K7, 6K86, 6B8. 6C86, 6F6, 80.
Speaker—1500 ohms field.
9 Coil formers, hardware, etc.



The circuit of the receiver shows clearly how the headphone jack is connected. The beat oscillator coil has the grid leak and condenser contained inside the can.

valve for the second detector plus the extra valve for the beat. We believe that this exists in the 6C8G.

In our last call-sign book we used a **6A6**, with one section as a leaky-grid detector and the other section as a triode beat-oscillator. We have used the set quite consistently until recently, particularly for 10-metre work. This has given us a chance to observe the operation of the system of a dual-wave performing these two functions, and, again, we are satisfied that one can dispense with the usual separate beat-oscillator valve without dispensing with satisfactory operation.

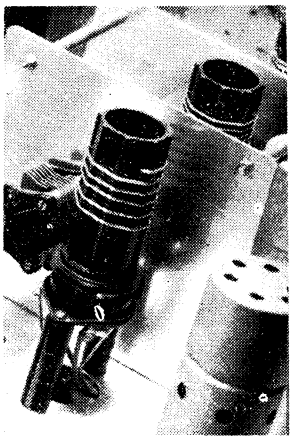
The 6C8G is a valve with two triode sections of medium-mu characteristics, each having a separate cathode. Thus it is in effect two separate valves. Now, as everyone knows, the coupling between the beat-oscillator and detector circuits needs to be very small indeed, if we are to avoid high noise when the oscillator is switched in. The capacity between the two valve sections in the one envelope is quite sufficient for this purpose, and when the beat is turned on one can obtain just as strong an injection as he could desire just by varying the plate voltage on the beat section of the valve. What could be simpler?

BIA SED DETECTOR

We have used the first section of the valve as a biased detector, which will give ample output to operate headphones, and plenty of "sock" for the high gain pentode in the output stage. The 6A6 made necessary a plate-feedback oscillator coil, which in our case was made from an intermediate transformer with the trimmer removed from the plate winding, the other trimmer being used to tune the grid circuit to line with the rest of the set.

Having a separate cathode, the 6C8G is even better, because we can use a simple beat coil with a tapping to which the second cathode is connected. We had a special coil made up for this service, which included the condenser and grid leak inside the can of the coil itself. Thus only three connections are required, one for the grid, one for the cathode, and the other is the earth connection for the secondary. A couple of inches of wire run from the coil over to the valve, and that is all there is to it. A glance at the wiring diagram shows how simple this is.

A COIL CLOSE-UP



This close-up of the oscillator coil shows how the coil sockets are mounted up on distance pieces.

PLATE FEED

The plate supply for the oscillator section is fed through a fixed resistance in series with the on-off switch, which cuts the voltage when the oscillator isn't required. This resistance is necessary for stability, otherwise changes in high-tension voltage will affect the stability of the oscillator. If a weak beat is required, use a high resistance—.5 meg, or even 1 meg. If a very strong beat, a smaller resistor of, say, .1 meg, will be enough for anyone. We compromised, and used .25 meg. for the job.

The separate cathode allows us to use the detector section in a biased circuit, as the leaky grid idea, with its condenser and leak in the open, is more sensitive, but prone to introduce hum, and will block easier on strong signals.

THE CIRCUIT

That's how we eliminated two of the valves which the ordinary man puts into his set. We can now use one of them for an R.F. stage, and the total is re-

duced to six valves in all, doing the same job which the average man attempts with eight.

Let us now run through the circuit. First, we have the R.F. stage. This we have shown with regeneration, and we have done so with mental reservations. We aren't altogether sold on this idea of regeneration. It makes the first circuit tricky—some say cranky—and although it does increase the gain, it also increases the noise when pushed past a certain point.

Just ability to turn up the regeneration and get more noise doesn't mean better signals, although how many think it does? As a matter of fact, we found that by using low-capacity tuning circuits, with a 6U7G type of valve, we were able to get practically the same gain as with the regenerative stage.

Again, it's hard to find a spot where regeneration is smooth and easy, while maintaining at least 70 volts on the screen before going over into oscillation. It's mainly a matter of balancing regeneration against aerial loading. If a tuned aerial is used, regeneration will be damped out very sharply as the resonant spot, and tend to fly off the handle at all others. Still, it can be tamed quite well, and it's worth playing about with until the best results are obtained. And it's no harder in this set than in any other.

The mixer, as we have said, is the 6K8G.

This feeds into a conventional I.F. stage, with variable gain, controlled by a variable resistance in the cathode circuit. There isn't much we can do here, except use good intermediates. We had special high-gain jobs developed for the set, using Trolitul insulation, but any good intermediates will serve.

The second detector is the 6C8G.

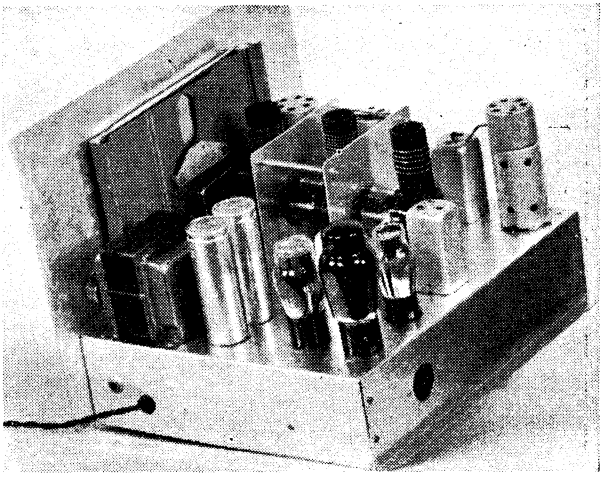
OUTPUT SECTION

The output valve is the Brimar 6AG6-G. This was used because it is probably the easiest valve to drive for high output. Only a couple of volts drive are required to give about 4 watts output, should this be necessary. It makes up for lack of an audio driver. But then, how many amateurs need to use their sets at more than about 250 milliwatts output? Again, it's the old idea that a big noise means an R8 signal, which a smaller one doesn't. Fortunately, most people are beginning to see its foolishness. Consequently, although this valve is most suited to the position, an ordinary 42 or 6F6 output valve can quite well be used.

The rectifier is an 80, and the power supply conventional.

THE COILS

Don't lose your hair when you see the large number of turns we have used on the secondaries of the tuning coils. It's the best way we know of to get sharp tuning and gain. At least one amateur who heard this set went home, and practically doubled the turns on his own coils, with most definite improvements in gain and selectivity. There's nothing like the use of small condensers and big coils to make a set perform. That's one reason we get such good gain and clean tuning.

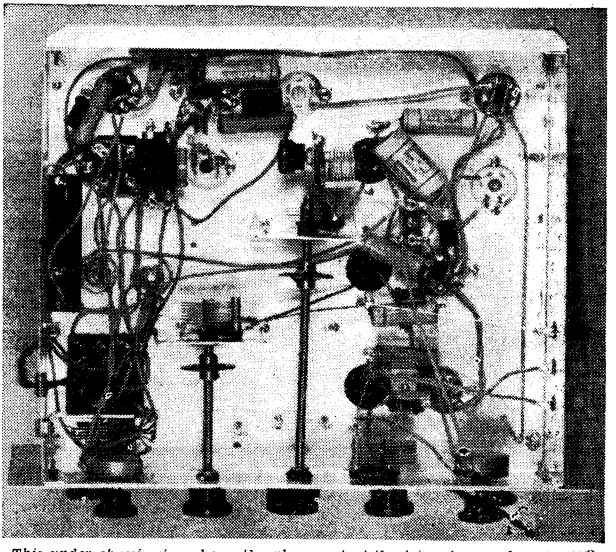


Another rear view of the set shows the audio end and power supply. The speaker socket can also be seen. The phone jack is near the outlet for the power cord.

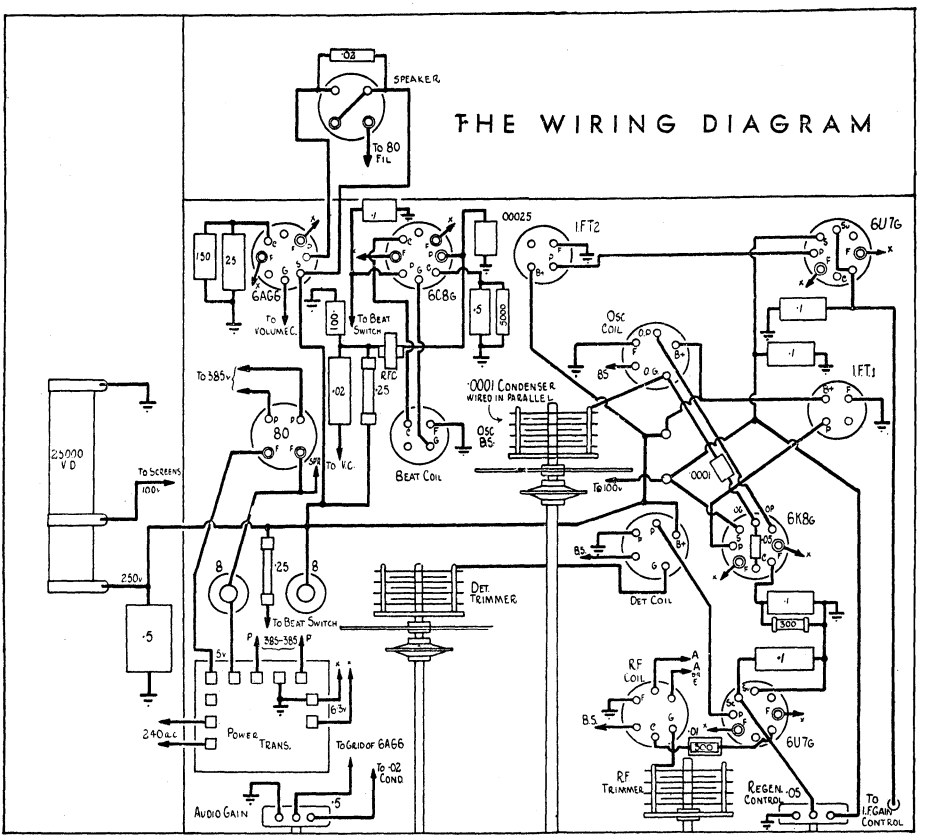
The set as photographed used .0001 midgets for trimming these coils, but only the last little bit of the tuning range was made use of. Since then, these condensers have been reduced to about 15 mfds. to give a vernier effect in the small trimming adjustments that have to be made to the R.F. stage with regeneration, and nothing could be easier than the well-controlled way they peak up on signals.

THE OSCILLATOR CIRCUIT

It's a different story in the oscillator circuit. Here there are only two things



This under-chassis view shows the placement of the trimming condensers and the two oscillator band-set condensers. Note the few components which are necessary.



This diagram shows all the wiring underneath the base of the set. The coils, of course, are above the chassis, and the leads run through to them.

to worry about—stability, and enough injection voltage for the mixer. High-C coils are no disadvantage here, and are to be preferred, mainly in the interests of stability, and, secondly, as an aid to good circuit tracking over the various bands.

An article covering this point recently appeared in "Wireless Weekly," so we don't want to cover the ground in detail again.

But the use of a big condenser here—.0001 fully meshed—makes the location of the marker station for bandsetting very critical. It's like tuning the receiver without even the aid of a decent dial. So we evolved the scheme of using a fixed condenser in the circuit to maintain the C of the circuit, and connecting a smaller one of about 15 mmfds. across it. By adjusting the turns on the oscillator coils so that the band-set station marker falls inside the range of this vernier trimmer, it's the easiest thing in the world to locate the marker after the coils for each band are plugged in. More than this, the tuning has lost its very critical nature, so that it is quite simple to bring the marker to its spot on the dial with the use of an ordinary knob or pointer. This simple idea is not to be appreciated until it is put into practice.

We tried the use of a fixed condenser of .0001 mfds., instead of the large variable type, with perfect success. However, a variable type makes it easier to adjust the coil turns when making the coils, in case you start off with a number that won't allow the marker to hit resonance in the range of the vernier.

Accurate condensers of the fixed type may be obtained from the makers of T.C.C. or Chanex condensers, if you ask for them.

The leads above the chassis include those indicated on the above diagram, running to the bandspread condenser, and the leads from the intermediates to the caps of the respective valves. The I.F. Gain control is also above the chassis, as is the beat switch.

BANDSPREAD

Every amateur receiver needs a good bandspread system. Again, we wrote an article about this in "Wireless Weekly," to which you can refer if you desire. The long and short of it is that we adopted the method of using standard 100m. mfds. midget condensers tapped part of the way up the secondaries to get the right amount of bandspread. It's a very simple and effective scheme. The coil data for the set will probably allow you to hit the right adjustment

straight away. If not, work on the oscillator section first. If not enough spread is obtained, tap the coil nearer the earth end. If too much, move the tap nearer the top.

Having got the dial spread you want, you may find that the R.F. and detector trimmers need adjustment from one end of the band to the other. If the condensers need increasing capacity as you go lower in frequency, move their bandspread taps nearer the grid ends of the coils, and vice versa. You should be able to strike an adjustment where tracking is practically perfect all over the dial. We used bare wire for the 20-metre coils, and soldered the taps direct to the wire from the outside until the right spot was found. As a rule, it will be the same number of turns for all coils, with the .0001 capacity in the oscillator circuit. Note that the oscillator coils are much smaller than the others. Obviously, this has the same effect as would padding condensers, in effecting the correct lag between oscillator and signal-frequency circuits to maintain the right frequency difference between them.

COIL DATA

Cathode coil for 40 metres has 8 turns of 20 gauge enamelled wire on 1 inch former spaced to 1 inch.

Plate coil of 6L6G has 10 turns for 20 metres, and 20 turns for 40 metres, wound on 1¼ inch formers, with 20 gauge enamelled wire, spaced to 1¼ inches.

Final tank has 30 turns of 1-8 inch tubing for 40 metres, 18 turns of 3-16th tubing for 20 metres, and 8 turns of 3-16th tubing for 10 metres, all centre-tapped.

This coil data should serve as an accurate guide, but is subject to slight change to suit conditions. Final tank coils 2 inches in diameter, and spaced over 4½ inches.

	R.F.				*Detector.*			*Oscillator.*		
Band.	A.	G.	Tap.	B.S.	P.	G.	B.S.	P.	G.	B.S.
20	6	13	½	2	6	13	2	4	6	2
40	10	23	1	5	10	23	5	5	12	5
80	15	45	1	12	15	45	12	10	24	12

Coils are wound on 1¼ inch formers. Use gauge 20 tinned wire for 20 metre grid coils, also oscillator grid coils for 40 and 80 bands. All others wind with 26-gauge enamelled wire. Primaries are interwound. Aerial coils wound at earthed end of grid coils, and spaced for best regeneration. Oscillator coils for 20 and 40 metres spaced to one inch, all other to 1½ inches. This data should prove a good guide, but is subject to small variation to suit your particular case.

THE DIAL

The dial is another of those little things the average amateur doesn't seem to worry enough about. Why use a dial marked in 0-100 scale when the stations don't come that way? Surely it is a simple matter to use a standard broadcast dial of good make, paste a thin card or drawing paper scale over the glasses, and calibrate the thing yourself? A bit of work with some compasses will result in the required number of "lanes" being drawn in, one for each band, upon which you can mark in pencil any checking spots you desire, plus any unusual stations you happen to hear, and want a record of their frequency.

With the band-spread arranged to cover the whole dial, we have as much as seven inches to play with on each band. Just imagine how convenient that is when using your set. No more mental arithmetic or tuning charts to work out your frequency. It's there staring you in the face, no matter where in the band a station may be.

Good dials can be obtained for very little more than many popular 0-100 types, and the difference—well, it's again one of those things you must use to appreciate.

Our preference is for the big straight-line type of dial which has maintained its accuracy for nearly three years in the 2JU Ten, but it costs a fair bit, and the semi-circular types are quite satisfactory. And if you get good dials, such as the Efco's we have been using, there won't be any backlash that you could notice. If you like to work out the distance represented by 1 kc. in 400m., but spread out over about seven inches, you'll see that it represents about 1/60th of an inch. You can get readings as close as that if your dial and condensers are lined up properly, and on 20 metres, too.

TUNING CONDENSERS

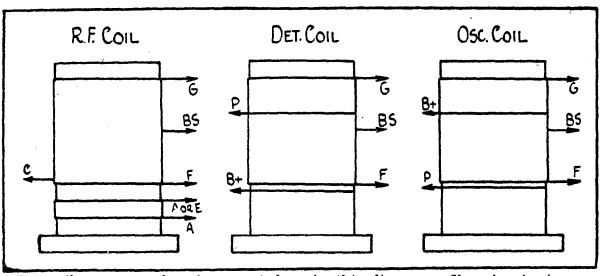
The tuning condensers we used are a new type put out by R.C.S. with Trolitul ends, and suitable for ganging. Many people incidentally blame a lot of things for backlash in ganged condensers when they should be blaming their poor, roughly fitting couplers. It is essential to use couplers which really do fit the shafts and don't allow about 5 thou. to spare. How can you keep them in line when you tighten up grub screws which do their best to put them out?

The partitions also must be of heavy metal—16 gauge at least. Take time in getting the mounting holes exactly opposite each other, with a bit of clearance to allow for your errors. Spend some trouble in seeing that the three can be rotated by hand with an ordinary knob, without binding or weaving, before you finally put the dial in place. The dial will drag 'em round all right, but you won't get decent results if the whole assembly ties itself in knots in the process. Plenty of others have done this job well, and you can do it, too.

Incidentally, there is a front support for the first condenser apart from the dial, so that the whole assembly is in one piece, even without the dial in place. Take care that the dial is also mounted firmly to the chassis. Our dial rests hard on the front of the chassis, with a couple of small feet to keep it there. There is no strain on anything when the assembly is in action, and there mustn't be, if you want to split those kc.'s on the tuning dial.

Incidentally, the use of a cut-down tuning gang is quite permissible, as a quick method of avoiding lining troubles with three condensers. But this will make your leads a bit longer, and the merits of the two methods just about balance. But for layout in this case, the midgets have it. There are several suitable brands on the market.

COIL CONNECTIONS



The coils are wound and connected as in this diagram. Use six-pin former for R.F. coils, five-pin types for all others. C indicates cathode tap.

LAYOUT

Take note of the extremely neat layout of parts. The coil sockets are mounted upon spacers so that the connections to

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(Continued from Page 35)

the coils are only about ½-inch long. The leads to the 6U7G and 6K8G are also quite short. Those to the trimming condensers for the detector and oscillator condensers are longer. In the case of the oscillator, it doesn't matter, and in the case of the detector, as long as the lead is clear of other wiring, it doesn't matter either.

The main objection to long leads is only an objection where coupling is possible, but you must have something to couple to before worrying.

This is true of shielding coils. It is bad to put cans over coils and thus reduce their Q most considerably. The shielding shown in our set is perfectly efficient, and any coupling which can exist isn't worth worrying about. The R.F. stage is regenerative anyhow, so why worry? That's another point that could do with a good sound talking about—the misuse of shielding.

The insulation of coil formers, sockets and the like is, of course, to be made as good as possible. However, as most fellows will use the standard gear, we have used it, in preference to Isolantite formers, etc., which are hard to get and expensive. These will help, but they aren't so important that you won't get worthwhile results if you don't use them.

ODDS AND ENDS

That's about all there is to be said about the set. There is no adjustment for varying the beat frequency, although a small variable condenser wired from grid to ground would do the trick. But it's one more control, and we don't find the need to use it much.

Keep the leads to the oscillator grid circuit firm, and make them with stiff wire. Any change here will spoil your stability. Also when earthing components associated with any one stage, make these connections if possible to the same solder lug. Anyhow, connect them all up with heavy wire, and fix the whole network with a lead to the earth terminal. This applies to the connections for tuning condenser rotors—don't leave the earth returns to the mercy of several inches of chassis. In most cases it will be all right, but it's so easy to put in that extra lead.

In the diagram, of course, we have shown some components in odd places for clarity. They don't have to be that way, but you can't draw them in if they cross over each other, and make the diagram clear. Most people realise this, but some may not.

OPERATING

We have covered practically all the points which need watching in construction, so we won't go all over them again. Anyone who has built a simple set should be able to get this one going, because one can't have a much simpler circuit. We've done all we can to make it as easy as falling off a log.

Write to us and let us know if you have any trouble or suggestions. Your letters will help us all.