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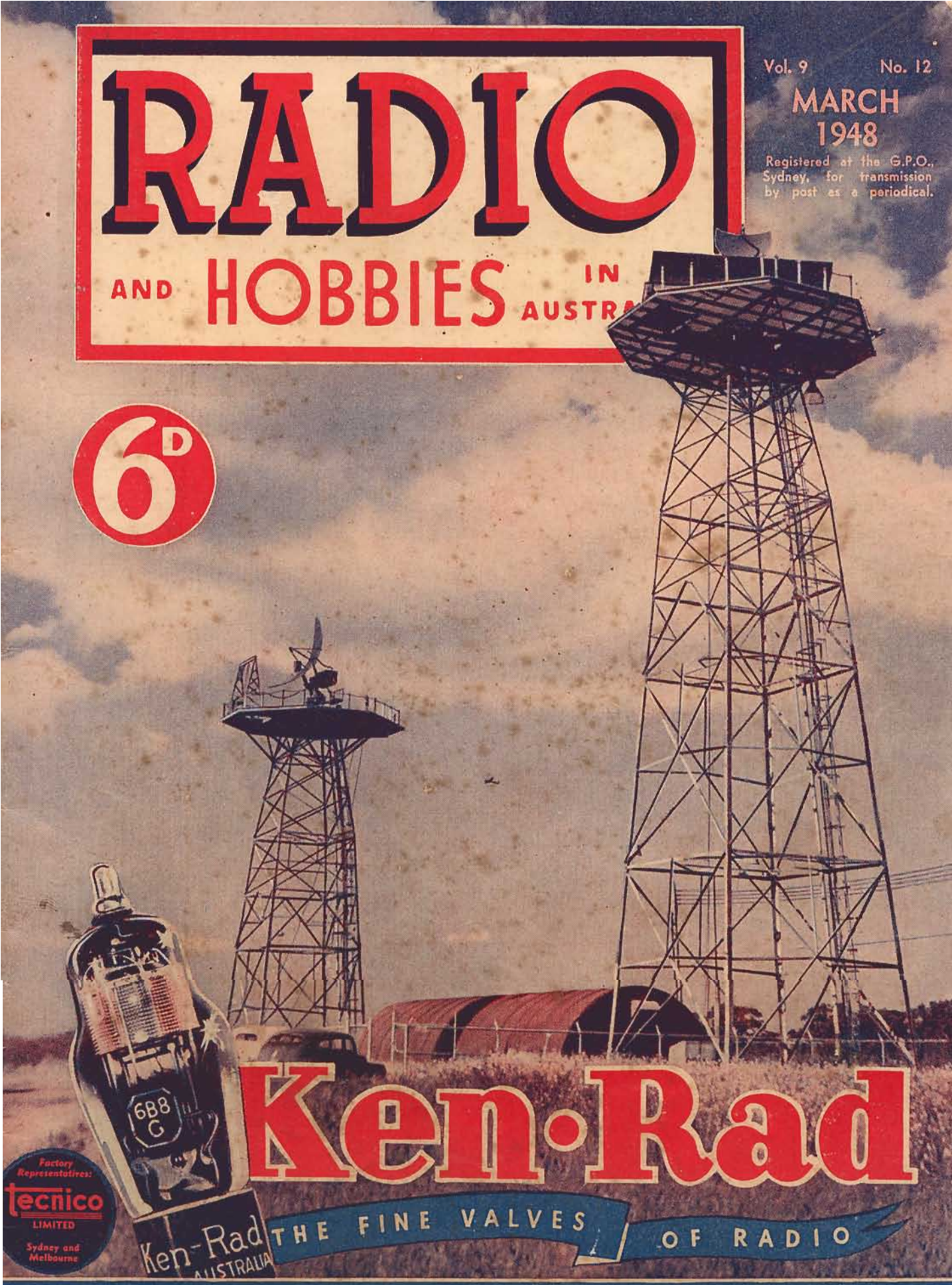
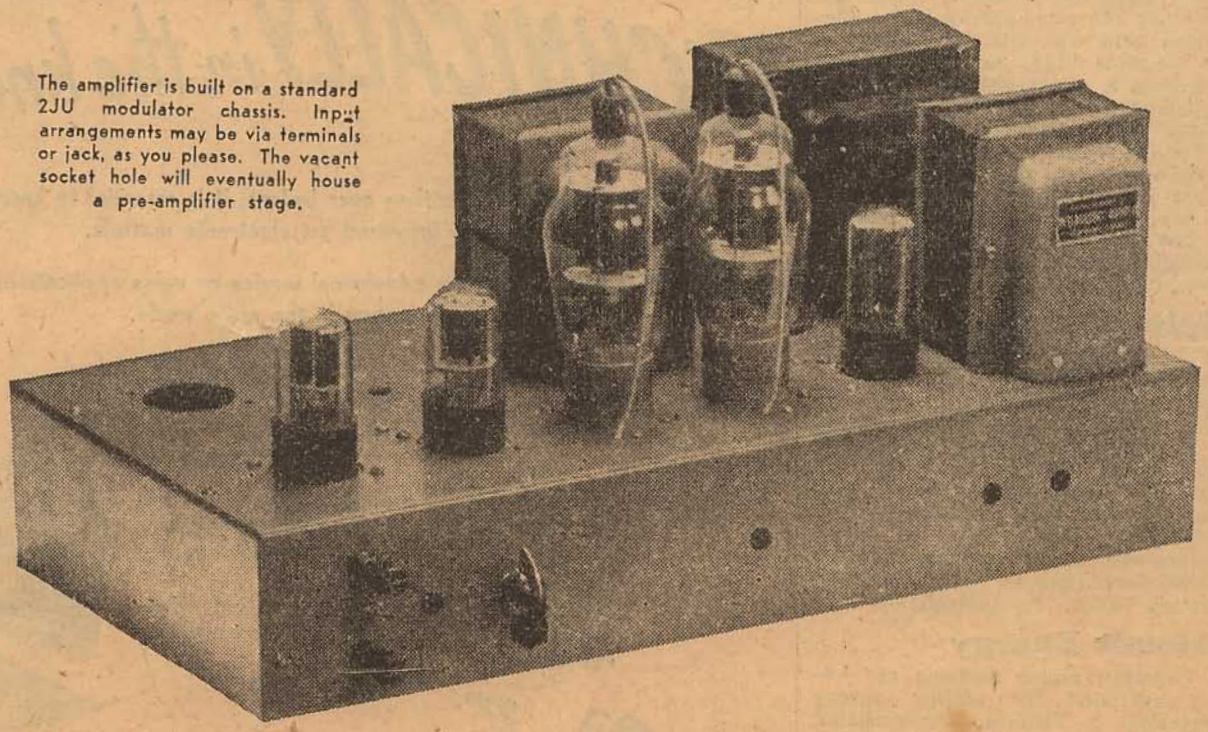


AMPLIFIER TO END AMPLIFIERS

TRIODE-CONNECTED 807 AMPLIFIER



The amplifier is built on a standard 2JU modulator chassis. Input arrangements may be via terminals or jack, as you please. The vacant socket hole will eventually house a pre-amplifier stage.

This amplifier is so good that more than once we began double-checking results to make sure we weren't mistaken. Its frequency response is so flat up to 35 kc that it can only be represented by a straight line. Its total harmonic distortion is below .1 per cent. at 11 watts and very little more at 17 watts. Its gain is sufficient for use with medium to high output pickups, and almost any type of radio tuner. Truly, an amplifier to end amplifiers!

YOU will remember that in our January issue, we were able to publish an article reprinted from "Radiotronics" describing an amplifier very similar to that described here.

This amplifier was based on a design first published in the English journal "Wireless World," well known for its sponsorship of many fine and original developments in radio.

The design attracted a great deal of attention, and our own interest in it was apparently shared by many other people, including the engineers of the A. W. Valve Co.

AUSTRALIAN VALVES

The original amplifier, of course, was designed for use with European type valves, not easily obtainable here, but for which we possess almost duplicate types.

The Radiotronics circuit was evolved in an attempt to use the original ideas as applied to valves which you can buy, allowing of course for the inevitable temporary shortages from time to time!

By reference to Radiotronics article, you will see that the results were unbelievably good, and substantially the same as those obtained by Wireless World.

It is not hard today to build amplifiers which have very flat frequency characteristics. What makes this job so much better is its low percentage of harmonic distortion—so low that we can consider it for our purposes as being non-existent.

ANY of the tuners described to date may be used with this amplifier, providing a suitable dropping resistor is used to reduce the tuner high tension to 250 volts. A spare filament winding is specified. We will be describing other tuners soon.

It is far and away superior to comparable characteristics which can be quoted in reference to pick-ups and loudspeakers with which it will be used.

The advantages of such an amplifier are obvious. It means that when assessing performance, we can virtually eliminate the amplifier from our calculations, as it is near perfection as a device to faithfully amplify any audio voltages we are likely to feed into it.

In actual practice, it sounds just that way. It has a clean, crisp character about it which can only be obtained by providing adequate reserve output without distortion of any kind.

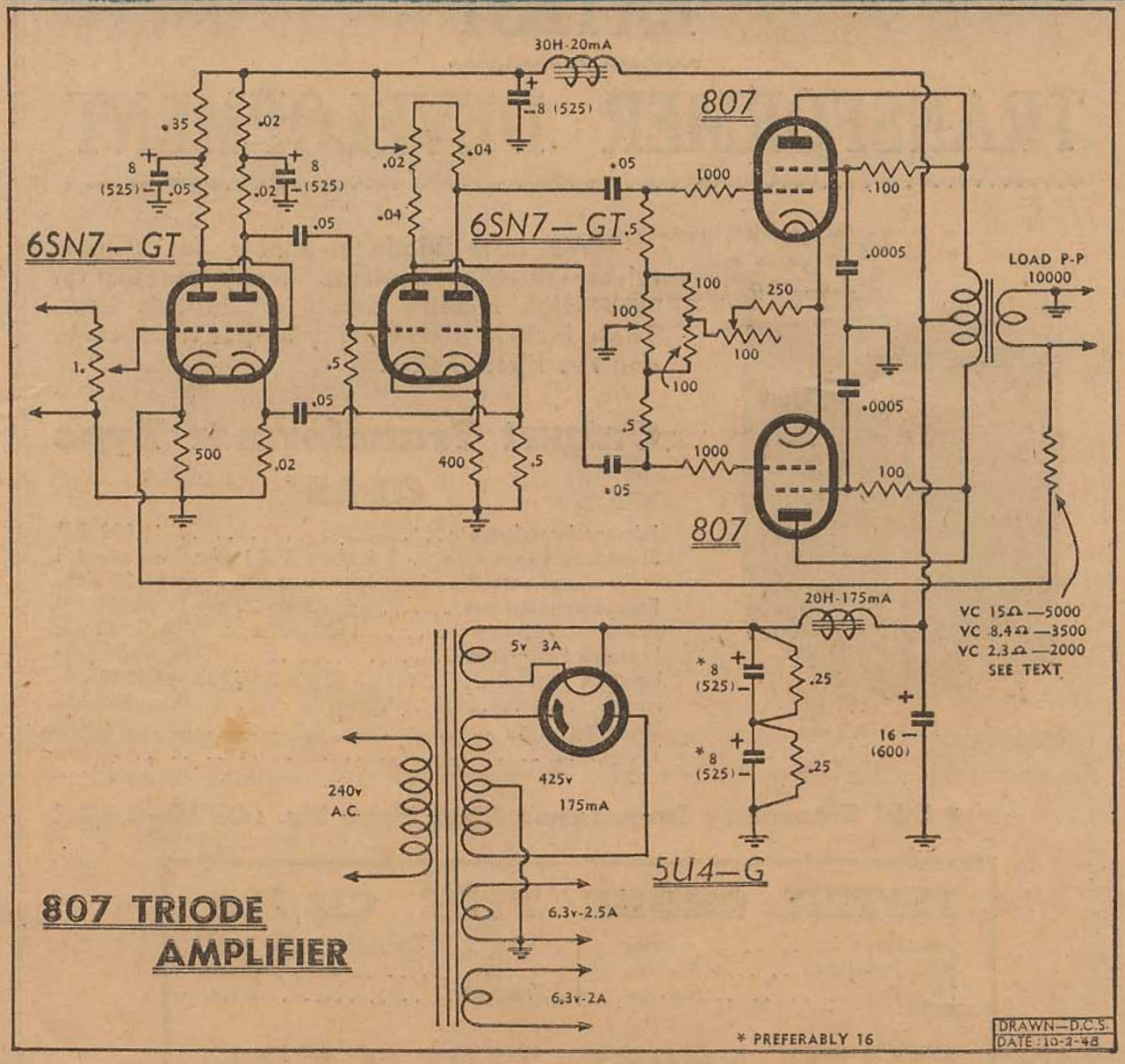
How does it compare with the amplifiers using 807 "pentodes" with feedback, we have been describing of late? That is a question many of our readers have already asked.

A "BEST" AMPLIFIER

Volume for volume, it is definitely better. The better your input and output arrangements are, the better it will sound. But if you use the average type of pickup and speaker, we don't suggest you scrap many hours of work put into one of our previous amplifiers expecting to be stunned by the improvement. Because it will be the limitations of pickups and speakers which will in effect limit your results with any of our recent jobs.

At the same time, if you intend to build a new amplifier from the ground up, would do well to consider this new design. If a maximum output of about 15 watts will suit you, and generally it will, your results will be better than with previous types. It will not have such a high over-all gain, and a pre-amplifier will be needed for pickups having a low output. We intend to do

CIRCUIT DIAGRAM OF THE 807 TRIODE AMPLIFIER



The circuit is particularly simple, consisting merely of a resistor condenser network. The feedback resistor valve is not highly critical, and results are nearly as good with no feedback at all.

some work along these lines with the idea of bumping up the gain without affecting present performance. But for the average crystal and magnetic pick-up, and the average 12 inch speaker, you will have enough gain to get plenty of sound.

Having more or less put the amplifier in its place in the scheme of things, we can proceed to tell you more about it.

Briefly, it consists of an output stage using a pair of 807's wired as class A triodes. In this connection, the plates and screen of each valve are connected together, a screen suppressor of 100 ohms being included, and a voltage of 400 used.

The valve manufacturers are carrying out life tests to see whether there are any undesirable effects due to operating the screen at this higher-than-usual voltage. There do not appear to be any, however, and no dissipation ratings are exceeded.

Ahead of the output stage is a pair of push-pull drivers, in the shape of a 6SN7 dual-triode, resistance coupled to the 807's.

INPUT STAGE

The input stage is another 6SN7, the first section being a voltage amplifier direct coupled to the second, which is a normal phase-splitter to drive the push-pull driver stage.

Degeneration is freely used throughout the amplifier. None of the bias resistors is bypassed, a practice which, although lowering the overall gain, reduces the harmonic distortion to a very low level.

A further feedback provision is made by bringing back into the cathode circuit of the first stage suitably phased voltage from the loudspeaker voice coil.

With an amplifier of this quality, the effectiveness of this feedback loop depends largely on the quality of the output transformer, as pointed out last month. For this reason, several manufacturers have made special transformers for the circuit. Two we have tested so far are the Ferguson, and the Swales and Swann, both of which are of exceedingly high quality.

Don't think that the circuit will not operate at all using ordinary output transformers. It will, but the extreme freedom from distortion which characterises the circuit will

not be attained to the same degree.

Inspection of our circuit will show that we have modified the Radiotronics version in a few minor details.

The first point to note is the lower transformer voltage we have specified. This is made possible by the use of condenser input instead of choke input. Choke input will allow slightly better regulation at the extreme limits of output, which, being about 17 watts, the average man isn't likely to require. As a result, our amplifier might have a maximum output slightly lower than this. A very small point, as few will ever use it over about 10 watts.

The absence of the second filter choke has no appreciable effect on hum level. Particularly if you use 16 mfds. filter condensers throughout, you will be hard put to it to notice any hum at all.

POWER SUPPLY

We have also included in our specifications an extra filament winding for use when and if a tuner is used. For the same reason, we have specified a secondary winding which will accommodate such a tuner. If you bring the necessary leads out to a socket at the rear of the chassis, you will have a handy point of connection. The voice coil leads are connected to a pair of terminals at some convenient spot.

The voltage from the power supply is much too high for a tuner. A series resistor must therefore be used to reduce it to approximately 250 volts. We found a suitable wire-wound resistor of 7000 ohms was OK for a three-valve tuner.

The circuit provides for adjustments to balance the drive to the 807's, and also the individual plate currents of these two valves. It would be possible to do without them, but their addition is such a simple matter that we strongly advise you to include them.

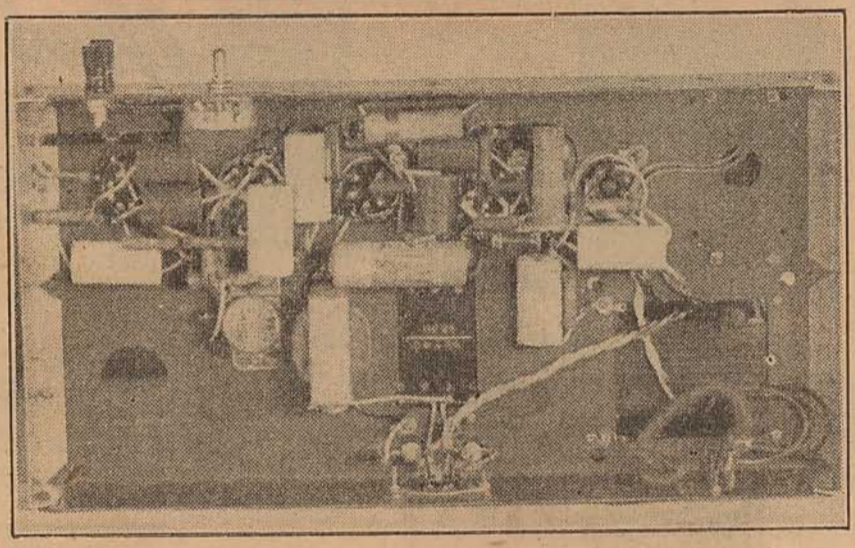
The adjustment of the 807 circuit is two-fold. There is a variable 100 ohm resistor, in series with one of 250 ohms, the function of which is to vary the grid bias until the plate current of the valves is 140 mills for the two.

807 BALANCE

The second resistor of 100 ohms allows the plate current of the 807's to be balanced, so that each draws 70 mills. Both these adjustments are made quite simply by the insertion of a DC milliameter of suitable range firstly in the common cathode circuit return, and secondly in the cathode return for each valve.

Balancing the input to each 807 isn't quite as simple, as the only obvious instruments likely to be satisfactory are the CRO or a VT voltmeter, with which to measure the grid voltages supplied to each output valve in turn. The degree of unbalance is likely to be about 10 per cent., or slightly more in extreme cases. This would show up only in a slight reduction in output without distortion, and if the amplifier is not required for high outputs, it may not be so important. However, this is something in the nature of a special amplifier, and to be even more exact, the method described in last month's article for balancing output voltages of the 807's instead of input voltages would be best of all. For practical purposes, balancing the grid circuit will be quite OK.

THE AMPLIFIER FROM BENEATH



The wiring is merely a matter of neat assembly and reasonably short leads.

OPTIONAL POT

The adjustment for bringing about this balance is the 20,000 ohms potentiometer in the plate circuits of the push-pull driver stage. There should be sufficient variation in this control to achieve balance in any normal 6SN7.

We mounted our potentiometer below the chassis on a bracket, immediately below a small hole, through which adjustment coud be made with a screwdriver. The shaft was a short one, fitted with a screwdriver slot.

If you cannot conveniently make this adjustment for the time being, by all means go ahead, omitting the potentiometer altogether. As we have said, in most cases, the difference in results will be very small.

As 6SN7 valves may not be as easy to obtain as one would wish, they can be replaced by a pair of 6J5 valves in each case, without alteration to the circuit or values. This necessity would affect layout, of course, but even if the chassis design were to vary considerably from the one we have used, results are unlikely to be prejudiced unless you do something very silly!

Building the amplifier should present no difficulties. We found that most of the components could be supported from the valve sockets themselves, with the aid of a few strategically placed insulated mounting lugs.

CONTROL POSITION

The place of the volume control and input terminals isn't symmetrical along the front of the chassis, but we don't like making leads to and from these things too long. If it is essential, the volume control can be placed centrally, with shielded connections, and an input jack can of course be used in place of input terminals.

PARTS LIST

AMPLIFIER—

1 2JU Modulator chassis.

1 Power Transformer, 425-0-425v at 175 mA, 6.3v, 2.5a, 6.3v, 2.5a, 5v 2a.

1 Special Output transformer, 10,000 ohm, CT to 2.1 or 8.4 ohm vc—see best.

1 Choke, 20 henries, 175 mA; 1 Choke 30 henries, 20 mA.

VALVES:

2 807's, 2 6SN7-GTs, 1 5U4-G.

CONDENSERS:

3 8 or 16 mfd, 600 PV, 1 16 mfd, 600 PV, 2 8 mfd, 525 PV, 4 0.05 mfd, 600v wkg.

RESISTORS:

2 100 ohm, 1 400 ohm, 1 500 ohm, 1 250 ohm, 2 1000 ohm, 1 5000 ohm, 3 20,000 ohm, 1 35,000 ohm, 2 40,000 ohm, 1 50,000 ohm, 2 .25 meg, 4 .5 meg, wire-wound—2 100 ohm, 2 100 ohm with tap.

POTENTIOMETERS:

2 100 ohm, 1 1.0 meg, 1 20,000 ohm.

SUNDRIES:

2 terminals, solder lugs, hook-up wire, nuts and bolts, power flex.

One reason we placed the control where it is was because of our intention to add an extra stage as a pre-amplifier. We have been making some experiments with low-output type pick-ups, and particularly with bass compensation circuits, we find extra gain necessary for full amplifier output. We may have something to say about such pre-amplifiers in the near future. But they will be additions to the present basic circuit, and we do not anticipate any alterations to the amplifier as a whole.

Talking of gain, the use of feedback from the voice coil reduced the gain by an appreciable amount. If you find that for any reason your pick-up is a bit lacking in output, removal of the feedback will, in all probability, not be noticed in your results, except possibly with the very best of equipment. Feedback in this circuit is not nearly as important as it would be, were the valves to operate in pentode connection, for obvious reasons. It is just one more precaution which can be taken to ensure that the extremely good output characteristics will be obtained.

FEEDBACK

To remove the feedback, it is merely necessary to omit the feedback coupling resistor from the voice coil circuit. It is interesting to note how the inclusion or otherwise of this resistor affects results.

This feedback resistor will require selection according to the voice coil impedance of the particular speaker you use. That is why we have shown alternative values on the circuit diagram.

It is obvious, of course, that with the high impedance voice coil, more voltage will be available than from a low impedance coil. Thus, in the latter case, it is necessary to reduce the value of the feedback resistor for these lower voice coil impedances.

The value of resistor given in the Radiotronic circuit is not very useful because it is operating from a 15-ohm output, and very few speakers in Australia have voice coils as high as this. The Rola K12 has a 2.3-ohm voice coil, the G12 and Amplion 12in. speakers about 8 ohms. Some others have 12 ohms.

Our circuit diagram shows values for use with these impedances, and which will give feedback values almost exactly the same as in the original design.

RESISTOR VALUE

We would point out once again that very little effect will be noticed by using a much lower degree of feedback than provided for—in fact, as we have said, it can even be removed altogether and still leave an amplifier better than the average.

It is not important, therefore, that the feedback resistor be of an exact value—should you have a speaker with a voice coil impedance differing from those shown, it will be sufficient, having first obtained a transformer which gives a good match, to estimate a resistor value from those given. It is much better to err on the large than the small side. Our values have been calculated and measured to give about 20 d.b. reduction in gain. This is just about the limit one can realise without a tendency to oscillation at the lower frequencies, and, therefore, it should not be exceeded.

Without feedback, output is about 7½ watts, increasing to over 11 watts with feedback. This is for completely clean output, but with feedback, 17 watts may be reached with little distortion. To obtain these latter figures, feedback is necessary.

RIGHT SIDE

Incidentally, it is important to connect the feedback resistor to the right side of the voice coil winding. If you get the wrong way round, violent oscillation can be expected, as the feedback will be positive rather than negative.

These output figures line up almost exactly with those obtained from the original Radiotronic amplifier.

Concerning distortion, we made a number of measurements across a resistive -loaded voice coil both for power output and frequency response. At the present time we cannot make direct measurements of harmonic distortion, but there is no reason to think that our amplifier would be very different from the original design.

Without the byoass condensers on the screen of the 807 valves, the frequency response was quite flat from 20 cycles to more than 50,000 cycles, with a requirement of 5 volts across an 8.4-ohm voice coil winding- an output of 3 watts.

RESPONSE

With the bypass condensers, output was flat from 20 to 20,000 cycles. At 50,000 cycles it had dropped to 4.3 volts, and it was still 2.5 volts at 80,000 cycles, with a slight peak to 5.5 volts at 80,000 cycles.

If you work that out in decibels, you will see just how good the amplifier is. For audio work, it can be regarded as being virtually flat and distortionless.

Our power output checks were taken at 1000 cycles.

It isn't very much use using the amplifier except with large speakers properly baffled. This restricts it virtually to the 12in. types, with the K12 type as being a reasonable compromise. If full output is required, some of the larger heavy-duty speakers occasionally obtainable should be used.

Although flat baffles are widely used because of their simplicity, we strongly advise a better method of loading, such as the use of a vented enclosure. This device reduces speaker distortion by quite a bit, raises speaker efficiency, and by elimination of the back radiation as such, greatly simplifies the problem of making use of the output. It is unwise to feed too much input to any speaker without good loading. With the use of an exponential horn, even an 8in. speaker could probably be used with good results