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updating the R-E twin-coupled amplifier

Variations of original twin-coupled amplifier eliminate instability, motorboating and give more gain and add tone controls

By NORMAN H. CROWHURST

SINCE the twin-coupled circuit was first published in November, 1957, in RADIO-ELECTRONICS, scores of people have built it and added various adjustments or improvements to suit their own particular needs. A few had to make changes to overcome difficulties. Everyone reports that it works well in comparison with everything against which it is compared. Quite a few asked for a larger version—particularly to drive currently popular inefficient loudspeakers with a larger reserve. So here are some of the questions that have come up, with the answers:

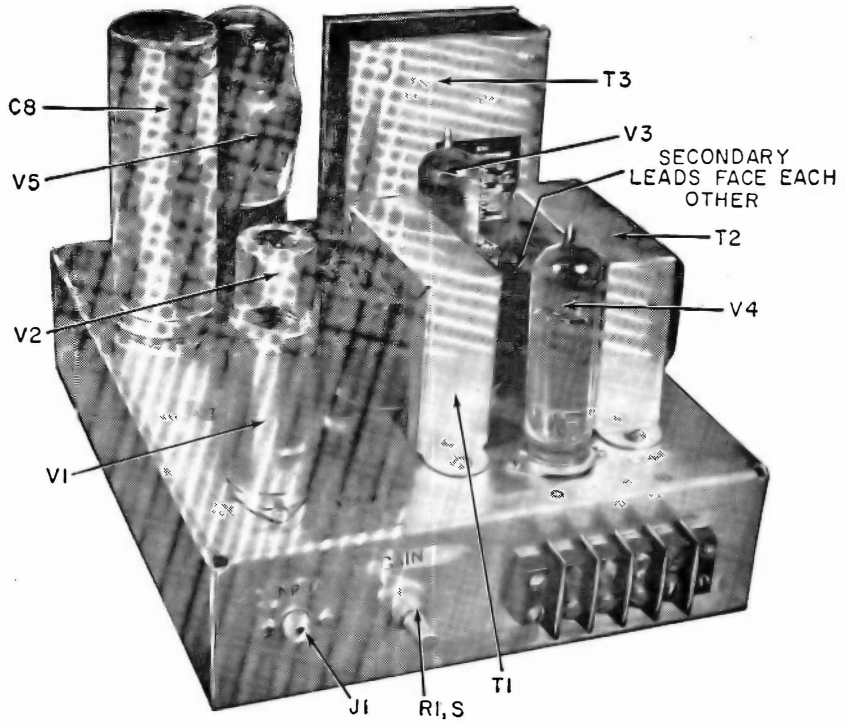
A very few asked for constructional details, such as those you might receive with a kit. But many more have written to comment how easy it was to follow the schematic (reproduced in Fig. 1), with the aid of the photos (also reproduced with this article, for the benefit of readers who missed the original story). Several commented that this was the first piece of equipment they had ever built, and they found it quite easy. I mention this as encouragement to any who feel they need more constructional details.

As I mentioned in the original article, the important thing is to keep the output tube wiring (from the transformers and the 0.5-μf capacitors between cathodes and screens) compact, following the layout illustrated. This is because this wiring carries a high audio voltage which must not be allowed to get near the earlier stages, or instability will result.

Apart from this, layout is simple. Just put the components on the chassis and mark where you want holes drilled and bigger holes made with a knockout punch, and the rest is easy. Alternatively, if you don't want to buy Greenlee punches just for this job, drill holes inside a scribed circle (using compasses), break out the middle part with wire cutters and file to a smooth round hole. It's harder work, but can make quite a presentable job.

Trouble with motorboating

Quite a few ran into this trouble when they coupled on a preamplifier, but usually only when the bass boost was turned well up. Sometimes just connecting the preamplifier to the main amplifier started it, regardless of any setting of controls. These differences depended on the type of preamplifier circuit used.



Top view of 15-watt amplifier shows large-parts layout.

The motorboating is due to insufficient decoupling in the B-plus supply to the preamplifier. As a result, there is enough feedback from the power output stage to the preamplifier stages to cause low-frequency oscillation. Fig. 1 shows the original circuit. The take off point for the preamplifier's B-plus (marked 240 v) has proved quite successful in many instances. But where instability has occurred, it has always been cured by adding a separate feed point for the preamplifier, as shown in Fig. 2. Using a separate feed permits better filtering, without causing loss of voltage to the first stage of the twin coupled amplifier.

Use a resistance that will drop between 50 and 100 volts. (Use Ohm's law to calculate the drop from the preamplifier tube currents.) Use enough electrolytic capacitance to get adequate decoupling (stop instability) or eliminate hum from the preamplifier stages.

Loss of bass

Two or three have found the twin-coupled produces a bass loss, in comparison with some other amplifiers, although otherwise its performance is completely satisfactory.

This is invariably due to poor matching. In two instances the reader was using the twin-coupled with a ceramic or crystal pickup, without any preamplifier. This will work, but the input

resistance of the amplifier as originally built is too low—causing this bass loss —as well as some loss of sensitivity.

The remedy is simple. Just change the input control from 100,000 ohms to 1 megohm or higher.

Another case where the preamplifier had the tone controls in its output circuit showed the same trouble. Here the bass boost works effectively only if the input to the main amplifier is at least 1 megohm and preferably higher. Making the same change remedied matters here too.

More gain needed

This complaint also came from those who used ceramic pickups without a preamplifier. It is not too difficult to remedy. The gain can be increased by reducing the feedback. Besides increasing the value of the feedback resistors, the balance of the voltage fed to the second half of the 12AX7 needs readjusting. The table gives approximate alternative values. If you wish, you can use a potentiometer to make fine adjustment, as shown in Fig. 3, the same as for the original circuit.

A few found insufficient gain because the preamplifier they are using gives less than a volt output. Surprisingly, there are preamplifiers that give less than a volt output even when given more than a volt input. This is because the gain does not equal the losses introduced by the tone control circuits.

Tone controls

Several people asked how treble and bass controls can be added to the twin-coupled amplifier. It is feasible to do this only by adding another stage. Also, where full output is required for less than a volt input, an extra stage is the better way of remedying matters because it avoids sacrificing feedback. Fig. 4 shows circuits using one half of a 12AU7. Other tubes with similar specifications can also be used.

When an extra stage is added for use with another preamplifier that has insufficient output, extra care is needed in decoupling the B-plus feed for the preamplifier. Fig. 2 shows the combined feed arrangement. Values will have to be determined by experiment. First see how much you can drop the B-plus voltage in resistor R without restricting the preamplifier output or making it distort. The value of R will depend on the voltage drop you can stand and the total current drain of the preamplifier. Having found a suitable value of R by experiment, make the value of C large enough to prevent instability at all settings of the preamplifier tone controls, or to eliminate hum induced in these stages.

Voice-coil feedback

That voice-coil feedback experiment of mine, described in RADIO-ELECTRONICS in October, 1956, inspired some to want to combine it with the twin-coupled circuit. As described in that article, the feedback must be worked out individually according to speaker and amplifier characteristics. But Fig. 5 is a good starting point, using the

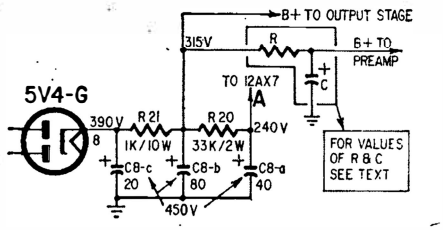


Fig. 2—Power takeoff point A for additional stage. Additional decoupling provides power takeoff for preamp.

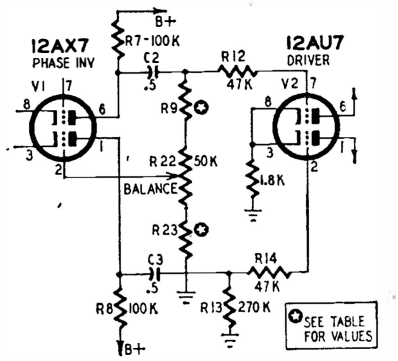
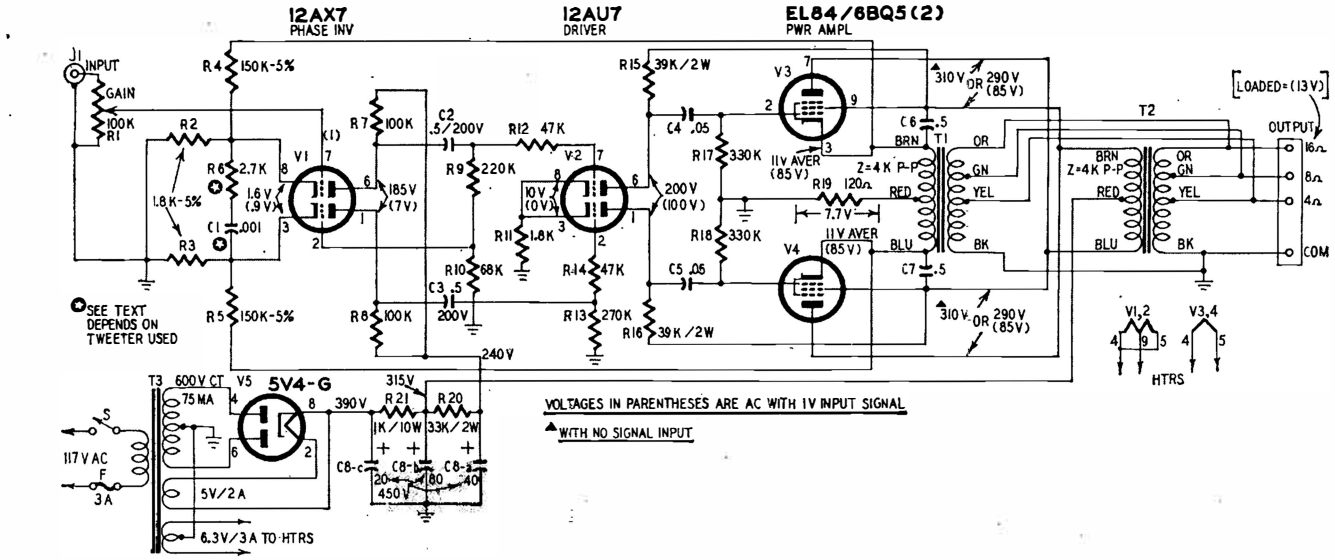


Fig. 3—Balance control for phase inverter.

Revision of Values to Get More Gain

Approx. feedback (db)	R4, R5 (Kilohms)	R9 (Fig. 3) (Kilohms)	R10 (Kilohms)	R23 (Fig. 3) (Kilohms)
14 (original)	150	220	68	47
12	220	220	51	33
8	470	270	33	10



R1—pot, 100,000 ohms, audio taper, with spst switch
R2, 3—1,800 ohms, 5%
R4, 5—150,000 ohms, 5%
R6—2,700 ohms, 5%
R7, 8—100,000 ohms
R9—220,000 ohms
R10—68,000 ohms
R11—1,800 ohms
R12, 14—47,000 ohms
R13, 26—270,000 ohms
R15, 16—39,000 ohms, 2 watts
R17, 18—330,000 ohms
R19—120 ohms, 2 watts
R20—33,000 ohms, 2 watts
R21—1,000 ohms, 10 watts, wirewound
R22—pot, 50,000 ohms, linear taper
R23—47,000 ohms
R24, 25—100,000 ohms
All resistors ½ watt, 10% unless noted
C1—.001 μf
C2, 3—0.5 μf, 200 volts, paper tubular
C4, 5—.05 μf, 600 volts
C6, 7—0.5 μf, 600 volts, paper tubular
C8—40-80-20 μf, 450 volts, electrolytic, can type
F—Fuse, 3 amp
J1, 2—phono jacks
S—spst switch on R1
T1, 2—output transformers, 7½ watts, 4,000 ohms, plate to plate ct; 8-, 16-, 32-ohm secondary (Stancor A-8094, Thordarson Meissner 22S21, Merit A-2997, Triad S-34X)
T3—power transformer: primary, 117 volts; secondary, 600 volts, ct, 75 ma; 5 volts, 2 amp; 6.3 volts, 3 amp. (Triad R9A, Chicago PV70A or equivalent)
V1—12AX7
V2—12AU7
V3, 4—EL84
V5—5V4-G
Chassis, 9 x 7 x 2 inches
Sockets, 9-pin shielded (2)
Sockets, 9-pin unshielded (2)
Socket, octal
Fuse extractor post
Barrier strip, Cinch-Jones 4-141 or equivalent
Grommets, ⅜ inch (4)
Grommet, ¼ inch
Tie strip, Cinch-Jones 52A
Tie strip, Cinch-Jones 53C (one mounting lug removed)
Miscellaneous hardware

Fig. 1—Circuit of the basic twin-coupled amplifier.

original twin-coupled as a basis. Change R2, R3 to 2,700 ohms, 5%. The 0.1-μf capacitor in Fig. 5 bypasses voice-coil feedback above 1,000 cycles. The .003-μf capacitors limit electrical feedback to frequencies above this point. R6 and C1 level off the high-frequency response of the amplifier. Their values may be varied for smoothest response when using voice-coil feedback. They are not necessary when using an electrostatic tweeter.

It may be hard to get very much feedback this way, because there is not too much gain available. On the other hand, remember that feedback obtained this way is far more effective in reducing *overall* distortion than amplifier feedback alone.

I would not recommend tackling this project unless you have an audio oscillator so you can check frequency response and make the necessary circuit adjustments to get balanced performance.

A preamplifier

This is something I still hope to get made up in due course, for publication in this magazine. Many readers have requested it. The problem is that scarcely any two readers want the *same* preamplifier. Some want the bare essentials: equalization but no tone controls, loudness compensation or filtering of any kind (rumble, scratch, etc.); others want "the works". Yet others would like this feature but not that, in various combinations. Finally stereo has thrown in a whole lot of other ideas, including how to arrange for balance and combined control facilities.

What I hope to do when time permits is develop a basic design with a number of circuit elements that can be combined in custom fashion to suit everyone's individual need. If you want the bare essential and think tone controls are superfluous to high fidelity, then build it that way. If you want any particular feature, add it as required, in the appropriate circuit position. But this approach needs careful planning and circuit workout to make sure everyone really gets what he wants.

More power

A large percentage of readers have been asking for more power. Some have even built two amplifiers and paralleled them. I am told this works quite well. But I am not in favor of it, for if either amplifier deteriorates, it will load down the other. This will give you even less power than one amplifier by itself. To me this doubles the opportunity for failure.

Several amplifier manufacturers use parallel operation (with the same theoretical disadvantage) and say they get no adverse complaints. This seems to mean equipment is so much more reliable these days that even doubling the chance of failure does not make the total liability big enough to matter!

Probably the main objection to parallel operation is that it doubles the work and cost. Some have gotten more power from the circuit merely by changing tubes and making some corresponding changes in the power supply and circuit values. To a certain extent this works. How much more power you can get depends to some extent on whether you are prepared to sacrifice some maximum power at the extreme low end—20 to 30 cycles.

Some manufacturers are using the circuit and have larger transformers made specifically for them. But this will not help readers, because such transformers are available only on quantity order. However, transformer manufacturers have now made a larger-version twin-coupled output transformer available as a catalog item, so that problem is now solved.

In a later issue we will show how to go about setting up a larger version, tailored to your own requirements or choice of tubes. You may use either the original transformer or the new larger version. Another thing we propose to include is how to use a transformer *input* circuit. This has been asked for two or three times. It seems the one-time prejudice against audio transformers is fading. There are stock transformers that will serve for this use without the manufacturers having to invent a new catalog number! END

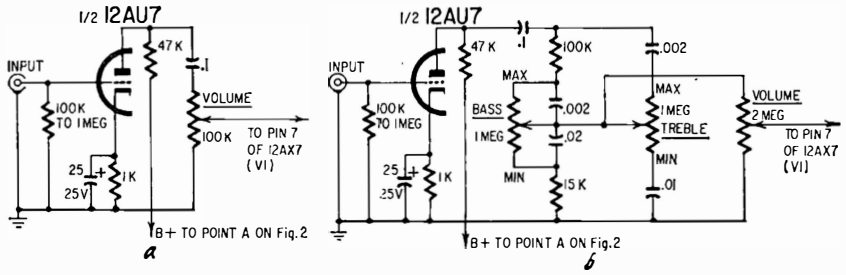


Fig. 4—Extra stage gives (a) extra gain, (b) tone controls.

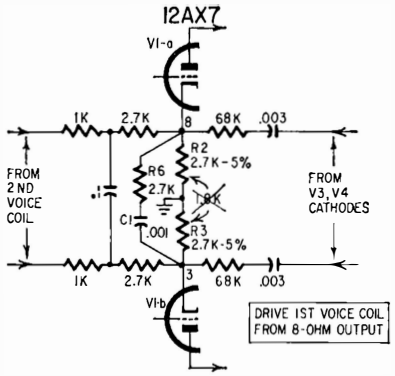


Fig. 5 — Second voice coil provides feedback.

Underchassis view of twin-coupled high-fidelity amplifier.