A Medium-Power Tetrode Amplifier With Stabilized Screen Supply

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Regulation of the final-stage screen supply permits high negative feedback and excellent performance in an easy-to-build amplifier complete with preamplifier and tone-control stages.

MANY OF THE MEMBERS of the audio fraternity view with alarm the increasing complexity of audio equipment. Although in most instances the addendum is accompanied by "higher fidelity," the price is sometimes higher yet. The need has been expressed for a fairly simple, self-contained audio amplifier of conservative design and acceptable performance which might be constructed for use in an apartment or small home. The subject of this article is such an amplifier.

Before beginning the design several features were fixed on as being desirable. (1) The amplifier should have inputs for both a tuner and a phonograph, with appropriate equalization for a reluctance-type pickup. (2) It should have a tone-control system furnishing both boost and attenuation of bass and treble. (3) Adequate power at low distortion should be available from the power output stage without requiring tubes of high dissipation capabilities or large power supplies. (4) The unit should be self contained and of small physical size.

A chassis $11\frac{1}{2} \times 6 \times 2$ inches with a 200-ma power transformer, output transformer, and 7 sockets mounted was available and design of the main amplifier was begun with this unit in mind. *Figure* 1 shows the result. The output stage was designed and constructed first, so that the tone compensation and preamplifier stages might be matched to it. Push-pull 6V6's were selected as power output

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tubes because of their relatively high efficiency and modest driver requirements. The 6V6's were fed from a cathodyne phase splitter which was coupled to a 6SJ7 voltage-amplifier stage. By using direct coupling between voltage amplifier and phase splitter the number of capacitors in the feed-back loop was reduced to one and the phase shift introduced by it was partially compensated for by the insertion of an R-C network between the grid of the phase splitter and ground.

It will be noted in *Fig.* 1 that the second triode of the 6SN7 is employed as a voltage regulator for the screens of the 6V6's. Deriving the screen potential from a source of low impedance such as this results in lower distortion, greater stability at peak power operation, and allows the use of more feedback around the output stage. The residual ripple present at the cathode of the voltage regulator is effectively filtered by the use of a 1-μf paper capacitor.

Since unbalance current flowing through the output transformer would cause loss of power handling capability at low frequency, steps were taken to balance the last stage. Pairs of 6V6's were selected with transconductance matched within 5 per cent. Their grids were then tied together and a 60-cps signal introduced to the grid circuit from the heater bus. Adjustment of the 150-ohm balancing potentiometer to the point producing minimum 60-cps output balances the stage dynamically.

Figures 3 and 4 show how the components were mounted on the existing chassis. This makes a compact and convenient arrangement, but other constructors will, of course, do as well with other arrangements.

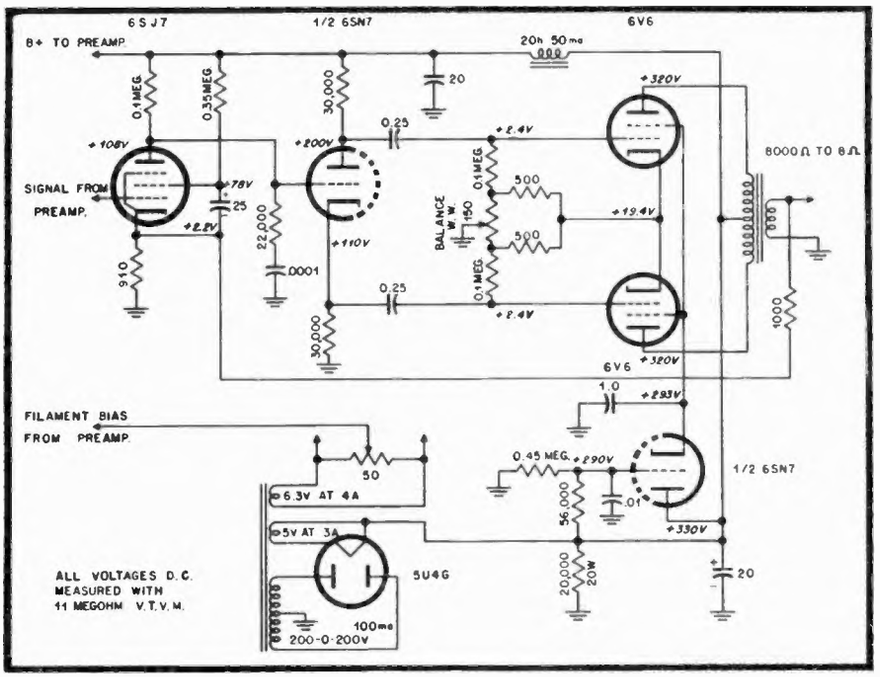


Fig. 1. The main amplifier. Half of a 6SN7-GT is used as a screen-voltage regulator. The 6SJ7 voltage amplifier and the phase splitter are direct-coupled.

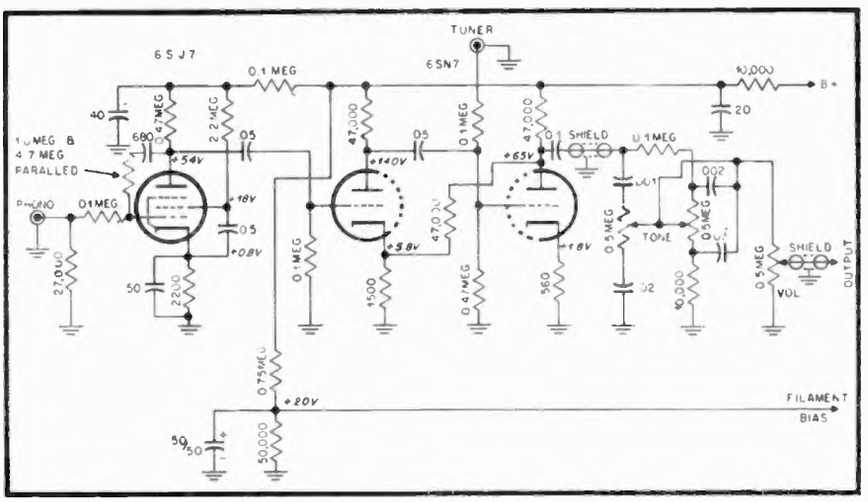
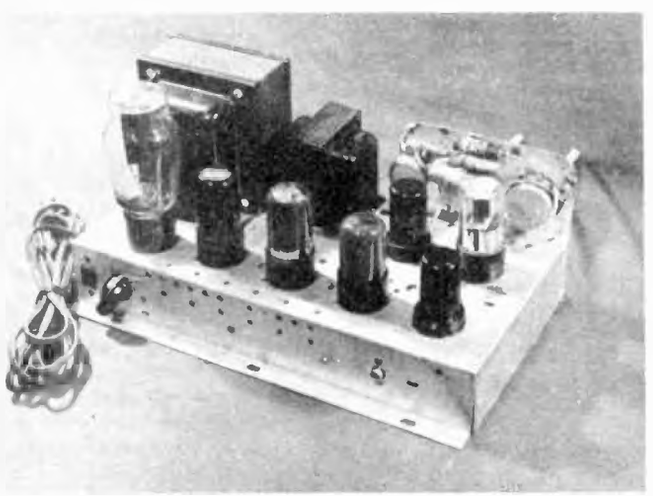


Fig. 2. The preamplifier provides for both magnetic phonograph pickup and tuner. The 6SJ7 is a phonograph preamplification stage with a simple feedback loop for bass equalization. The tone control is a single-shaft affair a center "flat" position and treble and bass boosts at the two ends of rotation.

The Preamplifier

The method of bass and treble control employed in the preamplifier, *Fig* 2, was selected because it required only two shielded leads from the amplifier proper to the treble, bass, and volume controls. Such a configuration allows simplicity of both electrical and physical arrangement. Placement of a variable



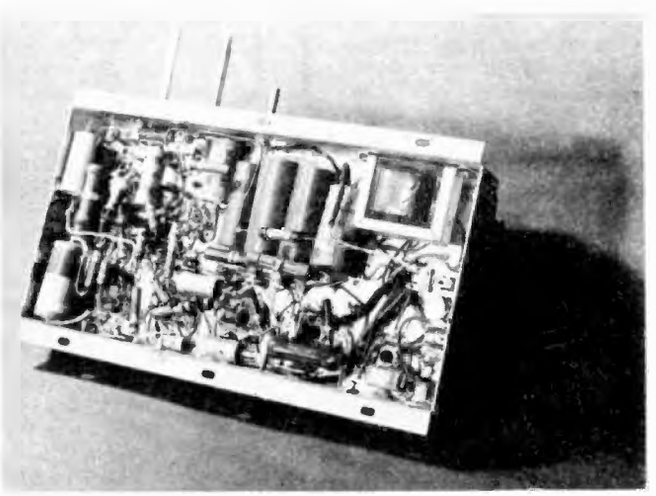


Fig. 3 (left). The entire amplifier, including preamplifier, is on a single chassis with the power supply.
Fig. 4 (right). The underside view shows that the space is well utilized.

resistance in the input circuit of a feedback amplifier is not the best design practice, but the only way to circumvent such a situation is either to add another stage or to place the control at an earlier point. No instability has been observed in the present arrangement, however, in a year of satisfactory operation.

The 6SN7 is arranged with triodes in cascade as a feedback pair. Use of feedback in this manner reduces tube noise, lowers the output impedance to the tone-control circuit and also effectively reduces stray signals from the tuner circuit when the latter is not in use. Injection of the tuner signal at pin 1 of the second triode furnishes isolation from both the tone control and the preamplifier.

The preamplifier is quite a simple affair by present standards and the only defense offered, if one is needed, is that it performs quite satisfactorily. The circuit is similar to that of Williamson in which bass equalization is accomplished by a grid-plate feedback loop, the turnover frequency being determined by the R-C product and the amount of feedback by the ratio between R and the grid stopper resistor. The turnover point is arbitrarily fixed at 300 cps which has been demonstrated in listening as a suitable compromise. The 6SJ7 has been found to be more quiet and less microphonic than triode pairs more conventionally used in preamplifiers. Undoubtedly the metal shell is responsible for some measure of hum reduction, and biasing the heater supply above cathode potential to prevent heater-cathode emission also contributes to reducing the output hum to the point of 83 db below 10 watts.

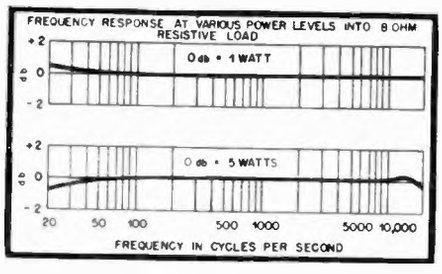


Fig. 5 (right). Distortion curve shows that intermodulation (60 and 7,000 cps, 4:1) just begins to rise above 1 per cent at 10 watts.

Fig. 6 (above). Frequency response curve made with an 8-ohm resistive load at 1- and 5-watt power levels.

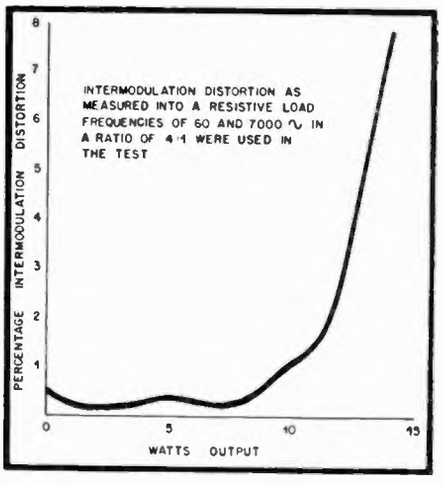


Figure 5 shows that the distortion level of the amplifier is acceptable by modern standards, and may even be said to compare favorably with the hallowed Williamson. Such performance is attributed to the action of the screen voltage regulator in holding the screen potential at a fixed percentage value below that of the plate. Undoubtedly, the large reserve of the power transformer, giving excellent voltage regulation to the power supply, is also an assisting factor. *Figure* 6 shows frequency response at 1 and 5 watts output.

In conjunction with a modified Gately Superhorn transducer the amplifier has quite smooth overload characteristics, and when deliberately overdriven to a level of 22 watts of sine wave output into a speaker load at 2000 cps, rounding, rather than clipping of the waveform was observed.

It is the writer's earnest desire to steer away from the sea of superlatives. At the present time the amplifier suits him; undoubtedly this will not always be the case. It is not to be heralded as the latest answer to the audio man's conquest of the 80-meter band. Nor is it necessarily "better than any triode amplifier." It does, however, have the appealing attributes of straightforwardness, adequate performance with respect to both power and frequency, and small physical size. It is felt that the circuit may well be appealing where budgets are modest and space limited.