Low-Power Cathode-Coupled Amplifier

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THE amplifier described below is the result of an arduous two year search for an inexpensive, low power, good quality audio amplifier for home use with an FM and AM tuner and a phonograph reproducer.

The circuit illustrated below represents the results of experimentation with many conventional circuits that have been published in the available magazines. All were discarded one by one until the author, in desperation, tried the cathode-follower output shown. The results were completely satisfactory.

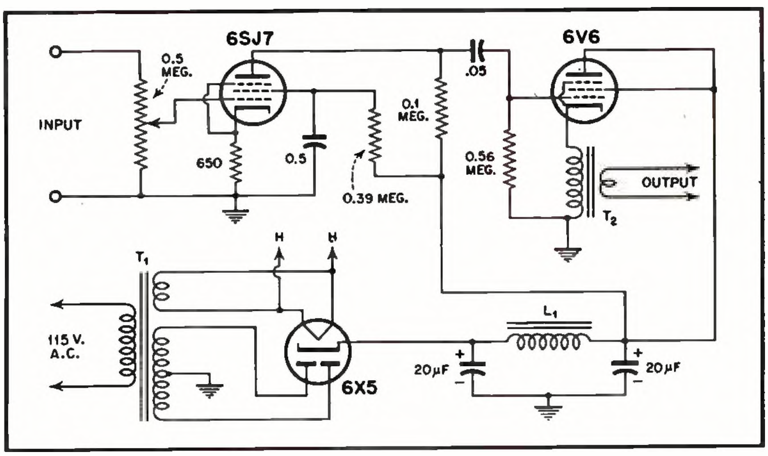
According to the limited literature available in various publications, a cathode-follower output stage, in comparison with a conventional output stage, will provide.

1. Improved low frequency response.
2. Improved high frequency response.
3. Damping out of peaks in both the output transformer and speaker.
4. Less distortion at the same rated power output.
5. 100% degenerative feedback with all its benefits.

The circuit is simple and straightforward with no special tricks to reduce hum, although the amplifier constructed has no audible hum at full gain.

The primary of the output transformer, T_2, was selected so that its d-c resistance was approximately equal to the normal cathode bias resistor, or approximately 250 ohms. The primary impedance should be 5,000 ohms, with the secondary impedance selected to match the speaker to be used. The plate and screen of the 6V6 are tied together, and to the B supply. The power transformer, T_3, has a secondary voltage of 250-300 v. each side of center tap, and the choke L_1 is a ten-henry, 70-ma unit.

When used with the new RCA 45-rpm record attachment or a good FM tuner, together with a Jensen extended-range twelve-inch speaker in a bass reflex enclosure, the results are astonishing, and the power output more than meets the requirements for small living room use. It will be noted that the gain is not adequate for use with low-level magnetic pickups, but the simplicity of the amplifier makes it well suited for small, high-quality installations.



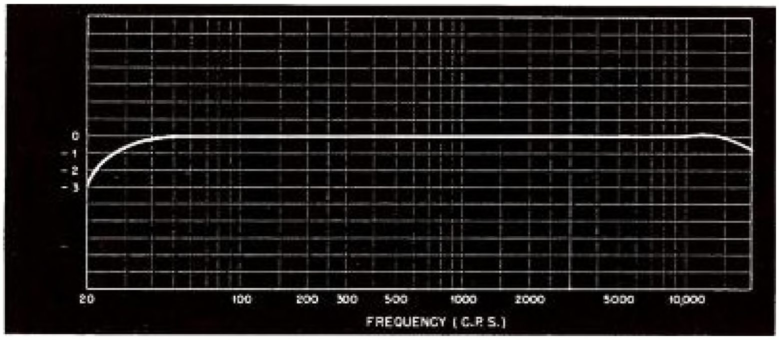


Fig. 2. Frequency response curve of audio amplifier at 30 watts output. Note that it is flat within less than one db from 30 to 20,000 cycles.

designs, at first made it appear an uneconomic choice, but a reasonable solution was found. The wide demand among radio amateurs for power equipment in this range has resulted in quantity production of the required transformers at tolerable cost. High-voltage condensers were available through war surplus. And a bridge rectifier was feasible with the low-priced 5R4GY rectifier tube, with its comfortable 250 ma current rating, and 2100 inverse peak voltage capability. The problem appeared surmountable if costly interstage transformers could be avoided.

So the 211 was tentatively selected, and in the interest of reducing drive requirements, insuring stability of operation, and eliminating the necessity of a fixed-bias supply, pure class A connection was proposed.

The availability of very high plate-supply voltages suggested the possible use of ordinary receiver triodes in conventional resistance-coupled circuits. The calculations revealed that this would be the most critical section of the amplifier, but with 600 volts at the high-potential end of the 6J5 plate resistors these tubes, operating at nearly full rated dissipation in push-pull, would drive the 211s just beyond the requirements.

The medium-mu driver triodes dictated the use of another stage of voltage gain, which could conveniently use the same tube type. Phase inversion was removed to the input stage so that degeneration in the drivers' cathode resistor would tend to remove any unbalance in a.f. grid-to-ground voltage remaining after inversion. The 6 decibels of gain added by making the input a push-pull stage was also desirable. The need for high stability with high gain demanded a tube inverter of unusual characteristics. The cathode-loaded inverter was rejected, despite its stability, because of the possibility of cathode-filament hum, a considerable hazard where relatively high gain follows inversion. Gain requirements ruled against the cathode inverter too. The ordinary voltage-divider type was eliminated by its necessity for constant readjustment with tube aging. The stability and gain of the conventional floating-paraphase inverter were attractive, but its never-quite-perfect balance was a disadvantage. In the end a modification of the latter type proved satisfactory: the load on the input tube was varied by shunting *R7* with *R6*, of varying values above a megohm, until a virtually perfect balance of a.f. to the driver grids was obtained. The floating-paraphase action maintained the balance over long periods of use.

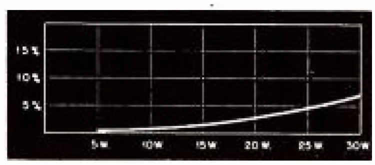


Fig. 3. Intermodulation distortion vs. power output.

The final refinement in the circuit was the addition of a short time constant filter in the input, calculated to counteract the high-frequency losses within the amplifier due to distributed shunt capacitances. High-frequency losses due to Miller effect, often experienced in high-impedance triode grid circuits, were held to a minimum by the 100,000-ohm value assigned the input potentiometer. This value likewise reduced the chances of frequency discrimination from RC effects, prominent in many higher-impedance input designs.

Again in the interest of low noise level and high stability, wire-wound resistors were used in all d.c.-carrying circuits, and oil-filled capacitors were used throughout. If a suitable quality of oil condenser is used for coupling, d.c. leakages will remain even after long use at values lower than those found in new paper condensers, keeping the grids essentially at ground potential, with attendant long-time circuit stability. In the presence of heavy a.c. fields the shielding afforded by the can construction is probably a considerable advantage too.

The photographs show how the entire unit was mounted on a single standard rack chassis. The controls illustrated

As shown, the amplifier is built on a standard rack chassis.