

Realistic Audio Engineering Philosophy

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The author presents the why's and wherefore's of the Unity-Coupled circuit which is the basic difference between McIntosh and other amplifiers, and according to the author it exemplifies the progressive approach to amplifier design.

THERE SEEM TO BE two basic approaches to the design of an amplifier. In one a price is decided upon, according to the intended market, and then different circuits are investigated, with careful cost comparisons, to find out how good the amplifier can be made within the price already fixed upon. This approach may lead to extremely competitive pricing of amplifiers but it is not conducive to progressive design. Instead design is tied to old-established readily-obtainable components, and research into new components is to be avoided.

Progressive design cannot be restricted by "what has always been done." The original unity-coupling patent broke away from accepted circuitry, and required one special component to do it—the bifilar-wound output transformer. Pentodes (or tetrodes) had become established as the most efficient way to achieve output power. Operated in Class B, the efficiency is extremely attractive. But certain distortions were previously "inherent" to this kind of circuit. Unity coupling resulted because its inventor did not accept their inherent nature, but found an effective way to eliminate them.

This article does not aim to tell you that the McIntosh line of amplifiers is the best. The often-asked question about which is the "best" amplifier is incapable of an *unqualified* answer. The McIntosh approach is one very good way to make amplifiers whose performance rates high, and it exemplifies the realistic engineering philosophy. But before getting into the real "meat," one minor, but common, source of confusion needs clarifying: the words "unity coupling" are applied to more than one circuit. Beside the circuit discussed here, a variety of single-ended push-pull also has this name.

The so-called single-ended push-pull method of operation uses two tubes in the output, connected in series between B+ and B-. (Fig. 1). In the quiescent condition, with no signal passing, half of the total B-supply voltage is across the upper tube and half across the lower tube. Driving the grid of one tube posi-

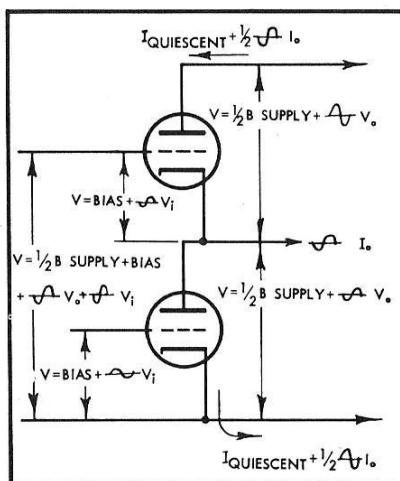


Fig. 1. Signal and supply current relationships in the so-called single-ended push-pull circuit. This also has been called "unity coupled," but is not to be confused with the circuit so named in this article.

tive and the other negative causes the voltage distribution to change. Interposing a load between this center tap point and ground reference, which is at the same a.c. potential as either B+ or B-, causes a variation in current through the two tubes as well as a variation of voltage across them. In this way, by suitable matching, each tube works with a load line very similar to operation in normal push-pull.

One major problem arises with this circuit because the reference point for the upper-tube grid is not ground while that for the lower one is. This means that the drive excursion provided for the lower tube has to be just the necessary grid drive, while that for the upper tube has to be the grid drive in addition to the audio output voltage. Thus an *unbalanced* phase splitter is needed. This produces a circuit much more susceptible to distortion than is the true push-pull arrangement, even when the correct load resistance is applied to the output. Practical operating conditions, of course, never apply the true load resistor for

which the amplifier is designed, but a loudspeaker, in which the load impedance deviates with frequency and includes reactive components. With this kind of a load, one tube produces all the output, while the other produces all the distortion.

Some variations of the single-ended push-pull circuit use a feedback compensating arrangement that readjusts the grid drive to the two tubes to balance out for this variation. However, even with such arrangements, the basic circuit introduces more distortion than the conventional push-pull arrangement.

The redeeming feature in the claims made by the designers of the single-ended push-pull circuit is the large amount of feedback that can be applied, due to avoidance of the hitherto necessary output transformer. This design permits as much as 40 db of over-all feedback to be applied. Thus, even with distortion figures in the region of 40 per cent, it is possible to end up with a resultant distortion in the region of 0.4 per cent, which looks quite an acceptable figure. But this figure overlooks two important facts: (1) the nominal figure of 0.4 per cent distortion is only obtainable *working into a resistive load*, such a circuit must inherently produce much more distortion when practical loads are applied; and (2) even the 0.4 per cent is relatively high distortion.

The idea that avoidance of the output transformer has automatically freed us of many of the distortion problems that have come to be regarded as coincident with this component is mere wishful thinking. Unity coupling, however, is built around a rather special kind of output transformer.

Class-B Operation

For some time now it has been realized that the most efficient output tube to use is a pentode or beam tetrode, and further, the most efficient way of using a pair of output tubes is to work them in class B, or as near to this condition as possible, so that the quiescent current is