Amroh Technical Information Bulletin 2F2

Phase Inverting Transformer

BI-42

cathode-driven push-pull output stages for radio receivers and amplifiers

When driving balance amplifiers there is usually only one choice from the following two options: driving by means of a phase-reversing circuit using one or two tubes where the additional tube is not contributing gain, or driving with the aid of a balanced input transformer which needs a triode tube driver amplifier stage where the gain of the driver stage is not as large as a normal pentode voltage amplifier.

A totally different solution to this problem has been found by the addition of a separate phase inverter transformer, which achieves the phase inversion in the output stage. This yields the following key benefits: that the driver amplifier may be a pentode for high gain, whilst including a significant suppression of harmonics as a result of negative feedback from the cathodes. The MU-ZED BI 42 is specially designed for this circuit to ensure very good results owing to set-up and quality. The self-inductance and the inter-leaving were selected such that no parasitic oscillations may occur, and a favourable frequency characteristic is obtained. Moreover, special attention was paid to keeping the unwanted phase shift small, which can be significant in more generic transformers. The transformer is of such quality that, if desired, feedback may be applied from the secondary of the output transformer to the cathode of the driver amplifier.

Circuit

The circuit is based on the following principles: One of the output tubes can be driven directly by the driver amplifier, with the second tube driven from the secondary winding of the transformer, in which the required voltage is induced as a result of the cathode current of the first tube through the primary winding. In order to disturb the symmetry of the circuit as little as possible, the cathode of the second tube is connected at the other end of the primary winding, while the centre tap is connected via the (common) cathode resistance. To set the control voltage supplied by the secondary winding to the second tube, a preset control resistor is placed in parallel to the primary-side cathodes.

The order follows the connections from the schematic. There is a common cathode resistor used, which should be approximately 10 ohms smaller than the prescribed value for obtaining class A operation of the power tubes, to compensate for the DC resistance of the transformer cathode windings. The grid of tube V1 is connected in the usual manner via a grid capacitor to the anode of the driver amplifier tube (pentode or triode).

Although this circuit permits only class A operation of the output tubes, the ability to generate maximum output power is offset by the advantage that class A operation has minimal distortion, and that modern tubes such as type EL41 deliver significant output power in Class A that is only slightly less than the maximum power achievable from class AB operation.

All modern power tubes can be used, such as EL41, EBL21, EL3, 6V6 and the like. The variable resistor R1 serves to give equal amplitude AC voltages at the grids of the two output tubes. With the aid of a tube voltmeter and tone generator, one can directly measure both grid voltages and make the amplitudes equal by adjusting R1. During this adjustment, the amplifier should be at full power.

Without these tools one can make the adjustment successfully using the following simple procedure. A voltage of about 4 V (50 Hz) is applied between the grid of the first tube V1 and earth. The voltage source can be for example the filament current winding of the power transformer. One side of the filament winding is usually grounded and the other side can directly connect to the control grid of V1. If the centre tap of the filament winding is grounded, one of the ends of this winding is used in the same way, in which a filament voltage of 6.3 volts will apply the control grid with 3.15 volts. The filament winding voltage can be reduced to about 4 volts by using a potentiometer with the ends connected to the filament winding, while the arm is connected to the control grid V1. It is also possible to use a pair of fixed resistors of 100 and 200 ohms in place of the potentiometer. A headset or speaker (high resistance) is connected between Rk and earth, in parallel to the cathode resistor. R1 is varied to achieve minimum volume from the headset or speaker. In order to use the speaker, which is connected to the output transformer, the speaker is replaced by a suitable load resistor during the adjustment process. The resistance R1 is approximately 600-1000 ohms when using the normal high transconductance power tubes such as EL 3, EL 41 etc.

Example of a balanced output stage in which the BI 42 is applied.

Application: phase-inverting transformer for balanced output stages, which offers the opportunity to save on the number of tubes to achieve a small, quality amplifier of simple design.

Max. permissible current in the primary:	150mA per half winding.
DC resistance of primary:	18 ohm per half winding.
DC resistance of secondary:	190 ohm.
Transformer ratio (total primary : secondary):	1 : 0.75
Frequency:	50-17,000 Hz for output tubes with a slope of less than 2.5 mA/V.
	30-17,000 Hz for output tubes with a slope of greater than 8 mA/V.
Packing:	in sturdy box
Dimensions:	see dimensional drawing
Weight:	550 gr packed 440 gr unpacked
Order No.:	39.018