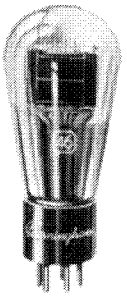


Cunningham RADIO TUBES

C-46

DUAL-GRID POWER AMPLIFIER

The '46 is a double-grid power amplifier tube recommended especially for service in Class B amplifier circuits of suitable design. In such circuits an output stage is preceded by a power amplifier stage designated as the "driver." A pair of '46's in a Class B output stage is capable of supplying an exceptionally large amount of virtually undistorted power; while a single '46, operated in the driver stage as a Class A amplifier, can deliver sufficient power to drive the pair of '46's in the output stage.

The dual application of the '46 to Class B and to Class A amplifier service is made possible by different connections of the two grids incorporated in the tube's structure. Each grid terminates in its respective base pin. For Class B operation, the two grids must be tied together. This connection causes the tube to have an amplification factor so high that negative grid bias is not required for its operation as a Class B amplifier. For Class A operation, the grid adjacent to the plate is tied to the plate in order that the tube will have a low amplification factor. In the latter case, negative grid bias is required for proper operation of the tube. See page 15 for discussion of Class B operation.

CHARACTERISTICS

Filament Voltage (A. C. or D. C.)	2.5	Volts
Filament Current	1.75	Amperes
Maximum Overall Length		5 5/8"
Maximum Diameter		2 3/16"
Bulb (See page 42, Fig. 10)		S-17
Base		Medium 5-Pin

As Class B Amplifier

Plate Voltage	300	400 *max.*	Volts
Grid Voltage (Both grids tied together)	0	0	Volts
Plate Current (Per tube)	4	6	Milliamperes
Peak Plate Current (Per tube)	150	200	Milliamperes
Max. Plate Dissipation (Avg. per tube)	10	10	Watts
Load Resistance (Per tube)	1300	1450	Ohms
Max. Signal Voltage (RMS per tube)	40	41	Volts
Max. Continuous Power Output (Two tubes)*	16	20	Watts

As Class A Amplifier

Plate Voltage	250 *max.*	Volts
Grid Voltage (Grid adjacent to plate tied to plate)	−33	Volts
Plate Current	22	Milliamperes
Plate Resistance	2380	Ohms
Amplification Factor	5.6	
Mutual Conductance	2350	Micromhos
Load Resistance (For max. undistorted power)**	6400	Ohms
Max. Undistorted Power Output	1.25	Watts

* Power measured across indicated value of resistor in plate circuit of each tube, with indicated signal applied through 250 ohm resistance in the grid circuit.

** Approximately twice this value is recommended for load of driver for Class B stage.

INSTALLATION

The base of the '46 is of the medium five-pin type. Its pins fit the standard five-contact socket which may be installed to operate the tube either in a vertical or in

a horizontal position. For horizontal operation, the socket should be positioned with the filament pin openings one vertically above the other. For socket connections, see page 39, Fig. 7.

The **bulb** of this tube may become very hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided around the tube to prevent overheating.

The **filament** is designed to operate at 2.5 volts. The transformer winding that supplies the filament circuit should operate the filament at this recommended value (as measured at the filament terminals) when rated voltage is applied to the primary of the power transformer operating under average load. The filament wiring should, insofar as possible, be isolated from the input circuit of the driver stage in order to avoid the possibility of hum caused by electrostatic induction from this wiring.

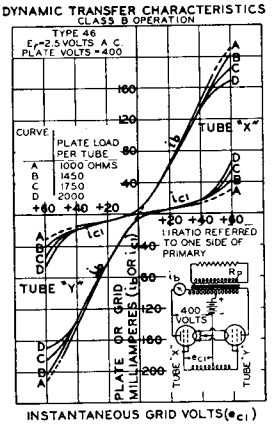
The grid and plate return for the driver stage should be made to a variable center-tapped resistor across the filament (or heater) supply for minimum hum adjustment. The use of a push-pull driver stage with either equi-potential or filament type tubes will reduce hum resulting from the filament supply, but is required only in special applications.

APPLICATION

For **Class B audio power amplifier service,** the '46 is particularly recommended because of its design. In this type of service, the two grids in the tube are connected together and, thus, the signal voltage is applied to both simultaneously. No grid bias voltage is necessary with this connection as the steady plate current at zero bias is only a few milliamperes. The design of the '46 permitting its operation as a Class B amplifier with zero bias is particularly important because it prevents variation of bias with applied signal which would otherwise exist if any self-bias arrangement were employed.

The direct-current requirements of Class B circuits are subject to fluctuation under operating conditions. The power supply, therefore, should have as good regulation as possible to maintain proper operating voltages regardless of the current drain. The use of a mercury-vapor rectifier in the power supply is recommended because it has a low and practically constant space-charge voltage drop within its operating range. As a further means of obtaining good regulation, the filter chokes and transformer windings of the power supply should have as low resistance as possible. In designing the power supply for a Class B amplifier, it should be remembered that such an amplifier may frequently demand peak currents of 200 milliamperes or more.

The grid of the '46 is operated sufficiently positive to cause grid current to flow in its input circuit. This feature imposes a further requirement on the preceding amplifier stage which must supply not only the necessary input voltage to the output stage, but it must be capable of doing so under conditions where appreciable power is taken by the grid of the Class B amplifier tube. Since the power necessary to swing the grid positive is partially dependent on the plate load of the Class B tube, and since the efficiency of power transfer from the preceding stage is dependent on transformer design, it is apparent that the design of a Class B audio power amplifier requires that more than ordinary attention be given to the effects produced by the component parts of the circuit. For this reason, the design of a Class B audio amplifier with its driver stage is somewhat more involved than for a Class A system.



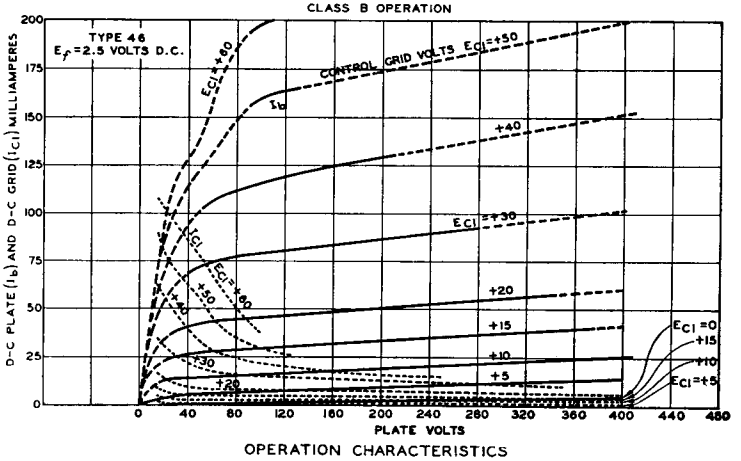
In the design of Class B amplifiers, the interstage transformer is the link interconnecting the driver and the Class B stage. It is usually of the step-down type,

that is, the primary input voltage is higher than the secondary voltage supplied to the grids of the power output tubes. Depending upon conditions, the ratio of the primary of the interstage transformer to one-half of its secondary may range between 1.5 to 1 and 5.5 to 1. The transformer step-down ratio is dependent on the following factors: (1) Type of driver tube, (2) Type of power tube, (3) Load on power tube, (4) Permissible distortion, and (5) Transformer efficiency (peak power).

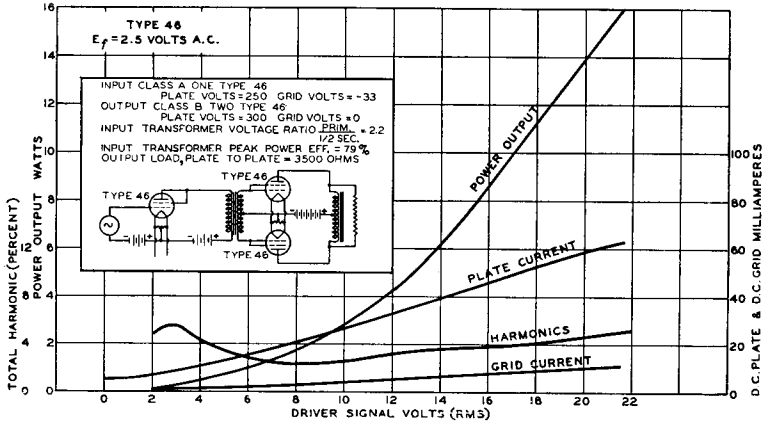
The primary impedance of the interstage transformer is essentially the same as if the transformer were to be operated with no load, that is, into an open grid. Since power is transferred, the transformer should have reasonable power efficiency. It should be noted that the power output and distortion are often critically dependent upon the circuit constants which should therefore be made as near independent of frequency as possible. This applies particularly to the interstage coupling transformer and to the loudspeaker.

The driver tube should be capable of delivering sufficient power to operate the Class B amplifier stage. If low distortion is desired, it is most important that the driver tube be worked substantially below its Class A undistorted output rating, since distortion produced by the driver stage and the power stage will be present in the output.

AVERAGE PLATE CHARACTERISTICS
CLASS B OPERATION



OPERATION CHARACTERISTICS
CLASS B OPERATION



For **Class A operation** of the '46, the grid adjacent to the plate is connected to the plate. The grid next to the filament serves as the control grid. Operation of the tube is then similar to any Class A power amplifier triode. The operation of this tube connected as a Class A amplifier is not indicative of its performance in Class B circuits and should not be confused with the latter.

The intended application of the '46 as a Class A amplifier is for driving two '46's in a Class B amplifier circuit. The tube has been constructed for this dual service in order to reduce the number of tube types necessary in a receiver. The tabulated values for Class A operation of this type as given under CHARACTERISTICS are for its operation as a power output tube.