SECTION 10

LINE AMPLIFIERS: AM7 SERIES

AMPLIFIER AM7/501

General Description

The AM7/501 is a mains-operated video-frequency line sending amplifier which is used where an unbalanced high sending level to line is required.

It has a fixed gain of 12 dB, and gives an output level of +12 dB into 75 ohms and an auxiliary output of −15 dB into 75 ohms for monitoring. The input impedance is high. The amplifier is constructed on a CH1/3 plug-in chassis for mounting on a PN3/2 type panel. An indexing system prevents the unit being plugged into the wrong position. Signal and mains connections are made through the standard 24-way plug and socket connector used with this type of chassis. Separate sockets labelled *Mon. Input* and *Mon. Output* are fitted on the front of the unit for test purposes.

The power consumption is 70 VA at 240 volts a.c. and the weight is 12·5 lb.

Circuit Description (Fig. 16)

General

The circuit of the amplifier is shown in Fig. 16. It employs three stages comprising an input valve V1, interstage valves V2 and V3, and valves V4 and V5 which form the output cathode follower. Overall negative feedback is taken from the cathodes of the output valves to the cathode of V1.

The h.t. for the output stage is derived from the bridge rectifier MR1 — MR4. An extra rectifier MR5 provides a higher voltage which is stabilised by valve V8 using V6 and V7 to provide a reference potential. This stabilised h.t. is used for V1, V2 and V3.

Video Chain

The incoming video signal is applied through the coupling capacitor C1 and the grid stopper R4 to the grid of V1. The grid resistor R3 is taken to the point at positive d.c. potential formed by the junction of R1 and R2 to enable V1 to draw the correct standing current through its bias resistors R5 and R6.

An amplified signal appears at the anode of V1, which is directly coupled to the grids of V2 and V3 by R11, R13 and R12.

R11 and R10 form a d.c. potential divider and reduce the direct potential applied to the grids of V2 and V3. The a.c. signal from the anode of V1 is applied straight to these grids by C4.

The cathodes of V2 and V3 have independent bias resistors, and since about 26 volts of bias is used for each, the cathode current of each valve is effectively established; this helps to stabilise the mutual conductance and thus the stage gain. Each cathode resistor is decoupled by a 250-μF electrolytic capacitor in parallel with a 120-pF ceramic capacitor. This technique of applying d.c. feedback to a valve cathode is also used to a certain extent with V1, which has about 4 volts of d.c. feedback applied to its cathode.

The anodes of V2 and V3 are paralleled through anode stoppers, and the signal is developed across R16 which forms the anode load for the two valves. The major part of the capacitive load for this stage is represented by the input capacitances of the two output valves, and to develop enough signal at the high frequency end of the spectrum across this capacitive load two CV3998 valves in parallel are used.

The signal appearing at the anodes of V2 and V3 is d.c. coupled by R26, R28 and R35 to the grids of the output valves V4 and V5. The potential divider R26, R25 reduces the direct potential applied to these grids and C14 couples the a.c. signal directly.

V4 and V5 are biased separately and the signal developed at their cathodes is fed through C16 and C17 in parallel, R42, and a low-pass filter formed by C22, L1 and C23 to the main output pin on the multi-way plug. The low-pass filter has a cut-off frequency of 20 Mc/s and serves to limit the high-frequency response of the amplifier. A low-level output for continuous monitoring is formed by R43 and R44.

Overall negative feedback is taken from the junction of R42 and C17, through C18, R34 and R29 to the cathode of V1. The ratio of R34 plus R29 to R6 determines the absolute gain of the amplifier. R29 is adjusted on test at the manufacturing stage and should not be altered. C19 controls the high-frequency gain of the amplifier and is set to give a frequency response flat to 5 Mc/s on initial test. It is then locked in that position and should not be altered.

About 30 dB of overall feedback is used. This gives the amplifier the following advantages:

(a) The output impedance of the cathodes of V4 and V5 is very low (1·5 ohms at 10 kc/s) which gives a good output impedance.
(b) The amplitude/frequency response is flat to 5 Mc/s.
(c) The differential phase shift at 2·7 Mc/s is made very small.
(d) The gain stability of the amplifier is improved
(e) The performance of the amplifier is made almost independent of the valve characteristics.

Power Supply

The mains transformer T1 has a tapped primary winding which must be set correctly. The mains fuses are of the P.O. 36A delay type of 500-mA rating, and the h.t. fuse FS3 is of the same type but of 250-mA rating. FS3 will blow in the event of an overload on either h.t. line; the subsequent reverse voltage applied to C6 and C7 is too small to cause them any damage. The heaters of V1, V2, V3, V4 and V5 are fed from one 6·3-volt winding, and that of V8 is fed from a separate 6·3-volt winding.

The main h.t. rectifier is formed by MR1—MR4 and is fed from the 125-volt winding on T1. The output from this rectifier is 180 mA at 140 volts. The output valves draw 140 mA of this, smoothing being carried out by C6, R19 and C7.

A further winding, of 100 volts, supplies through MR5 a voltage of 120 volts which is added to the 140-volt unstabilised line to give an unstabilised voltage of 260 volts. This is then stabilised by V8 to give a 185-volt stabilised line to feed V1, V2 and V3. V6 and V7 are series-connected neons which establish a grid potential of about 170 volts on the grid of V8. All the electrolytic smoothing capacitors have bleeder resistors fitted across them.

General Data

The following are representative figures of the amplifier performance:

Overall gain, 12 dB ±0·05 dB at 10 kc/s.

Amplitude/frequency response, ±0·10 dB to 5 Mc/s.

Gain stability, ±0·10 dB for ±6 per cent change in mains input voltage.

50-c/s response: sag on 50-c/s square wave of equal mark/space ratio, less than 1·5 per cent.

Low-frequency impulse: less than 16 per cent overshoot for d.c. step signal through any time constant.

Mains impulse: the total signal excursion for a sudden change of ±6 per cent in the mains input is less than ±400 mV.

Overload point, 11 volts peak-to-peak with sine-wave input at 10 kc/s.

Hum, 6 mV peak-to-peak.

Output impedance, 75 ohms −0% +10% to 3 Mc/s.

Level at low-level output point, −15 dB ±0·3 dB at 10 kc/s.

Installation

(a) Before plugging the amplifier into the PN3/2 panel check that the mains transformer tapping is set correctly and that the fuses FS1, FS2 and FS3 are of the correct value, and that valves are in position.
(b) Ensure that the indexing plugs in the back of the PN3/2 are correctly located.

Maintenance

The amplifier cannot be serviced while it is plugged into its PN3/2 panel. It must be withdrawn and plugged into a connector box type BX1/1 which is used to supply mains and video connections for testing purposes to units constructed on chassis CH1/3. Since the amplifier uses d.c. interstage couplings it should not be switched on if V1, V2 or V3 is missing.

Maintenance can best be carried out if the amplifier is stood on its handles with the main valve complement pointing downwards.

The performance can be quickly assessed by checking the output impedance which will rise if there is any fall in the mutual conductance of the output valves or in the feedback factor of the amplifier. This means that the separation existing between the main output and the *Mon. Output* socket on the front panel will decrease and the output impedance can be checked by measuring this separation.

The separation is measured at 50 c/s by feeding a 50-c/s signal from a 6·3-volt transformer winding through a 100-ohm Type-109 resistor to the *Mon. Output* socket. The peak-to-peak amplitude of the waveform appearing across the terminated main output terminal of the amplifier should not exceed 80 mV. Any substantial increase in this figure indicates malfunctioning and further investigation should follow.

The amplifier has been designed with conservatively rated components and a long life is to be expected. The main valves are repeater valves and lives of less than 10,000 hours should be very rare. In the event of a component breakdown the voltages in the stages following the defective stage will probably differ from those given below. All are measured with a Model-8 Avometer and show the normal variations.

If it is considered desirable to check the gain and frequency response, a similar procedure to the one described in Section 8 for General Purpose amplifiers AM5/501 and AM5/501A should be followed, substituting a 12-dB loss-pad after the amplifier for the 15-dB pad preceding the amplifier.

Point of Measurement	*Meter Range*	*Meter Reading*
Mains input	1 A a.c.	270 — 290 mA
H.T. supply *A* (Fig. 16)	250 V d.c.	132 — 142 V
H.T. supply *B* (Fig. 16)	250 V d.c.	175 — 185 V
V1 cathode	10 V d.c.	3·5 — 4·5 V
V1 anode	250 V d.c.	92 — 102 V
V2 or V3 cathode	100 V d.c.	23 — 28 V
V2 or V3 anode	250 V d.c.	85 — 95 V
V4 or V5 cathode	100 V d.c.	36 — 42 V

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