New Mullard

TWO-VALVE PRE-AMPLIFIER

Details are given of the circuit for a two-valve pre-amplifier which will accommodate a variety of inputs. The performance of the circuit is discussed when magnetic and crystal pick-ups, tape recorder playback heads, and microphone and radio inputs are used.

The pre-amplifier is intended for use with equipment built to either the Mullard 5-valve, 10-watt amplifier circuit or the Mullard 20-watt circuit. Facilities are provided for magnetic and crystal pick-ups, tape recorder playback heads and microphone and radio inputs. An auxiliary socket for any input source convenient to the user is also provided in the circuit.

Equalisation for disc recordings conforms to the latest R.I.A.A. characteristics which have been adopted by most of the major recording companies. The tape playback characteristic is intended for replaying pre-recorded tapes at a speed of 7½ inches per second.

Low-impedance tone controls which cover a wide range of frequency are used in the amplifier. These should provide sufficient control for most applications.

CIRCUIT DESCRIPTION

The pre-amplifier is made up of two stages each of which uses a Mullard high-gain pentode, type EF86. All the equalisation takes place in the first stage, and is achieved by means of frequency-selective feedback between the anode and grid of the first EF86. There is

This article is based on a report prepared by C. Hardcastle of the Mullard Applications Research Laboratory.

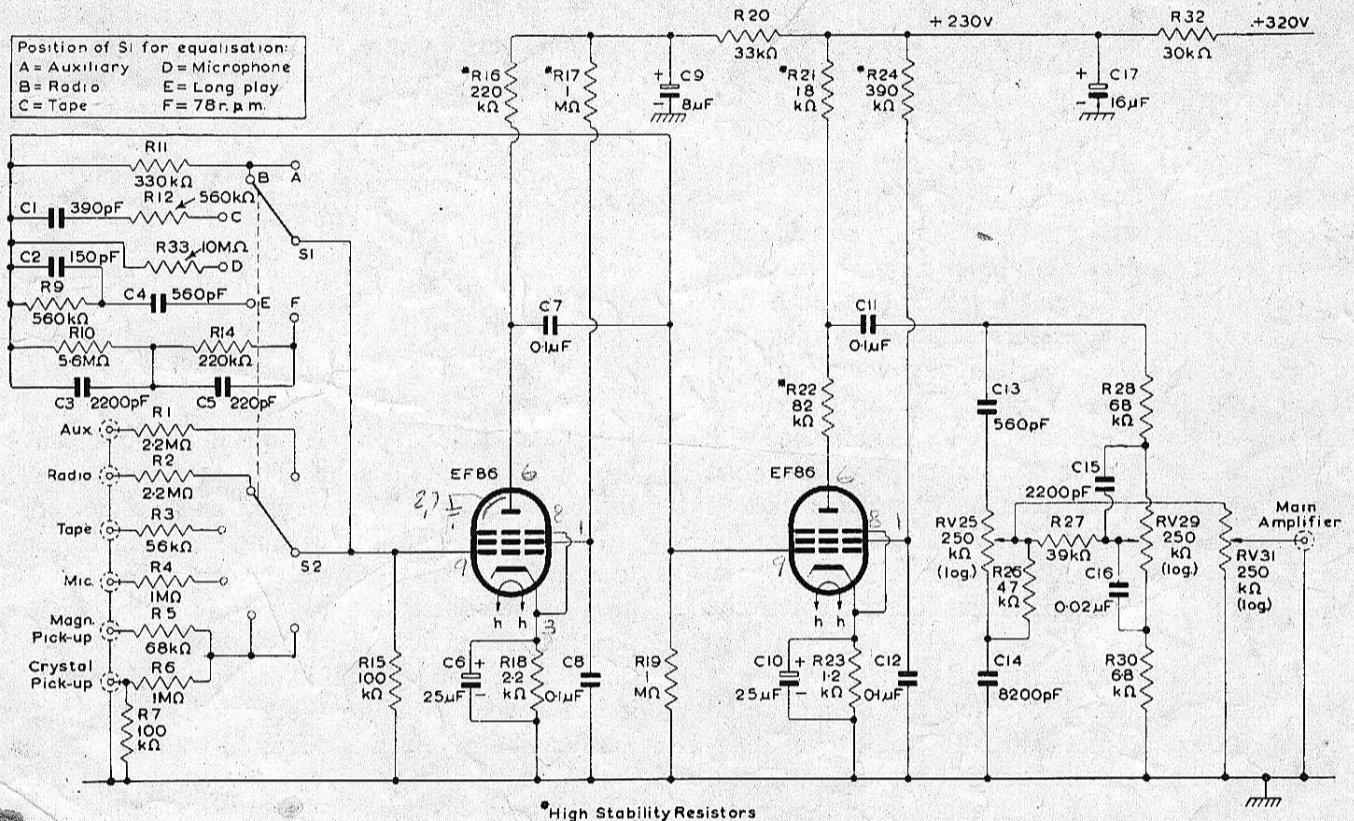

FIG. 1—CIRCUIT DIAGRAM OF PRE-AMPLIFIER

no feedback in the second stage, and the output from the second EF86 is taken directly to a passive tone-control network.

This arrangement was chosen so that the grid-circuit impedance of the first stage should be low. A low impedance at this grid lessens hum pick-up and reduces the effect of plugging-in external low-impedance circuits. Furthermore, the arrangement also results in low gain in the first stage. Hence, Miller effect between the anode and grid of the first EF86, which can be troublesome when high values of resistance are used in series with the grid, is reduced.

Series resistors are used in the input channels so that the sensitivity and impedance of any channel can be adjusted accurately. The component values given in Fig. 1 are intended for sources encountered most frequently, but the sensitivity and impedance* of each channel can be altered by changing the value of appropriate series resistor.

The sensitivity of the pre-amplifier can be altered for all the input channels by varying the output from the second EF86. This is achieved by altering the ratio of the resistors R21 and R22. (The sum of these two resistors should be maintained at 100kΩ). The values of 18kΩ and 82kΩ shown in Fig. 1 are appropriate for use with the 10W amplifier. With the 20W amplifier, the full output is taken directly from the anode of the EF86.

The smoothing components R32 and C17 shown in the h.t. line in Fig. 1 should be included in the main amplifier rather than in this pre-amplifier. The h.t. current drawn by the pre-amplifier is 3mA at 300V.

PERFORMANCE

The values for hum and noise in the pre-amplifier which are quoted for each input channel have been measured with the pre-amplifier connected to a 10W power amplifier. The measurements were made at the output socket of the power amplifier when the input terminals of the pre-amplifier were open-circuited. The frequency response curves were also obtained with this combination of pre-amplifier and power amplifier. The sensitivity figures given below provide outputs from the pre-amplifier of 40mV and 250mV when the anode load of the second EF86 is adjusted for use with the 10W and 20W power amplifiers respectively.

PICK-UP INPUT CHANNELS

It is important that the sockets for magnetic and crystal pick-ups are not used at the same time, otherwise the inputs from the two pick-ups will be mixed. Equalisation curves for the magnetic and the crystal pick-up channels are drawn in Fig. 2.

Magnetic Pick-up

Input Impedance:	100kΩ (approx.)
Sensitivity at 1kc/s	
(*a*) long playing:	3mV
(*b*) 78 r.p.m.:	9mV
Hum and Noise	
(*a*) long playing:	55dB below 10W
(*b*) 78 r.p.m.:	57dB below 10W

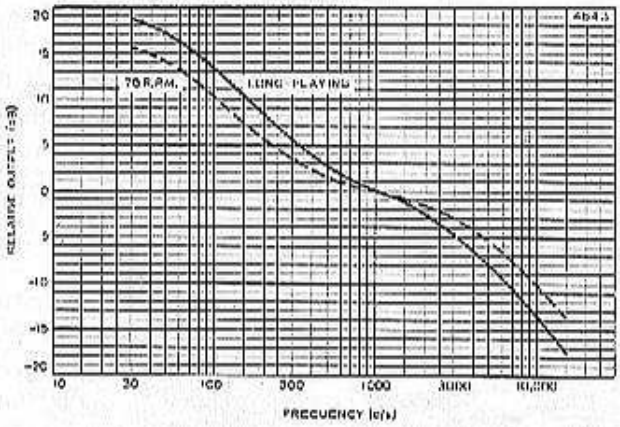

FIG. 2—EQUALISATION CHARACTERISTIC OF PICK-UP INPUT CHANNELS

This input channel is most suitable for pick-ups of the variable-reluctance type, but moving-coil types which have higher outputs can be used if a larger value of series resistance R5 is included. The difference in sensitivity between the long-playing and 78 r.p.m. positions is achieved by the different amounts of feedback provided at the positions E and F of the switch S1.

Crystal Pick-up

Input Impedance:	100kΩ
Sensitivity at 1kc/s	
(*a*) long playing:	50mV
(*b*) 78 r.p.m.:	150mV
Hum and Noise	
(*a*) long playing:	55dB below 10W
(*b*) 78 r.p.m.:	57dB below 10W

Low- and medium-output crystal pick-ups can be used for this input channel. The input is loaded with the 100kΩ resistor R7 in order that its characteristic shall approximate to that of a magnetic cartridge, and to allow the same feedback network to be used. This produces the best compromise with most types of pick-up. However, if the pick-up is not suitable for this form of loading, or if its output is too high, then it can be connected to the auxiliary input socket, the function of which is discussed below.

* The impedance of the input channels includes the grid impedance of the EF86 modified by the feedback components as well as the impedance of the input network.

TAPE PLAYBACK INPUT CHANNEL

Input Impedance:	80kΩ (approx.)
Sensitivity at 5kc/s:	3mV
Hum and Noise:	52dB below 10W

The equalisation characteristic used in this channel is shown in Fig. 3. For frequencies above 100c/s, the curve follows the C.C.I.R. characteristic, but below this frequency, slightly less boost is used. The channel is intended for replaying pre-recorded tapes using high-impedance heads, and the characteristic adopted results in good performance with these heads. If a greater sensitivity is required, the value of the resistor R3 can be decreased until the desired sensitivity is obtained.

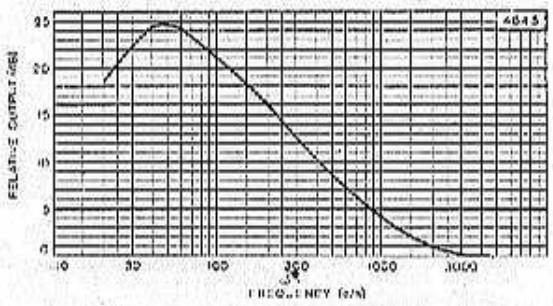

FIG. 3—EQUALISATION CHARACTERISTIC OF TAPE PLAYBACK INPUT CHANNEL

MICROPHONE INPUT CHANNEL

Input Impedance:	1MΩ
Sensitivity:	6mV
Hum and Noise:	44dB below 10W

The frequency response characteristic for this channel is given in Fig. 4.

The microphone input channel is intended for use with high-impedance systems such as crystal microphones or magnetic microphones with transformers.

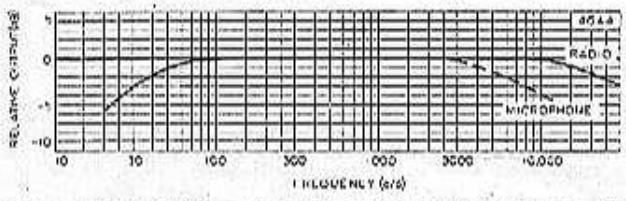

FIG 4— FREQUENCY RESPONSE CHARACTERISTIC OF MICROPHONE AND RADIO INPUT CHANNELS

RADIO INPUT CHANNEL

Input Impedance	2MΩ
Sensitivity:	250mV

The frequency response characteristic of this channel is given in Fig. 4.

With the values of impedance and sensitivity quoted above, this channel should meet most requirements. Other values can easily be obtained, however, by altering the feedback resistor R11 and the series resistor R2. If the input impedance of the channel is too high, it can be reduced by connecting a resistor of the appropriate value between the input end of R2 and the chassis.

AUXILIARY INPUT CHANNEL

It can be seen from the circuit of Fig. 1 that the auxiliary channel is identical with the radio input channel. The input with the component values shown in Fig. 1 can therefore be used for high-output crystal pick-ups, for example, or for tape amplifiers built to the Mullard circuits.* In addition, the channel can be adapted very easily for many other applications. For instance, if the value of series resistance R1 is reduced to 1MΩ, the auxiliary input will be suitable for crystal pick-ups which have low outputs.

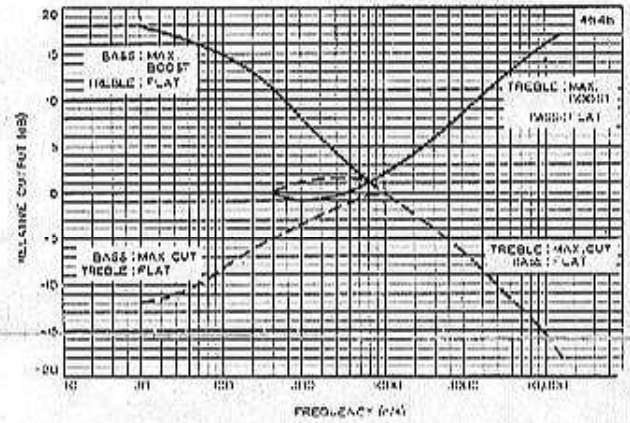

FIG. 5—TONE CONTROL CHARACTERISTICS

TONE CONTROLS

The treble and bass tone control characteristics of the pre-amplifier are shown in Fig. 5. These indicate that an adequate measure of control is provided in the unit for most applications.

Low-impedance controls have been adopted so that any capacitance resulting from the use of long co-axial leads between the pre-amplifier and main amplifier will have a minimum effect on the output impedance of the pre-amplifier.

HARMONIC DISTORTION

The total harmonic distortion of the pre-amplifier is less than 0·15% at normal output levels. At outputs of ten times this level, the total harmonic distortion is only 0·24%.

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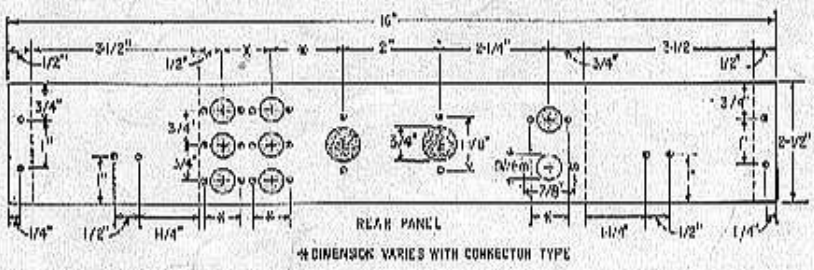
*D. H. W. Busby, W. A. Ferguson, C. Hardcastle and J. C. Latham. 'Circuits for Tape Recorders'. **Mullard Technical Communications**, Vol. 2, No. 20, November 1956, pp. 299 to 316.

D. H. W. Busby and J. C. Latham. 'Tape Recorder Circuit', **Mullard Technical Communications**, Vol. 3, No. 24, May 1957, pp. 110 and 111.



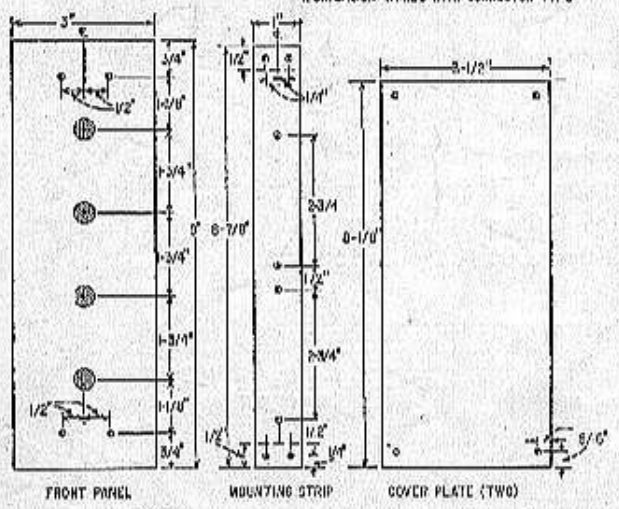
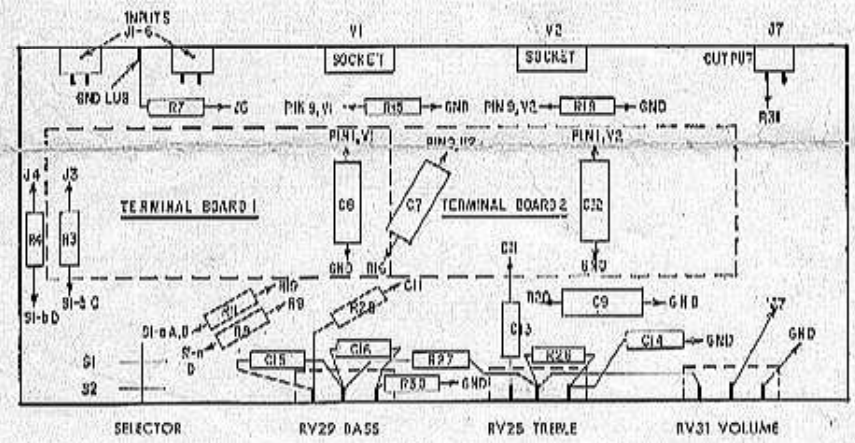


Fig. 6—Details of chassis construction.



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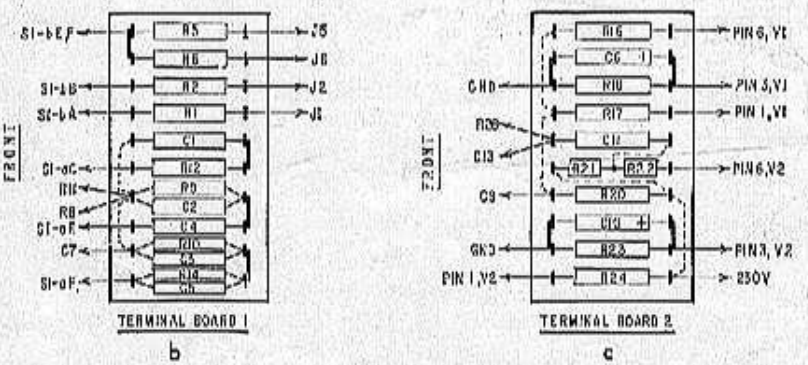

b c

Fig. 7—Recommended parts layout; a—the main chassis; b—terminal board 1; c—terminal board 2.

Construction details

The chassis and layout of the preamp have been designed specifically for the home constructor. A conventional box type chassis is not used. Instead, the chassis is made on the unit system, the separate parts being joined together during assembly of the equipment.

The chassis is made up of five separate pieces of sheet aluminium. The dimensions are given in Figure 6. Each piece should be marked as shown and the holes punched as indicated. When bending the pieces, the scribed lines should lie exactly along the angles. This assures that the pieces will fit together properly when assembled. For ease of assembly, components should be mounted on the two terminal boards, which should then be bolted to the mounting strip before the strip is attached to the rear plate. Diagrams showing the position of the components on the terminal boards, and the appropriate connections are given in Fig. 7.

When the mounting strip and terminal boards have been attached to the rear plate, make all connections between the valve sockets and the components on the terminal boards. (Mount the valve sockets so that the valves will be outside the completed chassis.)

Mount potentiometers RV25, RV29 and RV31 on the front panel and connect the components which make up the tone control network. Then bolt the front and back panels together and connect the remaining components.

LIST OF COMPONENTS

RESISTORS

R1—2.2 MΩ
R2—2.2 MΩ
R3—56 kΩ
R4—1 MΩ
R5—68 kΩ
R6—1 MΩ
R7—100 kΩ
R9—560 kΩ, 5%
R10—5.6 MΩ, 5%
R11—330 kΩ, 5%
R12—560 kΩ
R14—220 kΩ, 5%
R15—100 kΩ
*R16—220 kΩ
*R17—1 MΩ
R18—2.2 kΩ
R19—1 MΩ
R20—33 kΩ
*R21—18 kΩ
*R22—82 kΩ
R23—1.2 kΩ
*R24—390 kΩ
RV25—pot, 250 kΩ, logarithmic taper
R26—47 kΩ
R27—39 kΩ
R28—68 kΩ
RV29—pot, 250 kΩ, logarithmic taper
R30—6.8 kΩ
RV31—pot, 250 kΩ logarithmic taper
R32—30 kΩ
R33—10 MΩ, 5%

All resistors 1/2 watt 10% unless noted
*High stability low-noise resistors, 10% or better

CAPACITORS

C1—390 pF, silver mica, 5%
C2—150 pF, silver mica, 5%
C3—2200 pF, silver mica, 5%
C4—560 pF, silver mica, 5%
C5—220 pF, silver mica, 5%
C6—25 μf, 12 volts, electrolytic
C7—0.1 μf, 400 volts, paper
C8—0.1 μf, 400 volts, paper
C9—8 μf, 350 volts, electrolytic
C10—25μf, 12 volts, electrolytic
C11—0.1μf, 400 volts, paper
C12—0.1 μf, 400 volts, paper
C13—560 pF, silver mica, 10%
C14—8200 pF, silver mica, 10%
C15—2200 pF, silver mica, 10%
C16—.02 μf, silver mica, 10%
C17—16 μf, 350 volts, electrolytic
J1-7—coaxial connectors
S1—2-pole 6-position rotary, 2 decks
V1, 2—EF86

Metal sheets for chassis and case: 1—16 x 2½ inches; 1—9 x 3 inches; 1—8⅞ x 1 inch; 2—8½ x 3½ inches
Angle brackets 3¼ inches long, ½ inch wide in top and bottom corners (4)
Sockets, B9A, with shields (2)
Four-pin miniature speaker socket for power input
Knobs
Miscellaneous hardware

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