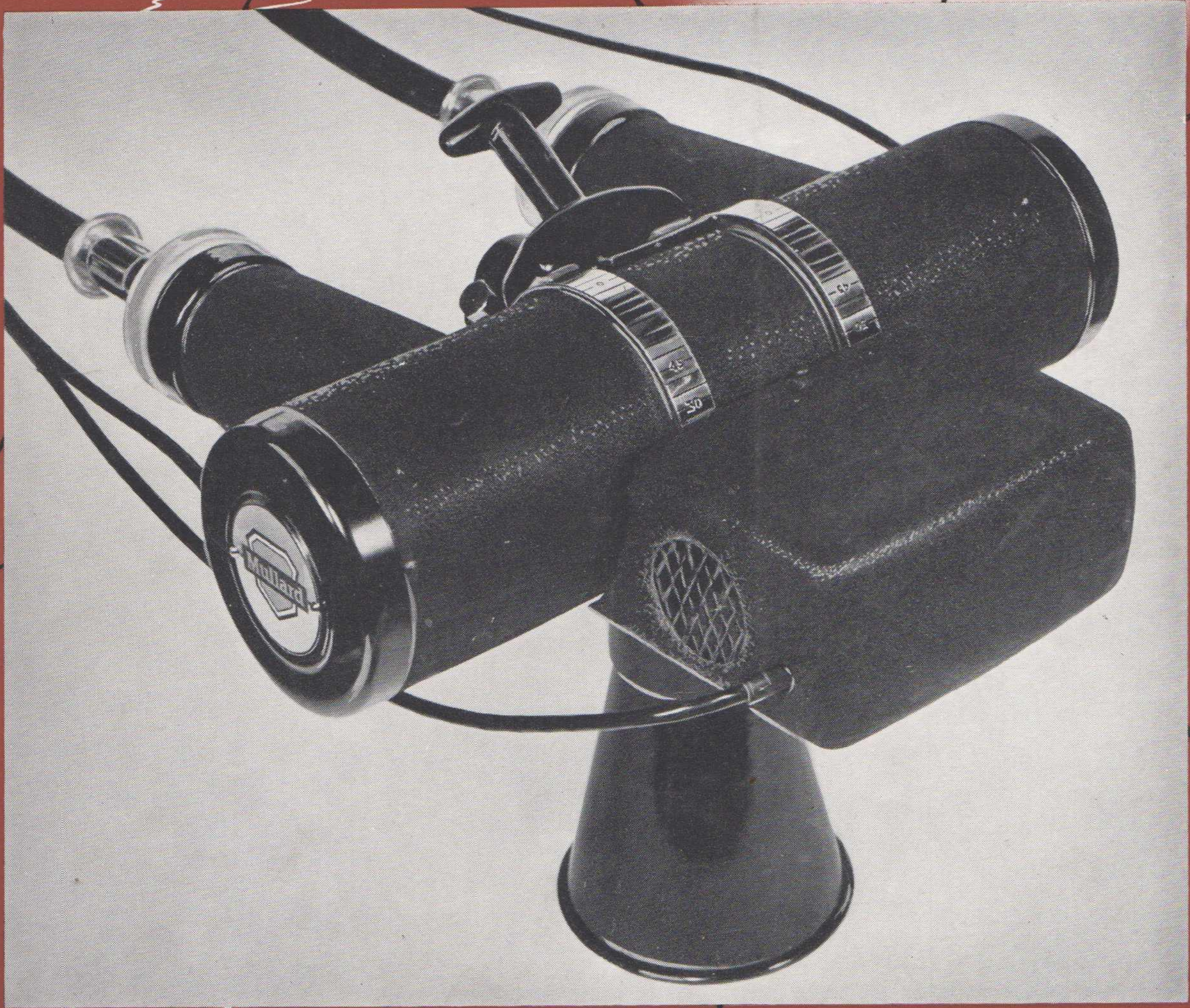
Mullard Outlook

Australian Edition



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1958

MULLARD-AUSTRALIA PTY LTD.

VOL. 1 – NO. 5 SEPTEMBER-OCTOBER, 1958

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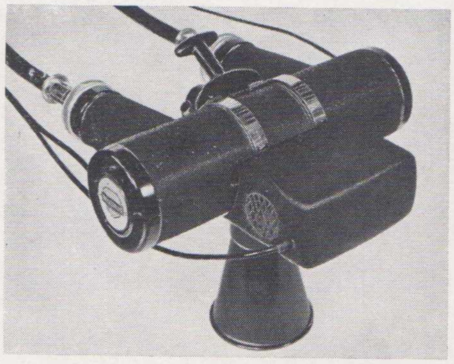
CONTENTS:



Our front cover features a typical Mullard rotating anode X-ray tube widely used for medical diagnostic purposes.

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It has been stated that "it is not what we know that matters but who we know." In the technical world, however, it is an accepted truth "it is not what we know but the knowledge where to look" that really counts.

With the tremendous development in the fields of Radio, Television and Industrial Electronics, the need for a comprehensive Technical Library in order to find the answers has never been of more importance than at the present time.

In all modesty we of Mullard are proud of our technical publications, data books, charts and application notes; and we have not been unmindful of the need to muster, compile, collate and cross reference the most comprehensive data on an International basis.

This Technical Data Service is provided through the Central Library located at our Head Office in Sydney and we are encouraged by the reliance placed in this service. Perhaps sometime we can assist you too!

VIEWPOINT WITH MULLARD

INSTITUTE OF PHYSICS EXHIBITION — ADELAIDE

An exhibition of scientific equipment was arranged by the Institute of Physics at the Adelaide University from the 19th to the 22nd of August to coincide with the A.N.Z.A.A.S. Conference.

The Mullard display, pictured above, included electronic test instruments, electro-chemical apparatus, ultrasonic equipment, as well as a selection of the more specialised valves, electron tubes and semiconductors. Also featured were a number of recently developed ferrite components and microwave devices, some of which were laboratory samples not yet in production.

In the field of ultrasonics the well known Mullard soldering equipment for aluminium work was demonstrated and the 60W. ultrasonic drill for machining tungsten carbide, ceramics, glass and gems was in operation.

A new 50W. ultrasonic cleaning bath for jewellery, ball races, small intricate mechanisms, etc., created considerable interest at its first public appearance in Australia. The selection of electronic equipment displayed included a Transistor Stabilised Power Supply, Transistor Tester, Dual Trace Oscilloscope, Television Line Selector, Valve Voltmeters, High and Low Pass Audio Filters, Temperature Controller, Magnetic Matrix Stacks for Computers and microwave devices. The highly-sensitive ORP 90 photoconductive cell was also shown in one of its many applications operating an automatic headlamp dipper.

The widely varied applications of the equipment displayed are indicative of the nature of the electronic products available for research and industry from the comprehensive Mullard range.

MULLARD SOUND FILM SERVICE

(16 mm.)

"Discharge Through Gases"—Effects produced by electron flow as pressure is reduced in glass tube—animated depiction of ion and electron movement under different conditions .... 11 mins.

"Industrial Application of Ultrasonics"—Introduction details experimental effects — demonstration of tinning, soldering, drilling, cleaning, etc. .... 21 mins.

"The Junction Transistor in Radio Receivers"

(Part 1. "The Design of I.F. Amplifier") .... 15 mins.

(Part 2. "The Complete Receiver") .... 10 mins.

Follow-on from simplified circuit which ends "The Transistor—its Principles and Equivalent Circuit" and deals with special circuitry required in transistor I.F. amplifiers and complete receivers.

"Made for Life"—Planning and production of television picture tubes step by step .... 34 mins.

"Manufacture of Radio Valves"—Tour through factory showing stages of manufacture .... 22 mins

"Mirror in the Sky"—Story of research and development of radio wave propagation with particular emphasis on effects produced in and by the ionosphere .... 22 mins.

"Particles Count"—The size and distribution of microscopic particles is important in many industries—the problem of rapidly sizing and counting these particles is overcome by the specialised Film Scanning Particle Analyser described in the film .... 15 mins.

"Principles of the Transistor"—Intended as an aid to teaching, the film reviews early use of crystals and subsequent replacement by thermionic valves. The larger portion of the film describes the working principles of the germanium diode and the transistor and summarises with details of application and advantages of these devices .... 20 mins.

"Principles of Ultrasonics"—Introduction explains sound and ultrasound—demonstration of production and detection of presence of waves—effects in liquids, i.e. emulsifying, etc.—some experimental and industrial applications .... 15 mins.

"Special Quality Valves"—Various developmental stages showing problems to be overcome, service, conditions, design approach and final production .... 25 mins.

"The Transistor—Its Principles and Equivalent Circuit"—Gives detailed explanation of the complex physics involved in the workings of the junction transistor. The subject is clarified by colour, animation and commentary .... 20 mins.

These films are available on loan to educational groups, etc. Applications should be made as follows:—

Title of Film ....

Date Required ....

Name of Organisation ....

Address ....

Signed ....

NEW 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.

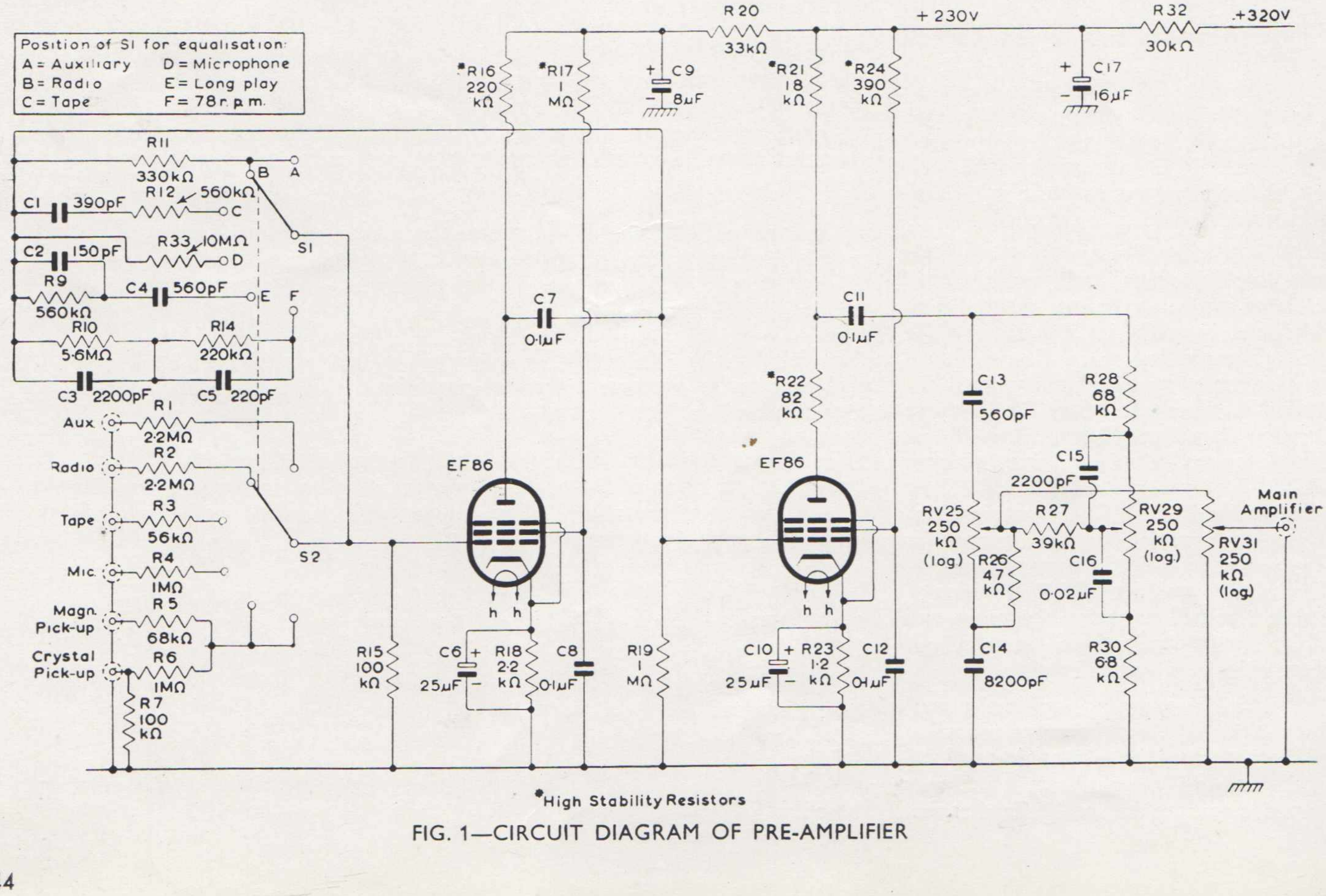


FIG. 1—CIRCUIT DIAGRAM OF PRE-AMPLIFIER

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.: 57 „ „ „

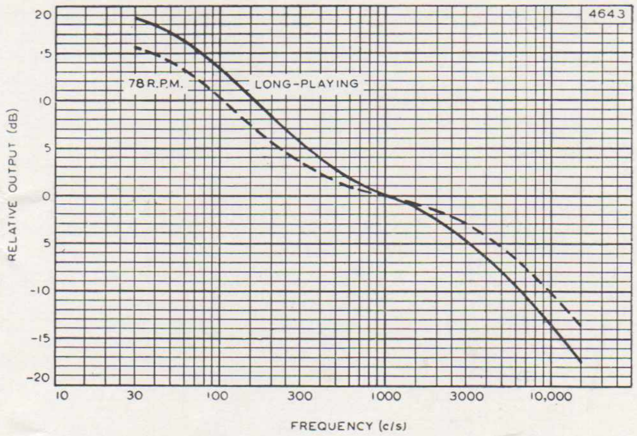


FIG. 2—EQUALISATION CHARACTERISTIC OF PICK-UP INPUT CHANNELS

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.

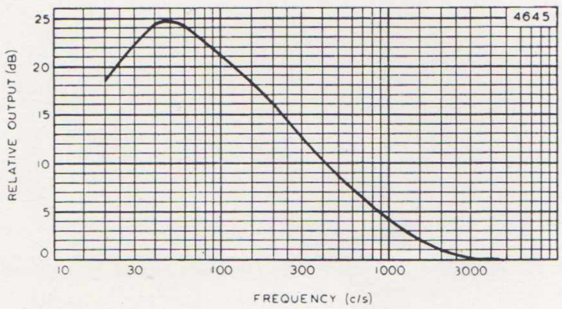


FIG. 3—EQUALISATION CHARACTERISTIC OF TAPE PLAYBACK INPUT CHANNEL

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.

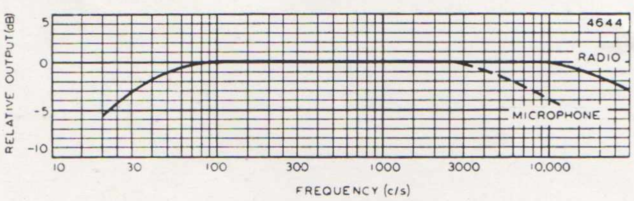


FIG 4— FREQUENCY RESPONSE CHARACTERISTIC OF MICROPHONE AND RADIO INPUT CHANNELS

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.

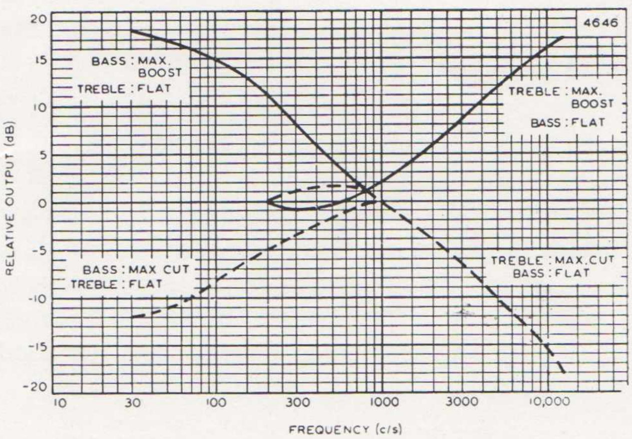


FIG. 5—TONE CONTROL CHARACTERISTICS

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%.

* 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.

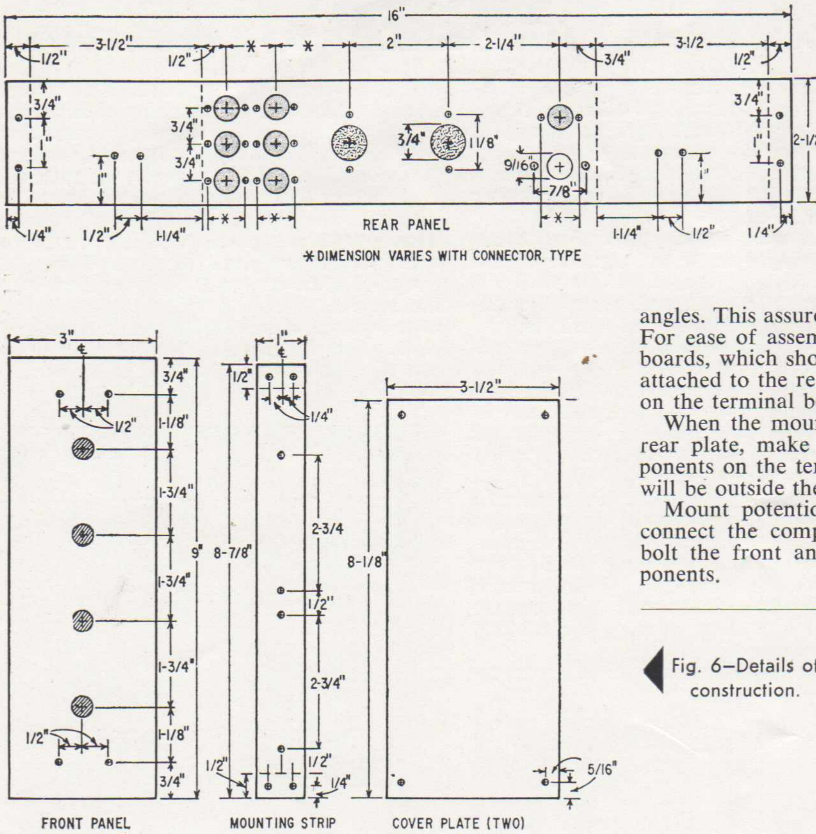


Fig. 6—Details of chassis construction.

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.

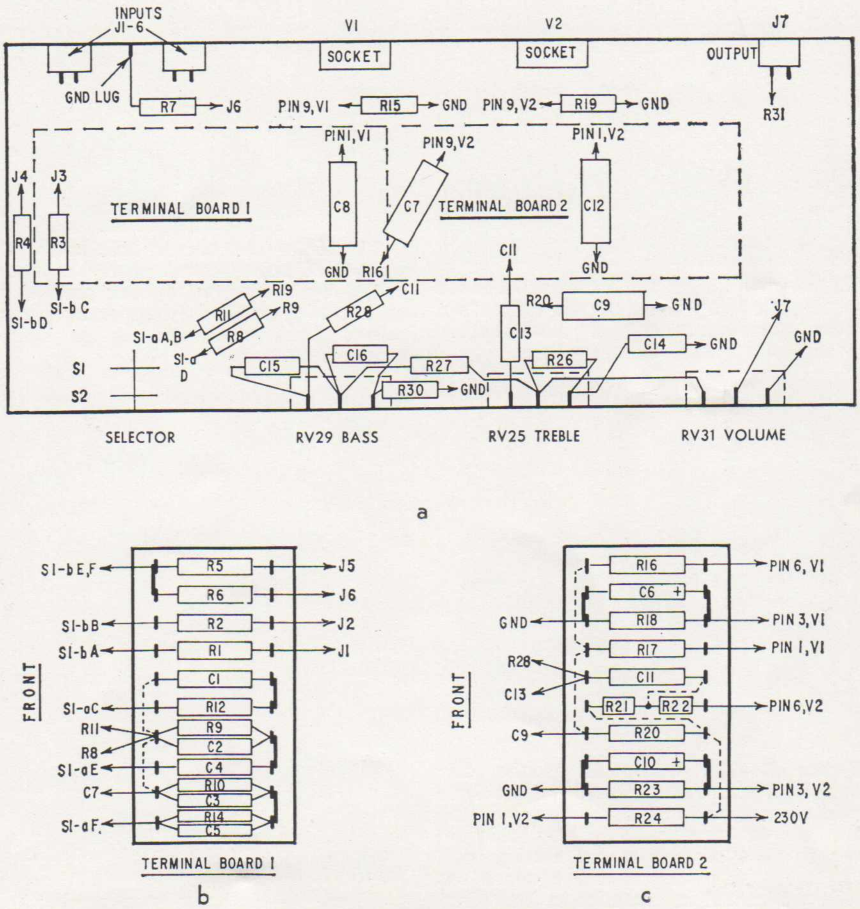


Fig. 7—Recommended parts layout; *a*—the main chassis; *b*—terminal board 1; *c*—terminal board 2.

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—8⅛ x 3½ inches
Angle brackets 3¼ inches long, ½ inch wide in top and bottom corners (4)
Sockets, B9A, with shields (2)
Knobs
Miscellaneous hardware

APPLICATION OF ULTRASONICS PIONEERED BY MULLARD

Ultrasonics is the name given to a relatively new branch of physics—the science of "sound" waves higher in pitch than the upper limit of human hearing. These waves can travel through air or through liquids or solids just as ordinary sound waves can. The only difference from ordinary sound waves is that the number of vibrations per second is much greater—in scientific terms, the frequency is higher and the wave lengths shorter.

There are numerous ways in which ultrasonics may be utilised. Established techniques in industry include:—

(1) Non-destructive flaw detection in castings, etc., by virtue of the fact that an echo is produced from the level of the flaw, instruments being used to plot its location and approximate size.

(2) Cleaning of intricate mechanisms by agitation of the solvent.

(3) Removal of firmly adhering films and coatings by a combination of violent agitation and disruptive effects produced by cavitational implosions in detergents and solvents.

(4) Emulsification of normally immiscible liquids and speeding up of certain mixing operations.

(5) Simple, rapid tinning and soldering of aluminium and its alloys.

(6) Machining of hard and brittle materials.

Previously impossible drilling and machining operations on hard and brittle materials such as ceramics, tungsten carbide, glass, germanium, synthetic gems, etc., are now being carried out by the application of ultrasonics.

Drilling and machining operations similar to those illustrated are normal functions of the 60W ultrasonic drilling equipment manufactured by Mullard Equipment Ltd., and recently introduced to this country by Mullard-Australia Pty. Ltd., 35-43 Clarence Street, Sydney. The equipment quickly and accurately machines any desired shape in the hardest materials using cutting tools which are readily and cheaply produced in easily workable metals.

The equipment is simple to use and does not require any special operating skill.

Vertical reciprocation of the cutting tool is produced which, in conjunction with an abrasive slurry, makes possible normal machining operations such as drilling, shaping, grinding and polishing.

Rapid cutting is achieved by the continuous light chipping action of the abrasive interposed between the cutting tool and the surface of the workpiece. The shape of the cut closely follows that of the tool, which is normally made of soft materials such as brass or mild steel. Special hardened tools of the conventional kind are not necessary. This means that the user can easily shape a cutting tool to suit any particular requirement. Since there is no rotary movement drilling is not limited to circular or symmetrical holes, but can accommodate intricately shaped holes made only with great difficulty by normal methods. There is no stressing or heating of the material, and troubles due to distortion and deformation are avoided.

Machining accuracy and surface finish are basically dependent upon the size of the abrasive particles. Surface finishes of 8 to 10 micro-inches are easily obtainable, and finer finishes can be obtained using appropriate abrasives. As with normal machining, a repassing action equivalent to reaming may be carried out using a fine abrasive, in order to obtain accurate sizing. Using a 1000 mesh abrasive, the dimensional accuracy of the finishing cut is of the order of 0.0005 in.

Speeds of working vary according to the materials being worked and the size of the tool used. A ¼ in. square hollow tool will penetrate soda glass to a depth of 1 millimetre within 25 seconds, and a similar cut in tungsten carbide would take approximately 8 minutes.

The machine has particular applications in the preparation of dies and tools and in the machining and finishing of materials such as ceramics, which cannot be moulded to close dimensional limits.

The equipment is similar to a normal light bench-type power drill and operates from 110-250V a.c. mains supplies. It comprises two units: the drill head mounted on a bench stand, and an ultrasonic power unit, connected by a single 4-core cable. Controls are limited to a simple tuning control and an on/off switch.

The drill head consists of a magnetostrictive transducer coupled to a brass velocity transformer, or matching stub, to the end of which are screwed the various cutting tools. These are turned with a standard B.A. threaded stud for fitting to the machine, or in the case of complex shapes, brazed to threaded studding. A number of velocity transformers are provided with each equipment, having tip diameters up to ¾ in. This range of stubs covers all drilling sizes from the smallest possible up to the equivalent of a square cutting tool having about ¾ in. sides. The appropriate stub is chosen to suit the particular size of tool being used.

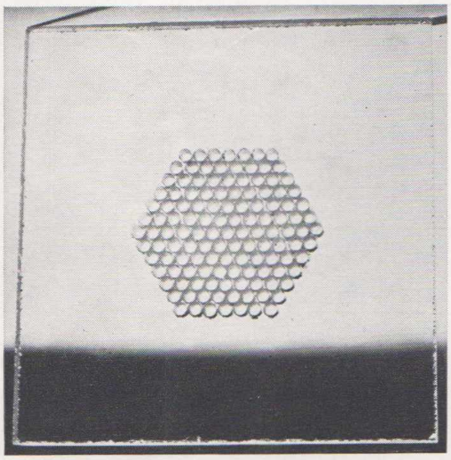


Figure 1—Multiple drilling of small holes in a single operation by the use of a "pin cushion" arrangement of short parallel studs attached to a common back plate.

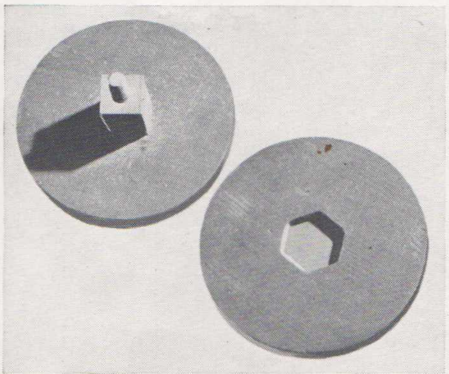


Figure 2—The upper ferroxcube disc shows a square cutter placed in the hole previously machined and the shape in the lower sample was produced by using a hexagonal headed bolt as the cutting tool. These are typical of machining operations readily performed in ceramics in their fired state.

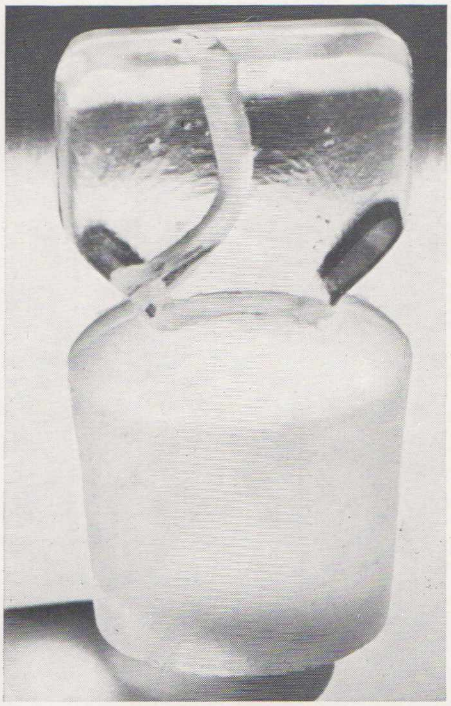


Figure 3—The curved hole in the upper section of this glass stopper has been obtained by the use of a bent piece of wire as a cutting tool, the stopper simply being moved through an arc as the operation progressed.

Figure 4—A brass printing block produced this design in a single operation.

INSTRUMENT TUBES

DG16-22

It is obviously wasteful of space, both on and behind the instrument panel, to use a circular cathode ray tube for a narrow rectangular trace. Mullard have, therefore, introduced the first British instrument tube with a face designed to fit the display.

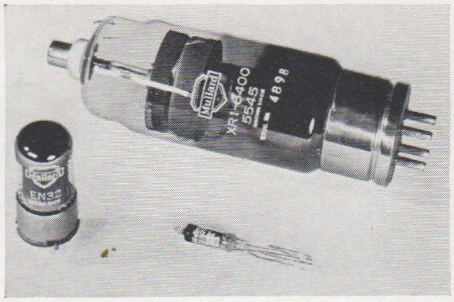
The DG16-22 has a $5\frac{1}{2}$ in. by $1\frac{1}{2}$ in. medium persistence screen, and a high deflection sensitivity of about 0.2mm/V at $V_{a3} = 5$kV. It can be used for radar range-finding and for decoding IFF or beacon signals. A number of tubes may be stacked for direct comparison of signals in different channels.

Strict control of x and y plate alignment, to within $\pm 1^\circ$ of 90°, has produced the excellent perpendicularity which is essential for accurate measurements. Accuracy is increased by the notably small spot.

This tube is manufactured with three different screen characteristics:—

	Fluorescent colour	Persistance
DB16-22	Blue	short
DG16-22	Green	medium
DP16-22	Blue with green afterglow	long

MULLARD THYRATRONS



EN32

The EN32, an inert gas filled tetrode thyratron with a peak cathode current capability of 2.0 A, has an international octal base and a negative control characteristic. In certain applications the valve may be interchanged with the E.I.A. Type 2050.

It is suitable for ground or airborne applications and for operation at frequencies up to 1.6kc/s.

The small control-grid current allows a high value grid resistor to be used, so that the valve can be controlled from a high impedance signal source such as a photocell.

EN70

The EN70 is a subminiature tetrode thyratron with flying leads for direct connection into switching circuits. The maximum peak cathode current is 100mA. It may be mounted in any position and the glass bulb length is 34.8 mm.

XR1-6400

The XR1-6400 is a triode thyratron with an inert gas filling and directly heated cathode. The peak current capability is 80A. It is mounted on a B4D 4 pin super-jumbo base. Applications include motor and direct welding control circuits.

DG7-5

This general purpose instrument tube has a $2\frac{3}{4}$ in. diameter screen and an overall length of 6.3 in.

It is intended for symmetrical deflection with a final anode voltage of only 800V.

The DG7-5 is also available in short and long persistence screens as tabulated below:—

	Fluorescent color	Persistence
DB7-5	Blue	short
DG7-5	Green	medium
DP7-5	Blue with green afterglow	long

MULLARD GEIGER-MÜLLER TUBES

Typical Mullard halogen quenched Geiger Müller tubes are shown above and have been designed to give years of satisfactory service under even the most exacting conditions. The counter tubes types MX115, MX120 and MX119 have been developed in collaboration with A.E.R.E. Harwell. The high degree of mechanical and electrical strength, the exceptional stability, and the unique standardisation of characteristics have been achieved after a long period of intensive research into the selection of the most suitable materials and their processing.

With the exception of the argon and krypton filled tubes for the measurement of X-radiation, all Mullard Geiger-Müller tubes are filled with neon, argon and halogen. A special technique has been developed for this process ensuring an exact and consistent specification which does not vary from tube to tube. The standardisation of working voltage is such that tubes taken at random or even supplied at different times will all operate under identical conditions.

FERROXCUBE AND ONE OF ITS APPLICATIONS

A glance through the circuit specifications of television receivers will reveal a fair number which include Ferroxcube beads. Some circuits use one or two beads; others as many as seven or eight.

The purpose of the beads is to suppress unwanted feedback of high frequency and pulse signals from output to input stages. The supply and control leads in television and sound radio receivers (especially v.h.f./f.m. models) often provide low impedance paths for these signals, and parasitic oscillation and instability are readily set up.

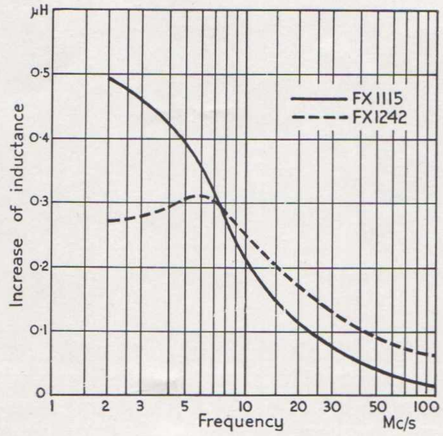
Attempts to prevent or cure these effects by means of capacitive decoupling are not always wholly effective, and the introduction of some form of impedance into the offending lead becomes necessary. If inductance in the form of a choke coil is introduced, the desired effect may be nullified by stray capacitances.

The unwanted feedback can, however, be adequately suppressed by introducing instead a lossy impedance in the form of one or more Ferroxcube beads. In the more conventional applications of Ferroxcube (for example, in the cores of high quality coils, or in transformer cores) use is made of the low loss properties of the material. These properties, however, are associated with a considerable but specific frequency range. At higher frequencies the residual losses, in any one grade of Ferroxcube, rise quite steeply. It is this effect which gives the Ferroxcube bead its valuable ability to suppress unwanted high frequencies.

A bead threaded on to a wire acts as a single turn toroid and makes use of the full permeability of the material; and, in conjunction with the high frequency losses, it provides a considerable increase in the effective impedance of the lead. This method of suppressing high frequency signals has the advantage of avoiding any d.c. or low frequency voltage drop in the lead. It is also simple, convenient, adaptable, and cheap.

EXAMPLES

Another glance through recent circuit specifications shows that Ferroxcube beads are used at many danger spots. They may be found on heater supply lines, especially at critical points in a heater chain. An example, in which groups of beads are used in association with an RC network, is



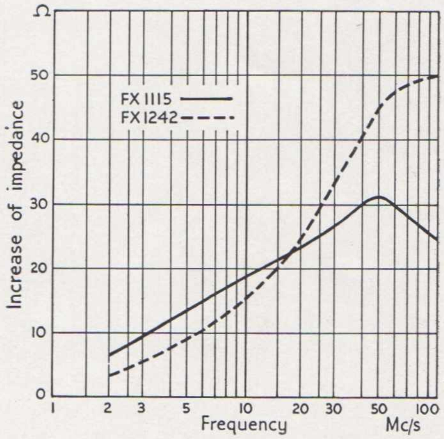
shown in the accompanying circuit diagram. (It should be noted that the beads are shown diagramatically for the sake of clearness. The standard symbol, however, consists of two short parallel broken lines shown alongside the wire.) Beads are also found in the grid input leads of audio valves; in the anode, grid, and screen grid connections of line time-base output pentodes; in r.f. and i.f. stages; and in the relatively long inter-connections between the front ends and the main chassis of television receivers.

TECHNIQUE

Theoretical articles on the effects of various sizes and combinations of bead have been published. But the layout of the wiring in, for example, a television receiver is complex; and the unwanted frequencies which have to be suppressed are likely to be very high and rather indeterminate. Attempts to calculate the precise value of added impedance which is necessary are therefore likely to be tedious and prolonged. It is obvious that it is far more practical and much quicker to proceed by trial and error. A bead or two can be tentatively slipped on to a wire, or tried at various positions along it, in a fraction of the time required for a rigorous calculation, and with a much greater hope of success.

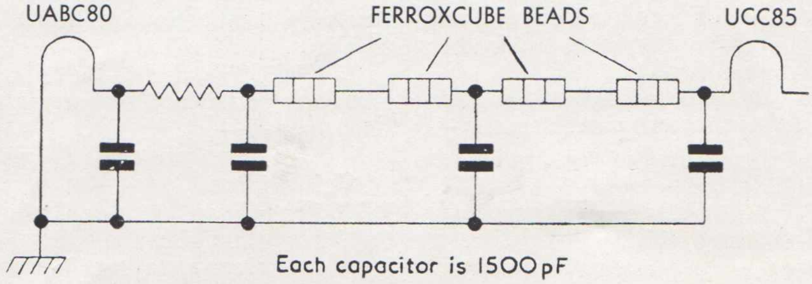
Two beads produce twice the damping effect of one, and so on arithmetically so far as conditions in domestic receivers are concerned. (In radar equipment and the like the relationship of the total length of beads to the wave-length of the oscillation becomes an important consideration.)

The mechanical aspect of the matter is even simpler. The beads are very small and very light; therefore they need no added support, and no complicated or inconvenient fixing. They can be pushed, if necessary, into almost inaccessible positions in the wiring.



BEAD TYPES

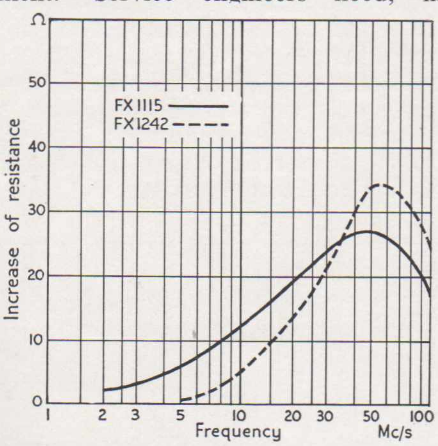
Two types of Ferroxcube screening bead are now commonly used. The first, type FX1115, consists of a short tube of grade A1 Ferroxcube. Its length is 5.0 mm., its internal diameter 2.0 mm., and its external diameter 4.0 mm. Grade A1 is, at its normal operating frequencies, a low loss high stability material. For suppression purposes, in bead form, it is particularly suitable for use where unwanted frequencies between 2Mc/s and 15Mc/s are met with. In this range its losses are high, and the effective impedance of the lead is considerably increased.



Where higher frequencies are likely to occur — say from 15Mc/s to 100Mc/s — bead type FX1242 is more effective. This bead is of grade B2 Ferroxcube—which is a material similar to grade A1, but which has greater losses in this higher frequency range. The dimensions of FX1242 are: length 5.5 mm., inside diameter 1.5 mm., outside diameter 4.05 mm. Both FX1115 and FX1242 can be threaded on to wires up to about 16 s.w.g.—dependent, of course, on the thickness of the wire covering.

Typical resistance, inductance, and impedance characteristics of 22 s.w.g. wires threaded with single beads are given in the three graphs for a wide frequency range. The values of resistance, inductance, and impedance are the values which the bead adds to the values which occur with no bead. The impedance graph clearly indicates the advantage of using the FX1242 when frequencies exceeding about 15Mc/s are being dealt with. The greater lossiness of the type in this region gives a markedly greater increment of impedance.

Although only the two commonest types have been described, the technique of using two or more beads end to end creates, in effect, quite a useful range of stoppers. Other types which may occasionally be found in receivers have special properties designed to meet some specific requirement. Service engineers need, in



general, to keep stocks of only FX1115 and FX1242 for replacement of lost or broken beads, and also for use where, for some reason, additional precautions have become necessary. Such conditions may arise when the wiring layout of a receiver has been disturbed, or when an original component has been replaced by one of a different make or of a rather different value.

The two Mullard Ferroxcube bead types may be easily distinguished from one another by their difference in size.

AIRCRAFT RADIO EQUIPMENT and the SOUTHERN CROSS

When you travel by air the latest navigational aids and communications systems are constantly being used to ensure that your flight is carried out with the maximum of safety and comfort. For example a typical radio installation in an airliner flying on international air routes will consist of two high frequency transmitter receivers each capable of operating on 144 channels. An additional receiver with continuously variable tuning will be provided and V.H.F. communication facilities will be catered for by two Trans/Receivers having 180 channels each. Such duplication of equipment ensures re-

Mr. James Warner with Mr. M. A. Brown (left) and Mr. M. H. Meyers, Communications Controller, Qantas.
(Photo by courtesy of Qantas)

The original H.F. Transmitter.

liability even under the most rigorous operating conditions.

Navigational aids such as Automatic D/F, VOR/ILS and Glide Slope are also duplicated, and additional facilities are available per medium of Loran, Radar Altimeter and Weather Mapping Radar. This latter device enables the pilot to avoid extreme turbulence by flying the most appropriate route through bad weather areas.

Compare this with the rather primitive conditions under which the famous Pacific flight of the "Southern Cross" was carried out in 1931 and one is more able to appreciate the enormity of the task with which the crew were faced.

The organisation at the time was in the able hands of Charles Ulm and the success of the flight was in no small way due to his untiring efforts. With Major Charles Kingsford-Smith in command, Charles Ulm as Co-commander, and two Americans, Harry Lyons as Navigator and James Warner as Radio Operator the "Southern Cross" took off from Oakland, San Francisco, on May 31st, 1931, to land at Eagle Farm in Brisbane on June 9th after a flying time of 83 hrs. 42 mins.

The radio equipment consisted of two transmitters, one H.F. and one M.F. unit. These were designed and built by Heinz and Kaufman U.S.A., with operating voltages being supplied by wind driven power units. James Warner was an ex U.S.N. Radio-Operator and maintained communication with Shore Stations and ships throughout the duration of the flight.

The H.F. transmitter and power unit from the aircraft were purchased by Mr. M. A. Brown some years later and remained in his possession until recently when they were restored to their original condition by the Technical Service Department of Mullard-Australia Pty. Ltd., and subsequently presented to the Sir Charles Kingsford-Smith Memorial in Brisbane for re-installation in the "Southern Cross".

2-OC72 or OC72?

Transistorised record players and radiograms which are now on the market use a matched pair of OC72 transistors in the output stage. If it becomes necessary to replace these transistors then another matched pair must be fitted. These are sold as separate units of two transistors in one box under the type number 2-OC72. These matched pairs must also be sold to constructors wishing to build the 200mW amplifier described in "Transistors for the Experimenter."

There are already a number of industrial applications in which only one OC72 is used and in the future it is probable that a single OC72 will be fitted as a driver for a power transistor such as the OC30 or OC16. To meet replacement needs in these applications, single transistors can now be ordered, using the type number OC72.

Remember!

One OC72 means a single transistor.

One 2-OC72 means a matched pair of transistors.

AND 2-OA79 or OA79?

The new germanium diode OA79 is also supplied singly and in matched pairs for use in different applications. In ratio detector circuits in f.m. and TV receivers where a matched pair of OA79's is fitted then they must be replaced by another matched pair. These are sold as a pair under the type number 2-OA79.

Remember:—

One OA79 means a single diode.

One 2-OA79 means a matched pair of diodes.

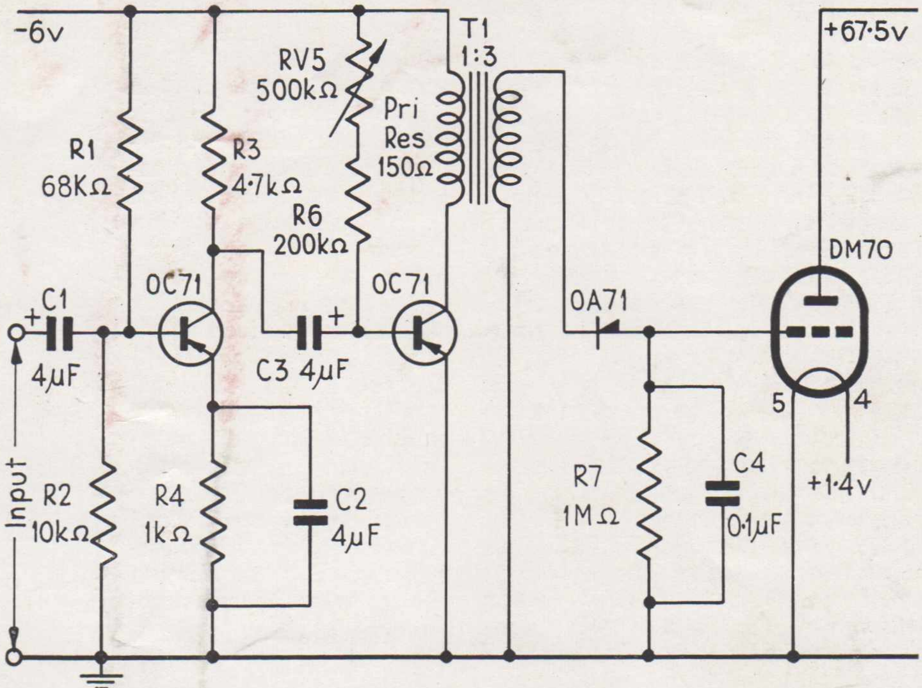
Other Mullard transistors which are now available as matched pairs:

2-OC16

2-OC30

AMATEUR EXPERIMENTERS COLUMN

AUDIO BRIDGE BALANCE INDICATOR



This unit consists of a two-stage transistor amplifier feeding a DM70 "magic-eye" subminiature tuning indicator. The lowest detectable signal is approximately 0.2mV and the "eye" is fully closed for an input of 2mV.

The transistor section uses two OC71's operating from a 6V battery. The first OC71 is designed round a nominal current of 0.5mA and is highly temperature stable because of the values chosen for R1, R2 and R4. The second OC71 is in a high gain output stage and is unstabilised, so that the bias control RV5 must be set to give the required 1mA collector current. The collector current can be adjusted initially by connecting a current meter in the emitter, or by reading the voltage drop across the primary of the output transformer with a high impedance voltmeter. The transformer loaded OC71 is matched to the OA71 rectifier circuit by a stepup turns ratio of 1:3. The transformer primary resistance should be kept as low as possible and in the prototype was 150Ω.

The rectifier circuit is conventional. For the 2mV input to the first transistor the rectifier provides —7V to the grid of the DM70, which is enough to close the "eye." With pin 5 earthed the DM70 draws about 105μA from the 67.5V anode supply. The filament draws 25mA from its 1.4V supply.

The DM70 is in the subminiature, wire-in construction and is about 10mm. in diameter and 44mm. long. The display when the "eye" is fully open has the appearance of a fluorescent exclamation mark—there is a dot and a wedge-shaped column joined together by a waist. As the grid goes negative the display is extinguished at the waist or narrowest part of the wedge first, that is, the wedge shortens and detaches itself from the dot. Eventually only the top of the wedge is fluorescent, and then that too becomes cut off; the dot is the last part of the display to be extinguished.

CIRCULATION

Please circulate this copy of OUTLOOK and sign after reading.

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