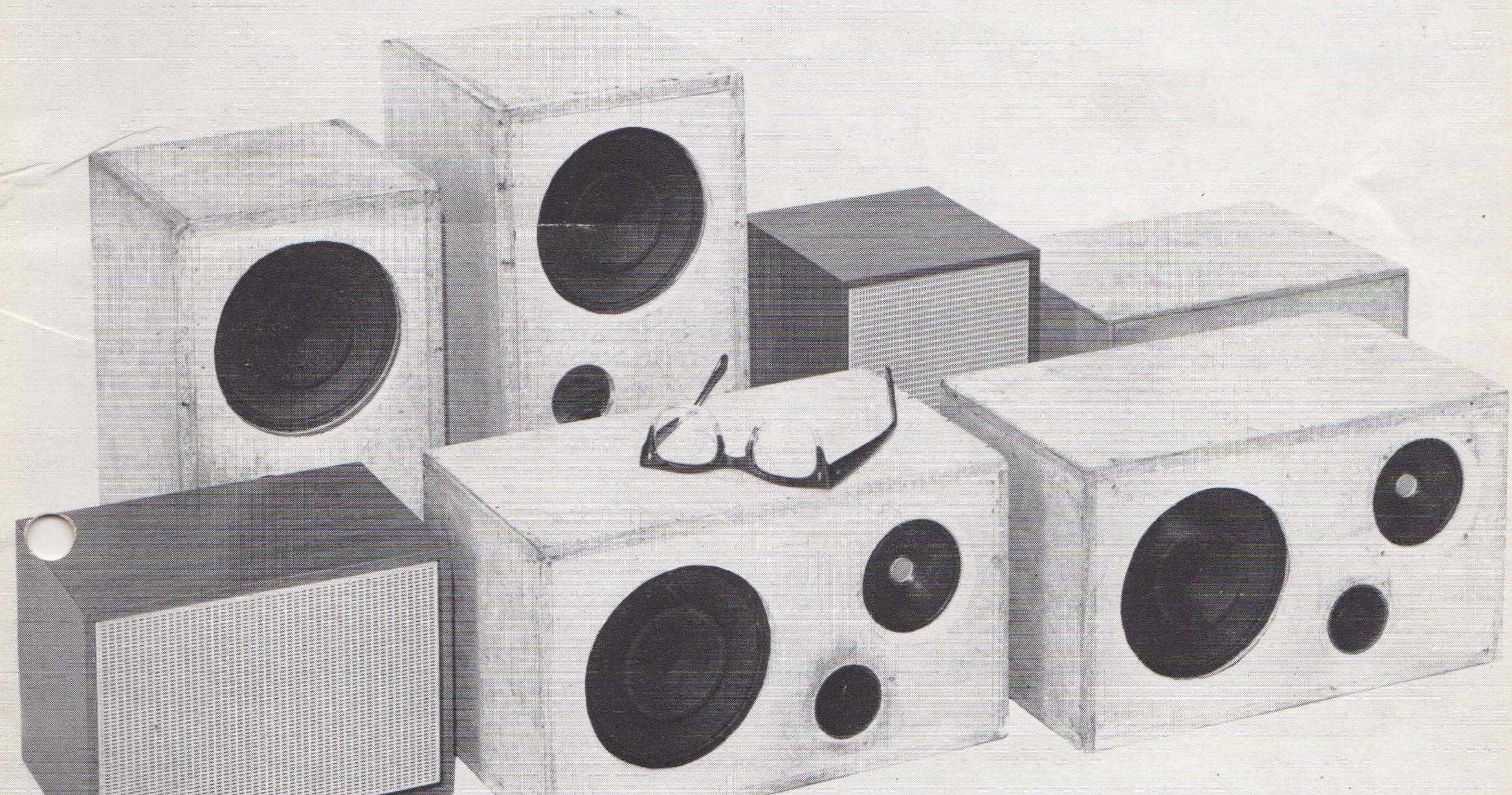
Mullard Outlook

AUSTRALIAN EDITION



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MULLARD-AUSTRALIA PTY. LTD.

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Editorial Office:
35-43 Clarence Street, Sydney.
Telephone: 29 2006

Editor:
JOERN BORK

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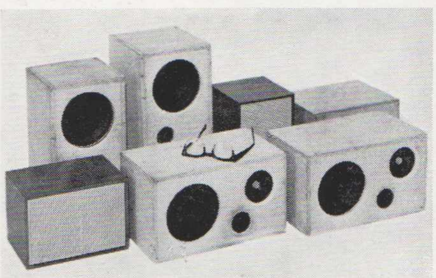

Elsewhere in this issue an article entitled "Mullard Mini Speaker Units" describes the construction of a low cost high-quality bookshelf loudspeaker enclosure—the Mullard Mini Speaker Unit (a pair of glasses identifies the unit discussed).

The other experimental enclosures are early developmental types together with two high-cost bookshelf enclosures, these were used as a yardstick during the development.

MULLARD-AUSTRALIA PTY. LTD.
35-43 CLARENCE STREET, SYDNEY
Phone: 29 2006
123-129 VICTORIA PDE., COLLINGWOOD, N.5
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Phone: 41 6644
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MULLARD LTD., LONDON

Warts and All.

"Mr. Lely, I desire you would use all your skill to paint my picture truly like me and not flatter me at all; but remark all these roughnesses, pimples, warts and everything as you see me, otherwise I will never pay a farthing for it."

(a remark attributed to Cromwell from "Walpole's Anecdotes of Paintings", Chapter 12.)

Oliver was seeking a faithful reproduction and be he telegenic, on television he would certainly show up that way.

The more faithful sound reproduction, the more critical we become of recording imperfections and incidental noises. In this issue we hav[e] something to say about low cost "warts and all" sound reproduction from small boxes. One listener claimed he could even smell the resin on the bows of the violins — such are the joys of an imaginative mind, perhaps many of us miss a little by rejecting some fantasy.

The romance of good sound at low cost is much with us and let us share it with you.

Quality Merchandise and Quality Merchandising.

Reliable performance and profitable merchandising do not necessarily demand high cost, but are factors essential to the dignity of successful business. Our contribution is high quality merchandise, continuity of supplies through the years, full technical information and from time to time a reflection on the problems of end product merchandising, ever topical, such as the warmly received "How Much Do Margins Matter?" article in the previous issue of OUTLOOK.

M.A.B.

VIEWPOINT WITH MULLARD

SERVICE ENGINEER– AMBASSADOR EXTRAORDINARY

We still have a few of the "There is more To Service than repairing a Set" coloured posters, and the reprints "Service Engineer —Ambassador Extraordinary" and have been considering additional quantities of both.

It would assist our Technical Service Department if we could know the number of further copies required.

A small blue booklet—at least with a blue cover—is at present being distributed as complementary to the poster, being a direct link in our Mullard service engineer ambassador promotion. Something to promote the respect and dignity of the Servicing Industry by doing this from within and shining out. A booklet to be perused at a quiet and pensive moment, and when heeded, passed on to your retailer clients.

The travelling service engineer starts off with everything on his side. Unlike the door-to-door salesman, he is there by the customer's invitation and is watched for and welcomed. In fact, there would be no end of a row if he failed to keep his date! These favourable circumstances put him in a unique position, not only to give the customer a good impression of the firm he works for, but also to do some positive "selling" on his employer's behalf.

It is not suggested that he should become a glorified sales representative. His contribution to the overall sales effort is made in much more subtle ways, as shown in this booklet.

If you are a service engineer remember that you can play a vital part in "after-service sales"—keep this in mind when you are out on service calls! ■

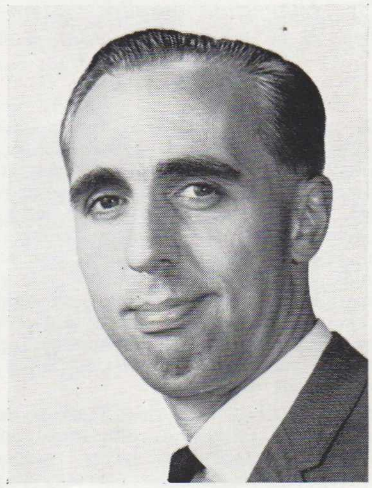
. . . A BIRD IN THE HAND

"Well, it says MALLARD on the order and you know how annoyed this customer gets if we substitute!"

We believe Mullard means something in Australia—even if we say so ourselves—for that matter in Old England as well. In the Northern Hemisphere a mallard is a somewhat prolific species of indigenous duck. Be it fish or fowl, mullet is better known as a fish from these waters and Mullard is definitely not a corruption of the two.

We just thought that you would like this cartoon from one of our Mullard, U.K. journals, in that if we were preparing it locally the salesman would probably be endeavouring to shove a mullet into the carton! However, the theme is the same and we are glad that here, also, the customer specifies Mullard! ■

MULLARD-AUSTRALIA PERSONALITIES



MR. JOHN D. WARD

We are happy to announce that John D. Ward has been appointed Senior Resident Representative in South Australia.

We must emphasise christian names for **John** Ward has **Lew** Ward the well-known and helpful Adelaide "valve man" as his associate and assistant; both on the same telephone number and both our members in South Australia.

Mr. John Ward has joined us after a long period of association with the guided weapon and aircraft industries: Previously with Westland Aircraft Limited at the Weapons Research Establishment at Salisbury, South Australia, he has specialised in telemetry and instrumentation and is an Associate Member of the Society of Instrument Technology, Australia.

Mr. Ward holds a Private Pilot's Licence and is an active member of the Royal Aero Club of South Australia. He also has a special ready-made Mullard team stamp—ex R.A.F. and holds an Amateur Radio Transmitting Licence.

He will extend the Applications Engineering and Technical Service scope in Adelaide by projecting the facilities of our laboratory and technical-commercial engineering departments. With Messrs. John and Lew we go towards a greater Service in South Australia, with two more it would be precisely forward! We hope we have made our point and you have remembered the names, for the Wards are there to assist and extend the Mullard hand in conjunction with our good friends and South Australian distributors Telcon Australia Pty. Ltd. ■

MULLARD MINI SPEAKER UNITS
A DESIGN FOR SMALL LOUDSPEAKER HOUSINGS

*Continuing the article in January-February, 1966, Vol. 9 No. 1 of Outlook, a small loudspeaker housing for bookshelf mounting is described. It is pointed out that the Mullard Mini Speaker Unit has been the result of a design study for a low-cost loudspeaker enclosure unit for application with solid state amplifiers. However, it is anticipated that many readers may wish to build this unit and it is understood that a number of approved kits will be available from component suppliers.**

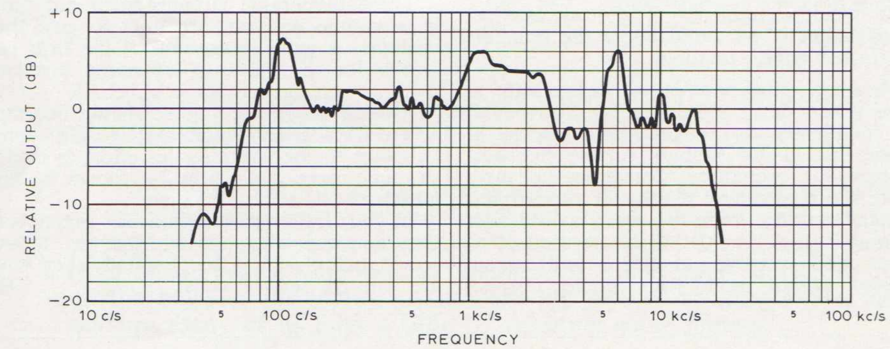


Fig. 1—The response curve of the Mullard Mini Speaker Unit was measured with the microphone on the tweeter axis 18 inches away from the front of the enclosure.

The never ending hunt for adequate, smooth and hang-free bass reproduction has resulted in a continuous improvement in loudspeakers and loudspeaker enclosure design. Manufacturers have developed loudspeakers with lower and lower fundamental resonance, a host of enclosures, and more recently loudspeakers of much lower cone mass and substantially higher cone rigidity, for example, moulded cones of polystyrene foam; an illustration of the sensible application of entirely new materials when related to cone techniques.

It is not intended in this article to highlight physical limitations, efficiency and so on, but to accept that larger enclosures where space permits are a necessity to produce the ultimate in bass reproduction. Factors not readily accepted and more readily rejected where the real household controller has the last say! Nevertheless, where commonsense dictates, and there is adequate time, money and space it is relatively straight forward—the real challenge is to achieve this at low cost, with a small enclosure and perhaps a little compromise along the line.

The Specification

With a number of solid state amplifiers in mind, and no less the introduction of new transistors enabling high quality sound amplification at low cost, it was necessary to provide the design of a complementary loudspeaker enclosure unit.

Physical Size: Whilst it has been briefly touched on in Outlook Vol. 9 No. 1 we believe that any small housing should **fit into** a bookshelf—not just sit on the top or on the floor! A survey of bookshelves shows that the height and depth of an enclosure must not exceed 8″, and the length should not exceed 12″ to 14″ maximum.

Loudspeakers: From a low cost view it was considered essential that the loudspeakers be standard, locally-produced, commercial types. With an enclosure height of 8″ the dimensions limit the loudspeaker size to 6″ diameter or an oval type with relatively small cone area. For adequate power handling the voice coil diameter should preferably be a minimum of 1″, and in view of the restricted enclosure cubic capacity the free cone resonance must be as low as practicable: also that the field flux be the highest consistent with the loudspeaker chosen. If a dual cone loudspeaker is inadequate, or for those who prefer two loudspeakers, provision was made for a tweeter. For optimum performance with the particular transformerless solid state amplifiers considered, a voice coil impedance of 7.5Ω was required.●

Performance: To detail the performance specification is difficult, and perhaps better specified by something substantially flat from 60 cycles to 15,000 cycles, or at least to be practical, the best performance without exceeding the overall outside dimensions of 8″ x 8″ x 14″.

Loudspeaker Choice

With the foregoing factors in mind the Magnavox 6WR loudspeaker came nearest the mark. It was found a tweeter was desirable and subsequently the new Magnavox 3TC Mark II tweeter was added. Messrs. Magnavox have advised that this tweeter, only recently developed, was designed as a companion for the 6WR loudspeakers where space limitations do not allow the use of their 525SIC tweeter. As the 6WR has been in use for some years there were many yardsticks on which to compare performance, although mounted in much larger enclosures.

The Design Combination

In analysing the ultra-small, totally-sealed enclosures employing high cost loudspeakers of low cone resonance, high mass and high compliance, it was evident with the 6WR that the first attempt with a sealed enclosure of 8″ x 8″ x 11″, 490 cubic inches was inadequate, the cone resonance moved from 49 c/s in free air to 108 c/s, the enclosure being constructed of $\frac{1}{2}$″ thickness pine board. Space does not permit the reproduction of all the performance curves taken, for apart from completely sealed enclosures with various amounts of filling, figures were taken with enclosures having vented ducts of various diameters and lengths. Whilst theoretical considerations showed ducts in some cases up to 10″ long, (these were arranged in concentric form) the performance of the final design is shown in Fig. 1.

It must be pointed out that whilst the performance is considered more than adequate there was a strong temptation to further develop the enclosure. However, to achieve additional refinement it was considered that any improvement would be marginal, but having shown what could be achieved with low cost loudspeakers in small enclosures no doubt further development will continue elsewhere—even with this particular loudspeaker and enclosure combination.

The experimental and comparative figures were taken with the enclosure in free air, subsequently performance curves and the final curve (see Fig. 1) was recorded with the enclosure situated against a wall.

From the final performance figures it will be seen when applying the Mullard Mini Speaker Unit, bass boost is not necessarily required, so offering a further cost advantage. It will also be noted from the performance figures that a measure of "presence" has been built in, which on listening tests provides a pleasing balance on the majority of present-day recordings.

Air Tight Housing Essential

Before describing the final cabinet design it must be stressed that it is essential the enclosure be completely airtight. To obtain this with the prototypes, and also to gain the maximum inside capacity the enclosures were constructed of $\frac{3}{8}$″ thickness pine board, the corners mitred, front and back

● In this particular issue, on Page 22, a small 2.5W amplifier is described. The frequency response curve indicates that 7dB of bass boost are employed at 90 c/s to enhance the quality, for example, for small record spinners with self contained loudspeakers and no facilities for an enclosure.

* As it is essential the design parameters be strictly followed, Messrs. Magnavox (Aust.) Pty. Ltd., 6-8 O'Riordan Street, Alexandria have requested that all prototypes be submitted for their evaluation. Magnavox will also provide the names of kit suppliers and offer additional constructional information if required.

panels rebated, the front panel and corners securely and airtight glued. The back panel was secured with a non-setting, airtight mastic gasket; plasticine was used in the experimental enclosures. For the final design $\frac{3}{8}$" pine board and an outside dimension of 8" x 8" x 14" provides an inside capacity of 695 cubic inches. All cubic measurements given are for the bare housings without the loudspeakers in position. It will be noted that for clear take-off the aperture surrounding the tweeter is chamfered at 45°.

It is interesting to note the performance is far superior to 6WR loudspeakers in far larger housings, the smallest compared being of 930 cubic inches and of different form factor and appearing twice as large.

Damping or Filling

The amount of filling was found to be somewhat critical, and one piece of bonded acetate fibre ("Innerboard") 7" x 8" fixed directly behind the loudspeaker and over it was found optimum.

Cross-Over Network

Whilst an LC network could be applied, with cost a consideration, only a series capacitor of 2μF was used.

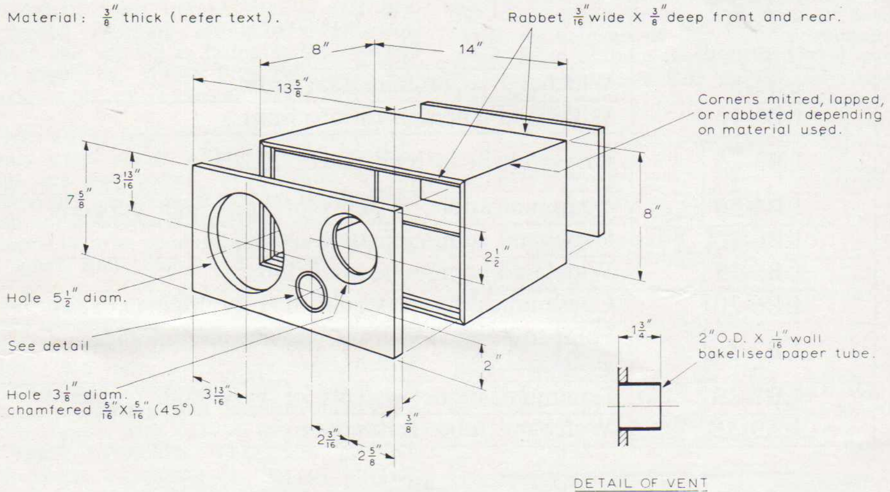
Final Cabinet Design

Having achieved this remarkable performance at low cost it must be emphasised that the Mullard Applications Laboratory is concerned with the end result from solid state amplifiers, and as such, it was a necessity "to go all the way" with a loudspeaker configuration. Solid state amplifiers will be described from time to time, first the small 2.5W per channel stereo amplifier operating from a 17 volt supply.● This may be for a small player obtaining the 17 volt supply from a tapping on the motor field winding, or from a conventional mains supply with transformer and part of a completely solid state lower power radiogram; the loudspeaker efficiency compensating to some degree for the lower power, but again with cost a dominant factor.

Manufacturers will no doubt have their own approach to enclosure construction methods, for example, a small over-hang in the front to accommodate the speaker cloth. However, it is essential that the basic height to depth ratio be followed, the enclosure being perfectly sealed including the area around the 2" diameter duct and the loudspeaker flange gaskets. The duct is glued into the front panel and a non-setting mastic applied around the speaker flange gaps adjacent to the screw mounting holes. Be aware that the cumulative pressures in time can blow the sealing, in short, if one has the courage to glue the back panel in position, for it is not only a complete and permanent airtight seal but also enhances the overall rigidity of the housing.

Another method would be to secure metal angle brackets inside the cabinet with the outside surface just below the rebate line, with the back secured with P.K. self-tapping screws and a mastic gasket. Any form of internal cleat must be compensated by additional cubic capacity, for example, adding to the length of the housing.

It is important that any cloth placed over the speaker and vent openings should be acoustically transparent, such as open weave plastic grille cloth.



● In this particular issue, on Page 22, a small 2.5W amplifier is described. The frequency response curve indicates that 7dB of bass boost are employed at 90 c/s to enhance the quality, for example, for small record spinners with self contained loudspeakers and no facilities for an enclosure.

Power Handling

Magnavox engineers provide the 6WR with a maximum power handling rating of 6-7 watts, which we understand is a most conservative rating, however, it is considered this is more than adequate for most domestic purposes, for it is rarely that the whole family can live for any length of time with a full-blooded 10 watts per channel, and if so, the enthusiast invariably has larger and more expensive loudspeaker arrangements, and perhaps more sensibly, a separate room.

Performance Figures

The Mullard Applications Laboratory is indebted to Messrs. Magnavox (Aust.) Pty. Ltd., 6-8 O'Riordan Street, Alexandria for their assistance and measurement facilities; and it must be appreciated that for the duplication of performance it is essential to rigidly follow the dimensions given. It is strongly urged where enclosure kits or complete units are offered, or where plywood or veneer-covered pine board, or other material, or material of a different thickness is used, that prototypes be submitted to Messrs. Magnavox for their evaluation. Indeed, it is essential.

Flats and Home Units

Finally, with the theme as expressed in Outlook, Vol. 9 No. 1 it is suggested that Mullard Mini Speaker Unit configuration as described lends itself ideally to commercially produced record reproduction equipment for flats and home units, or where space is a limitation. In any case, where it is desirable to avoid cluttering up large rooms, these small units can be unobtrusively tucked away, for there is a certain fascination in having the sound come from one end of a large room and the record playing device and amplifier at the other, moreso when the loudspeaker enclosures are lost in a bookshelf or similar furniture. ■

ENCAPSULATED MODULE FOR THYRISTOR CONTROL

A new Mullard thyristor firing module (MY5011) recently introduced is designed for single-phase operation, but can also be directly incorporated into three-phase systems.

The module will fire four 70A thyristors connected in parallel or in series and provides continuously variable and reliable control over a range from 0.25% up to 99.9% of maximum power.

The module forms the basis of a very cheap and simple thyristor control; the only other requirements of a complete system are a feedback signal or potentiometer to control the firing angle of the thyristors, and an external AC supply of 30-0-30V (obtained from an isolating transformer).

Small size (9.14 x 6.60 x 4.82cm), rugged construction and the protection of an epoxy resin encapsulation make the module suitable for use under the most arduous conditions.

Connections to the module are by soldering tags or individual push-on connectors.

A simple, single-phase module (MY5000) capable of driving two 70A thyristors is also available. ■

MULLARD TRAVELLING WAVE TUBES

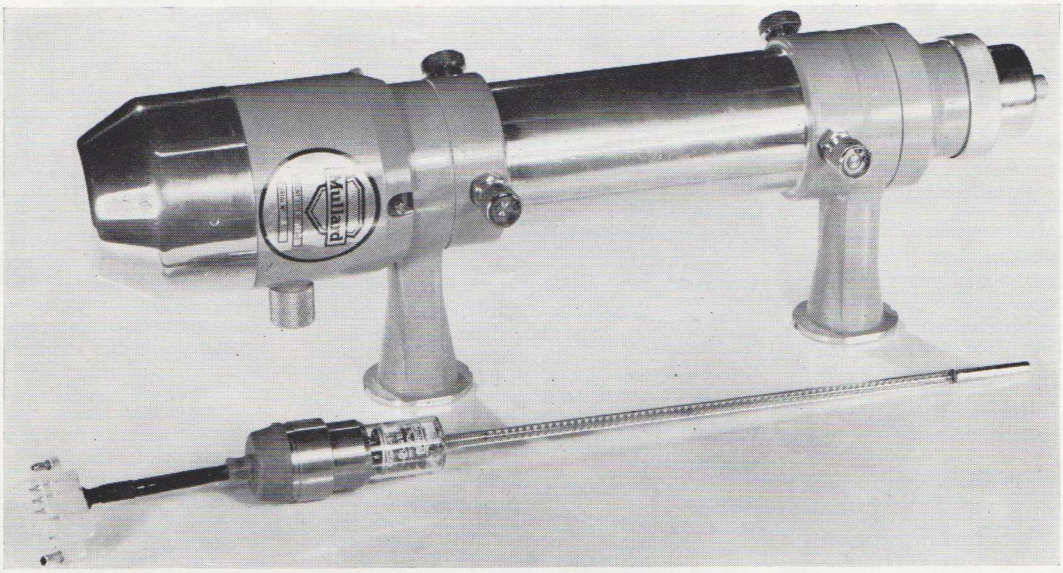
Mullard travelling wave tubes in communications links joining New York with San Francisco and Montreal with Vancouver have completed over 100 million tube-operating hours. Many tubes are still operating at full efficiency after 20,000 hours of continuous use.

Won against fierce international competition, including bids from U.S. Firms, the contracts to build these tubes for R.C.A. companies confirmed Mullard as the leading producer of travelling wave tubes. Design, costs, the resources to mass-produce such specialised devices and the ability to make them consistently were decisive factors which have since influenced other equipment manufacturers.

While the tubes in the North American links give 10W saturated power output in the 6Gc/s band there are now in the Mullard range communications tubes of twice that power—the most advanced devices yet produced for microwave communications. These 20W tubes double the channel capacity of microwave links, or greatly extend their range, without increasing the a.m./p.m. distortion and with negligible increase in operating costs.

MULLARD TRAVELLING WAVE TUBE RANGE

Power Output (W)	*Frequency Gc/s*	*Forward Wave Amplifiers*	*Use*
8.0	3.8-4.2	LB4-8	Wideband communications links
12.0	5.9-7.125	LB6-12	Wideband communications links
250.0 (peak)	~ 3.0	LB3-25	Driver chain in high power radars
20.0	3.8-4.2	LB4-20	Communications systems of very high capacity
10.0	5.9-7.125	LB6-10	Wideband communications links
15.0	5.9-7.125	LB6-15	Wideband communications links
20.0	5.9-7.125	LB6-20	Communications systems of very high capacity
5.0	6.9-7.9	LB7-5	Point-to-point TV links, private communication systems
20.0	7.9-8.9	LB8-20	Communications systems of very high capacity
3.0	8.9-11	LA9-3B	Wideband tubes for radars



A typical travelling wave tube which, together with the mount, incorporating periodic permanent magnets for focussing, forms the travelling wave amplifier unit.

BACKWARD WAVE TUBES

10mW	11-18 tunable	BA16-10	Wideband radars
50mW	8-12 tunable	YH-1100	Wideband radars also with Mullard spin tuned magnetron in diversity radars: signal generators

THE USE OF SILICON TRANSISTORS
IN THE ELECTRONIC ORGAN

This article intends to illustrate the use of silicon transistors in this application, and further elaborations such as tone filter networks, pre-amplifiers, stop tabs and keyboards will not be discussed.

Described are two oscillators suitable for use in an electronic organ. The first type is typical as used in instruments incorporating individually tuned oscillators for every half-tone of the musical scale. The second type is unusual in that the one unit covers the two octaves of bass pedal frequencies by a saturable reactor and voltage control.

Tone generation in commercial and non-commercial organs has shown quite some promising if not unusual methods in the past. Some have used master oscillators and frequency divider chains consisting of multivibrators, counter circuits, sawtooth generators, neon trigger circuits and synchronised blocking oscillators. Individual tuning and voicing as found in the classical pipe organ has always been difficult in the divider type of electronic organ.

This stems from the fact that mathematically exact ratios within octave relationships are not correct or pleasing to the human ear. Sounds that can be obtained from divider-type instruments appear quite acceptable to a good proportion of people, to others, quite 'hard' and unreal.

Square, triangular and sawtooth waveforms as obtained from frequency dividers when converted can make very realistic voices, and can, after very sophisticated filtering, make reasonable flute voices. The greater proportion of a flute (or tibia) voice is sine wave, with only a mere suggestion of upper harmonics. The main problem with sharp waveforms is that of filtering out all harmonics of the fundamental. For every key of a 61 note manual such a set of filters would prove quite cumbersome.

The easier solution would be to design a generator supplying two waveforms. Such a generator would need to produce a sine wave and a waveform rich in upper harmonic content.

Increased frequency stability and efficiency is achieved by utilising the properties of the Hartley-type class C oscillator. From this type of oscillator two waveforms are available. One is a sine wave, the other an angular portion of each tip of the same fundamental wave.

The oscillator coil was designed around a standard wasteless EI lamination which is used in the smaller sized audio output bobbin-wound transformer. The existing clamp was modified to enable a hinging of the 'I' laminations. This, with a long 4BA steel bolt, nut and reasonably strong compression spring provides the variable gap tuning facility. When adjusted correctly, this method of tuning is comparable to any screw core coil.

The coil was scramble wound on a suitable nylon bobbin and provided with two tappings; connected to these were the supply and emitter drive resistor. A typical inductance value was found to be approximately 12H with the core adjusted to a 0.025" gap.

OSCILLATOR CIRCUIT

The circuit is shown in Fig. 1. The Mullard type BC108 n-p-n silicon planar transistor was chosen because of its high current gain. This allows the use of a simple bias arrangement to ensure reliability of cut-off at the negative swing of each cycle. As a result of this, a proportionally small value of base coupling capacitor can be used when compared to the resonating capacitor.

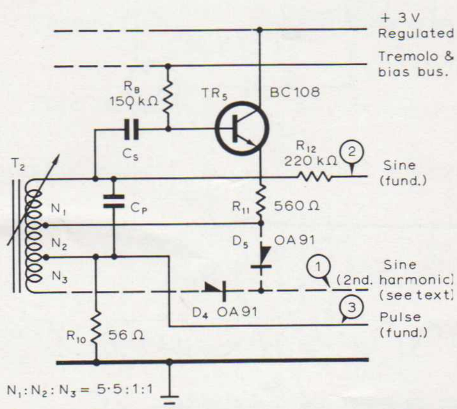


Fig. 1—Circuit Diagram of the Manual Oscillators (for values of C_P and C_S—See table).

The high dynamic input impedance of the transistor under oscillatory conditions matches the tuned circuit by transformer action. This is a good feature as waveform distortion of the sine wave is not as great as if the circuit were loaded by mismatch conditions.

A Q of 10 was obtained by placing the emitter drive tapping at a ratio of no less than 5.5:1; with a 3760 turn coil, this would amount to 680 turns. Using this ratio, a 560Ω series resistor from the emitter allows a constant current drive to the tuned circuit. The conduction angle is set at approximately 60° by the 150 kΩ resistor, R_B.

The second harmonic is provided by the full-wave rectifier consisting of diodes D_4 and D_5. These are only used to extend the range of the instrument into the 1' pitch, saving 12 additional oscillators to achieve this pitch at the top end of the keyboard. Lower frequencies do not necessitate this feature, as this is provided by the oscillators above them. (See dashed components in Fig. 1)

Frequency range of this oscillator extends from 64 c/s to 4186 c/s. Different values of C_S and C_P for different frequencies can be selected from the table entitled "Recommended values of capacitors "C_P and C_S in circuit Fig. 1 for frequencies from 60 c/s to 2,000 c/s."

BIAS AND TREMOLO

Fixed bias is applied to the generator system through a separate regulator transistor. Provision is made in the bias circuit for 'Chorus' and 'Tremolo'. Chorus is applied by slightly altering the bias (and therefore the pitch) in different octaves by switching the bias voltage divider so that some octaves receive more and some receive less bias than at which the generators were originally tuned.

Chorus in individually tuned generators is equivalent to the sound of an ensemble of musical instruments where at any instant no two in the group are exactly in tune with each other. This is most effective when a complex chord is played.

Tremolo is introduced simply by modulating the bias regulator with a low frequency sine wave of the order of 5-7 c/s. This in turn will result in small frequency variations in the tones produced.

Outputs from the generator as taken from points 1, 2 and 3 are fed to the keying and voicing circuits.

TEMPERATURE Vs. FREQUENCY STABILITY

One complete generator was subjected to a frequency/temperature test run. Best temperature stability was achieved by using a steel tension bolt in preference to a brass one on the transformer assembly. Stability for brass and steel tension bolts are shown in the graph Fig. 2.

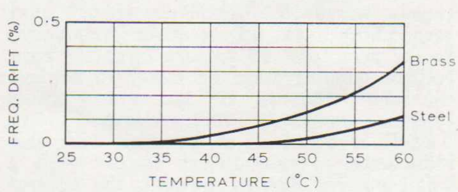


Fig. 2—Temperature v. Frequency stability graph plotted for brass and steel tension bolts.

BASS GENERATOR

A basic requirement of two octaves of pedal frequencies as applied to electronic musical instruments has never been a great problem where either frequency dividers or a string of single-pitch oscillators are used. Various methods of generation are employed, but the most pleasant and deepest

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sounding bass has always come from a waveform that is essentially a sine wave with very little upper harmonic content. The basic fundamental tone is sometimes slightly modified to add a character of richness to the basic tone by mixing in an upper harmonic or modifying the fundamental slightly.

The fundamental sine wave appears at the junction of D_3 and R_7. At this point a low impedance output is available; pulse output is taken across R_9 through C_6.

The Q of the circuit was once again kept at an approximate figure of 10 by placing the emitter drive tapping at no less than a ratio of 5.5:1. On a 2,000 turn coil, the tap was at 365 turns. By using this ratio, a 390Ω series resistor from the emitter permitted a constant current drive to the tuned circuit; with the conduction angle set at approximately 65° by means of the 220 kΩ resistor, R_8.

CONTROL CIRCUIT

The base voltage of transistor TR_1 is determined by the charge across the capacitor C_1. Transistors TR_2 and TR_3 are directly coupled to TR_1, thus obtaining an amplified current change to the control windings. The contact assembly S_{1A} derives a bias voltage from the series string of potentiometers which form a voltage divider.

Different frequencies are chosen by S_{1A} selecting these potentiometers and the small vernier adjustment to tune the oscillator to the exact frequency is established by the particular potentiometer selected.

The second section of the contact assembly S_{1B} switches on a normally off keying circuit a moment after the oscillator has been tuned. When S_1 returns to its rest position, the keying circuit will continue to pass the signal until it is cut off. Even though the keyer is off, the oscillator will continue to oscillate with a slowly decreasing frequency depending on the time constant of C_1 and leakage of transistor TR_1.

The resistor R_4 limits the control current to a value necessary to produce a frequency slightly above the desired maximum of 132 c/s. The resistor R_4 also swamps the adverse effect on the frequency due to the leakage of C_1.

TEMPERATURE STABILITY

Both oscillators exhibit a temperature stability well within the acceptable limits required by musical standards. This is because a class C oscillator conducts only for a fraction of a complete cycle, and the temperature stability will mostly be dictated by the characteristics of the tuning coil and resonating capacitor. Because the BC108 silicon transistor is used in this circuit, the temperature drift due to changes in transistor parameters is kept to a minimum.

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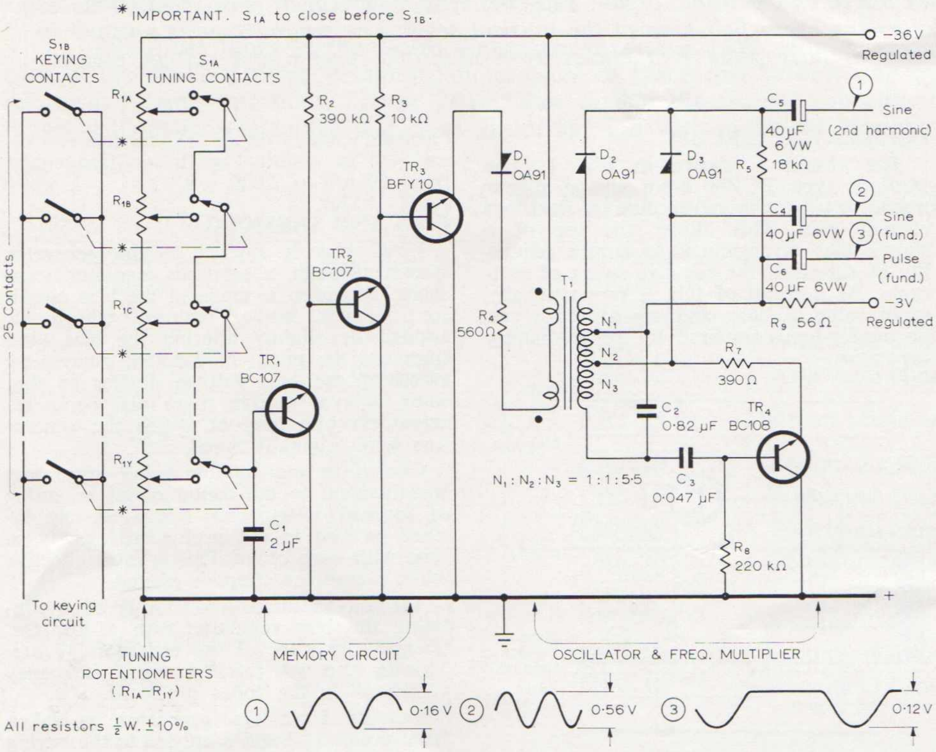


Fig. 3—Circuit diagram of the bass generator and control circuit.

Mumetal was chosen as a core material for the saturable reactor and the high permeability properties of this material required minimum saturation current to the control windings for a maximum change of inductance.

The design target for this saturable reactor was a 16:1 inductance change (corresponding to a 4:1 ratio in frequency). In the prototype, 15 ampere turns for each control winding were necessary to achieve the above change of inductance which typically would be 98H. A capacitor of 0.82μF is required in parallel with this inductance to resonate at 30 c/s with a small current flowing through the control windings.

Two coil tappings are provided, one being the connection of the supply, the other the emitter drive point.

BASS OSCILLATOR CIRCUIT

The same circuit as used in the manual generators is used for the bass generator as shown in Fig. 3, with the exception of the operating frequency range, the saturation control circuit and the fixed capacitor values. Diodes D_2 and D_3 are connected to form a full wave rectifier circuit, generating the second harmonic.

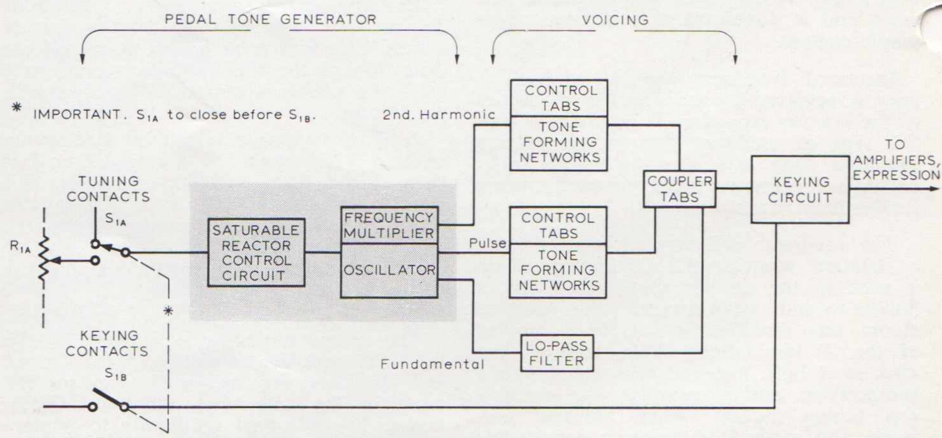


Fig. 4—Block diagram of bass generator in a Hypothetical Electronic Organ.

MAILING LIST

If you change your location, don't forget to let us know in good time, otherwise your Outlook may reach you late or never. And please, when you change, quote both your old and your new address. We can then be sure of destroying the obsolete mailing plate.

CHARACTERISTICS OF PROTOTYPES

Manual Oscillator

Ouput voltages:

Pulse	200 mV
Second Harmonic	125 mV
Fundamental	1·2V

Frequency stability < 0·1% for 20°C ambient temperature change.

Bass Pedal Oscillator

Frequency range	30 c/s – 130 c/s
Control Current	0 – 40 mA
Output voltages:	
Pulse	200 mV
Second Harmonic	350 mV
Fundamental	1 V

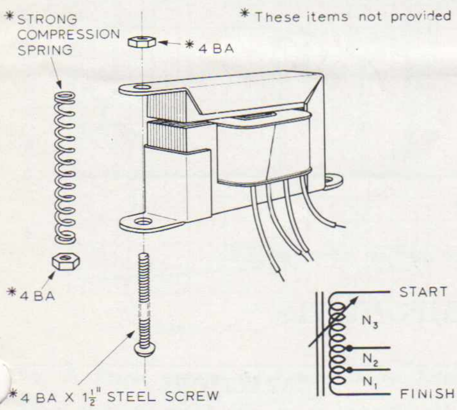
OSCILLATOR TRANSFORMER SPECIFICATIONS

N1 : N2 : N3 = 1 : 1 : 1.5

Inductor winding: 3,760 turns 38 B&S D.T.E. taps at 2,600 and 3,180 turns

Core: ½" wasteless medium resistance 7/16" stack

Clamp: Standard ½" (modified see sketch)



COMMERCIALLY AVAILABLE WOUND COMPONENTS

	Special* Transformers	Ferguson* Transformers
	Type No.	Type No.
Saturable Reactor	ST 3348	770
Adjustable Oscillator Transformer	ST 3494	CF 558 (kit set only)

*Special Transformers Pty. Ltd.
139 Sydenham Road,
Marrickville, N.S.W. Tel. 56 7287.

Ferguson Transformers Pty. Ltd.
331 High Street,
Chatswood, N.S.W. Tel. 40 0261.

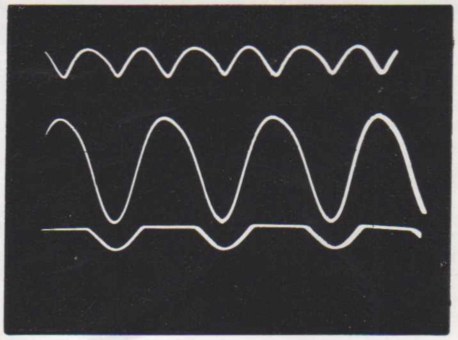


Fig. 5—Photograph of the waveforms obtainable from each oscillator.

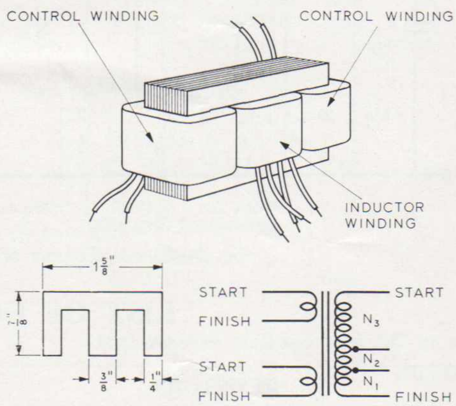
SATURABLE REACTOR SPECIFICATIONS

N1 : N2 : N3 = 1 : 1 : 5·5 (on centre leg of core)

Inductor: 365 + 365 + 1,635 turns 38 B&S D.T.E.

Control Coils: 2,000 turns each 40 B&S S.E. (on each leg)

Core: Mumetal



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Electronic Music is Here.
Radio-Electronics Feb. 1963, P.48.
Vol. XXXIV No. 2.

Electronic Organ Tuning Made Easy.
Radio-Electronics July 1963.
Vol. XXXIV No. 7. ■

G. F. HUGHES,
Applications Laboratory—Sydney.

RECOMMENDED VALUES OF CAPACITORS C_P & C_S IN CIRCUIT Fig. 1 FOR FREQUENCIES FROM 60 c/s to 2,000 c/s.

Key	Generator No.	Frequency (c/s)	C_P (μf)	C_S (μf)
C	13	64.406	1.5	0.1
C♯	14	69.296	1.5	0.1
D	15	73.416	1.2	0.1
D♯	16	77.782	1	0.068
E	17	82.407	1	0.056
F	18	87.307	1	0.033
F♯	19	92.499	0.82	0.027
G	20	97.999	0.68	0.022
G♯	21	103.83	0.47	0.022
A	22	110	0.47	0.022
A♯	23	116.54	0.47	0.018
B	24	123.47	0.39	0.015
C	25	130.81	0.33	0.015
C♯	26	138.59	0.33	0.015
D	27	146.83	0.27	0.012
D♯	28	155.56	0.27	0.012
E	29	164.81	0.22	0.012
F	30	174.61	0.22	0.01
F♯	31	185.0	0.22	0.01
G	32	196.00	0.18	0.0082
G♯	33	207.65	0.18	0.0082
A	34	220	0.15	0.0075
A♯	35	233.08	0.15	0.0068
B	36	246.94	0.12	0.0068
				(pf)
C	37	261.63	0.12	5600
C♯	38	277.18	0.1	5600
D	39	293.66	0.1	4700
D♯	40	311.13	0.082	4700
E	41	329.63	0.082	4700
F	42	349.23	0.075	3900
F♯	43	369.99	0.068	3300
G	44	392.00	0.068	3300
G♯	45	415.3	0.056	2700
A	46	440	0.056	2700
A♯	47	466.16	0.047	2200
B	48	493.88	0.047	2200
C	49	523.25	0.039	2200
C♯	50	554.37	0.039	1800
D	51	587.33	0.033	1800
D♯	52	622.25	0.033	1500
E	53	659.26	0.027	1500
F	54	698.46	0.027	1500
F♯	55	739.99	0.022	1500
G	56	783.99	0.022	1200
G♯	57	830.61	0.018	1200
A	58	880	0.018	1200
A♯	59	932.3	0.015	1000
B	60	987.7	0.015	1000
C	61	1046.5	0.012	1000
C♯	62	1108.7	0.012	1000
D	63	1174.7	0.012	820
D♯	64	1244.5	0.01	750
E	65	1318.5	0.0082	750
F	66	1396.9	0.0082	680
F♯	67	1480.0	0.0075	680
G	68	1568.0	0.0068	560
G♯	69	1661.2	0.0056	560
A	70	1760	0.0056	560
A♯	71	1864.7	0.0047	470
B	72	1975.5	0.0047	470
C	73	2093.0	0.0039	470

All capacitors of polyester ±10% 125V

Reprints of the printed wiring board drawings for both oscillators are available upon receipt of a stamped addressed envelope no smaller than foolscap size endorsed "Oscillator".

A MEDIUM POWER AMPLIFIER

employing two new Transistors AC187 and AC188

Two new transistors have recently been added to the Mullard range, making possible an economical 2.5W audio frequency amplifier. These transistors are the complementary output pair AC187 and AC188; preliminary abridged data is tabulated at the end of this article. In addition to the new germanium output pair the amplifier employs n-p-n transistors, the BC108 and BC109, recently added to the preferred silicon range of entertainment transistors.

Circuit Description

The circuit diagram of one channel of a stereophonic amplifier is shown in Fig. 1. The pre-amplifier stage uses transistor types BC108 and BC109, the driver stage employs an AC125, and the output stage the complementary pair AC187 and AC188. The circuit is designed to give full output with a high impedance pick-up cartridge having an output of 60mV, i.e. 60mV via 500pF capacitor.*

If a high output cartridge is used or the amplifier fed from a radio source then one of the pre-amplifier stages could be omitted.

Some degree of negative feedback is introduced in the first pre-amplifier stage by leaving the emitter resistor R_3 un-decoupled. Overloading is thus prevented up to and including an input of 1.1V.

If increased sensitivity is required, this can easily be achieved by decoupling the emitter resistor R_3 with an electrolytic capacitor in the conventional way.

Fig. 2 shows the frequency response of the amplifier with the treble cut tone control in its extreme positions. It may be seen from the curve that 7dB of bass boost are employed at 90c/s in relation to the mid-frequencies by using a frequency dependent network in the feedback path of the amplifier between the centre point of the output pair and the emitter of TR_3.

This type of amplifier is likely to be used in portable record players with small loudspeakers having relatively poor bass parameters. The additional 7dB of bass boost employed in this amplifier will compensate for this; if bass boost is not required the frequency dependent network, R_{13}, R_{14}, R_{15} and C_7, C_9 could be replaced by a single 560Ω resistor.

The output transistors are attached to a heatsink of four square inches of 16 gauge aluminium to ensure thermal stability for ambient temperatures up to 45°C. This heatsink area represents the minimum requirement under normal conditions.

If the output transistors are used near another heat radiating component, then the heatsink area should be increased accordingly.

→ page 23

* The matching and equalisation of Piezo-electric Pick-ups was described in Outlook, Vol. 8, No. 5, Sept./Oct., 1965, page 79.

Ed.

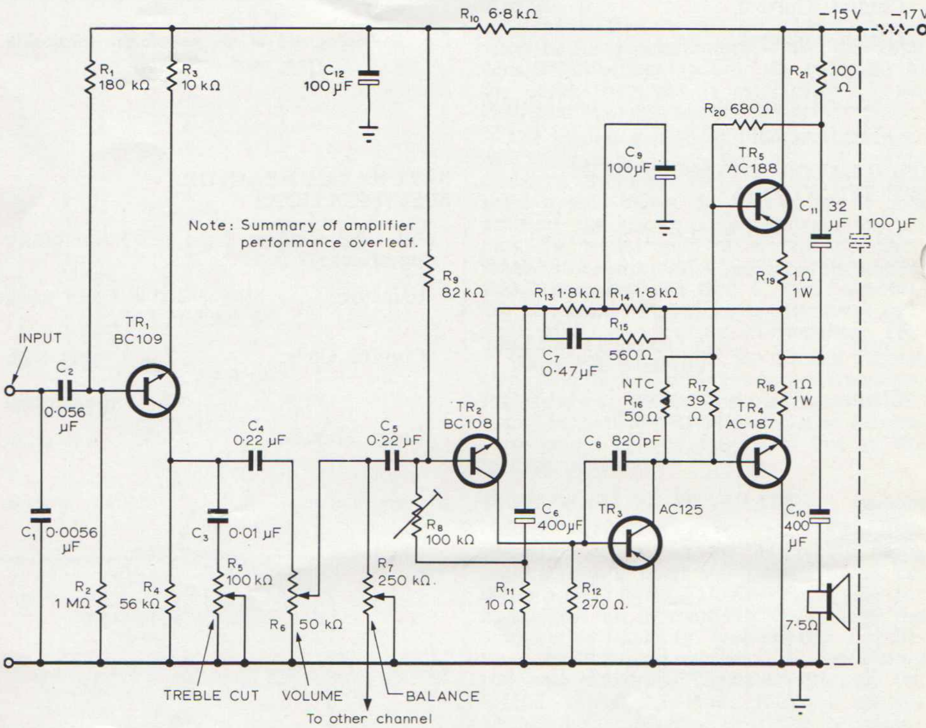


Fig. 1—Circuit diagram of the medium power amplifier.

LIST OF COMPONENTS

RESISTORS
All resistors 1/2W, 10% unless otherwise stated

Circuit Ref.	*Value*	*Description*
R_1	180 kΩ	
R_2	1 MΩ	
R_3	10 kΩ	
R_4	56 kΩ	
R_5	100 kΩ	1/2W lin.
R_6	50 kΩ	1/4W log.
R_7	250 kΩ	1/2W lin.
R_8	100 kΩ	1/4W lin.
R_9	82 kΩ	
R_{10}	6.8 kΩ	
R_{11}	10 Ω	
R_{12}	270 Ω	
R_{13}	1.8 kΩ	
R_{14}	1.8 kΩ	
R_{15}	560 Ω	
R_{16}	VA1034 N.T.C.	
R_{17}	39 Ω	
R_{18}	1.0 Ω	Wire wound
R_{19}	1.0 Ω	Wire wound
R_{20}	680 Ω	
R_{21}	100 Ω	

CAPACITORS
All capacitors in μF, 10% unless otherwise stated

Circuit Ref.	*Value*	*Description*	*Rating*
C_1	0.0056	Polyester	125V
C_2	0.056	Polyester	125V
C_3	0.01	Polyester	125V
C_4	0.22	Polyester	125V
C_5	0.22	Polyester	125V
C_6	400	Electrolytic	10VW
C_7	0.47	Polyester	125V
C_8	820pF	Polystyrene	125V
C_9	100	Electrolytic	10VW
C_{10}	400	Electrolytic	16VW
C_{11}	32	Electrolytic	16VW
C_{12}	100	Electrolytic	16VW

MULLARD TRANSISTORS

TR_1	BC109	TR_3	AC125
TR_2	BC108	TR_4	AC187
		TR_5	AC188

A Medium Power Amplifier

← page 22

It may be seen from the curve shown in Fig. 3 that the total harmonic distortion is less than 1% for a power output of 1W, 1.35% for 2W, rising to 10% at 3W, making the amplifier most suitable for medium power record players and in low

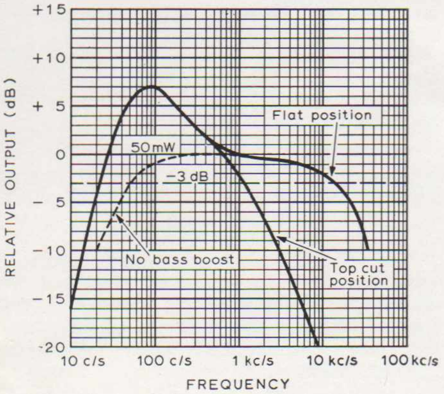


Fig. 2 Frequency response of the amplifier with the treble cut tone control in its extreme position as well as in the "flat" position.

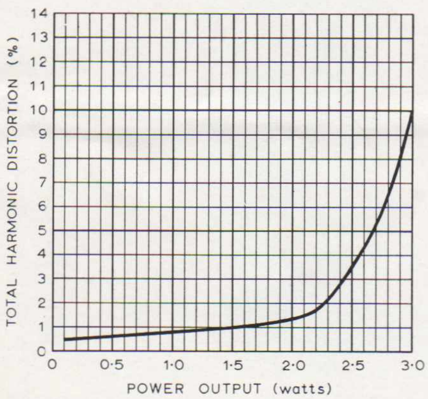


Fig. 3 Power output tabulated against total harmonic distortion.

cost solid state radiograms. It may be used either as a single channel amplifier or by duplicating the circuit as a transistor stereo amplifier using the small bookshelf enclosures described elsewhere in this issue. ■

Summary of Amplifier Performance

Power output at 10% distortion	3W
Power output before clipping	2.2W
Sensitivity for 2.5W output from 500pF source	60mV
3dB frequency response	25c/s-15kc/s
Power requirements for 3W output	15V at 350mA

It will be a month or two before the AC187 and AC188 are available through trade channels, in the meantime receivers and record players will appear equipped with these types.

R. E. BROWN
Applications Laboratory, Sydney

COMPLEMENTARY GERMANIUM MEDIUM POWER TRANSISTORS

AC187 — AC188

The AC187 and AC188 alloy junction transistors are intended for use in medium power complementary symmetry Class B output stages.

ABRIDGED PRELIMINARY DATA

			AC187	AC188	
V_{CBO}		max.	25	25	V
V_{CEO}		max.	15	15	V
I_{CM}		max.	2	2	A
P_{tot} at T_{case}	58°C	max.	0·8	0·8	W
h_{fe} at I_C	0·3A		100 to 500	100 to 500	—
f_{hfe}		>	10	7	kc/s

RATINGS (Limiting values)

Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

			AC187	AC188	
Thermal Resistance	R_{th} j-c		40	40	°C/W

Characteristics

Leakage currents

			AC187	AC188	
V_{CB} 10V; T_j = 25°C	I_{CBO}	<	25	15	μA
V_{CB} 10V; T_j = 90°C	I_{CBO}	<	2	1·1	mA
V_{CB} 25V; T_j = 25°C	I_{CBO}	<	0·1	0·2	mA
V_{CB} 25V; T_j = 90°C	I_{CBO}	<	2·5	1·4	mA
V_{EB} 10V; T_j = 25°C	I_{EBO}	<	0·1	0·2	mA
V_{EB} 10V; T_j = 90°C	I_{EBO}	<	2·5	1·4	mA

Knee Voltage

			AC187	AC188	
I_C = 1A (I_B: value for which I_C = 1·1A at V_{CE} = 1V)	V_{CEK}	<	0.8	0·6	V

Cut-off frequency

			AC187	AC188	
I_E = 10mA; V_{CB} = 2V	f_{hfe}	>	10	7	kc/s

Base-emitter voltage and DC current gain

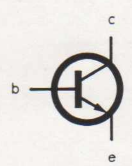
	AC187 V_{BE} (mV)	AC187 h_{fe}	AC188 V_{BE} (mV)	AC188 h_{fe}
I_E 5mA; V_{CB} = 10V	100 to 130	> 70	115 to 145	> 70
I_E 50mA; V_{CB} = 0	< 350	90 to 450	< 280	90 to 450
I_E 500mA; V_{CB} = 0	< 660	95 to 500	< 550	95 to 500
I_E 1 A; V_{CB} = 0	< 900	> 50	< 700	> 80

Outline and Dimensions

Conforming to J.E.D.E.C. TO-1

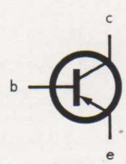
AC187

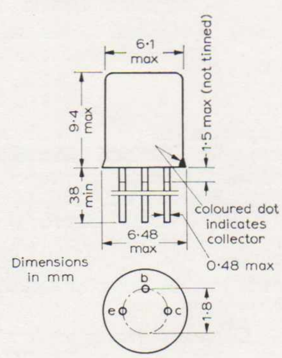
n-p-n



AC188

p-n-p



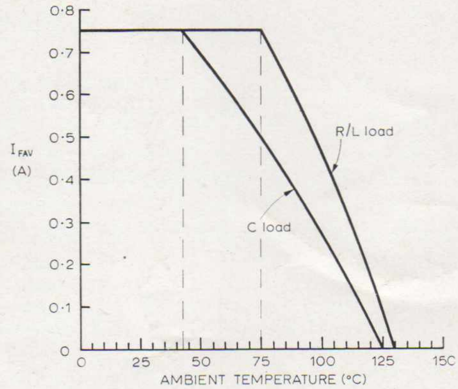


SILICON DIODE BY100 = 750mA

The BY100 was added some years ago to the preferred range of Mullard Silicon Diodes. It is one of the most widely used rectifiers in the comprehensive range of Mullard High Efficiency Silicon Double Diffused Junction Diodes.

Whilst this diode provides excellent performance technically, development proceeded and has resulted in an improved heat transfer from junction to case thereby making possible a current uprating (I_{FAV}) from 550mA to 750mA. The graph depicts the current derating for elevated ambient temperatures as well as for inductive and capacitive load when used in conventional rectifying circuits.

Maximum transient peak rating of 1250V makes the BY100 suitable for rectifier applications where 800V repetitive peak reverse voltages are normally encountered together with switching transient voltage spikes in 240V mains.



The current uprating is also applicable for OA650, OA660 and OA670 Silicon Diodes which are identical to the BY100 except for peak reverse voltages of 500, 600 and 700V respectively. ■

CHIEF ENGINEER OVERSEAS

Mr. H. S. Watson, Mullard - Australia Chief Engineer, will leave Sydney on the 17th of May, 1966 for overseas. He will visit our parent company in the U.K., also visit the Continent, United States and Canada. Mr. Watson expects to return mid-July. During his absence Mr. R. Donohoe will be acting on his behalf. ■

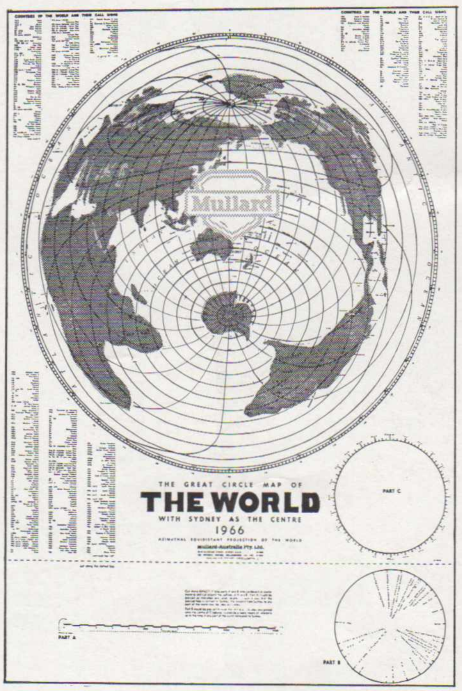
MAP OF THE WORLD CENTRED ON PERTH

Readers may be interested to know that the wide acceptance of the recently released Mullard Great Circle Map has already necessitated a second printing.

Whilst this chart has been centred on Sydney as a compromise for N.S.W., Southern Queensland, Victoria and South Australia, a separate chart has been compiled centred on Perth.

The map for our friends in Perth is printed in one colour only and identical to the original Great Circle Map of the World in multicoloured print. It also measures 2′ x 3′ and is an azimuthal equidistant projection of the World. A complete 1966 listing is provided tabulating approximately 400 countries together with their prefixes.

It is suggested that the Great Circle Map is mounted on to strawboard approximately 1/16″ thick. With certain types of strawboard, particularly the lighter variety, there is a tendency to warp and in order to counteract this, it is suggested that a sheet of neutral paper is applied to the other side.



This is a greatly reduced one colour facsimile centred on Sydney similar to the one centred on Perth as discussed.

PLEASE NOTE

The map centred on Perth is available only from the Mullard Distributors in Western Australia

Tedco Pty. Ltd.
579 Murray Street,
PERTH, W.A.

for $1.00 each plus $0.11 for packing in a cardboard mailing tube to avoid damage and $0.09 postage.

The original version, centred on Sydney, may be obtained from

Mullard-Australia Pty. Ltd.
35-43 Clarence Street,
SYDNEY, N.S.W.

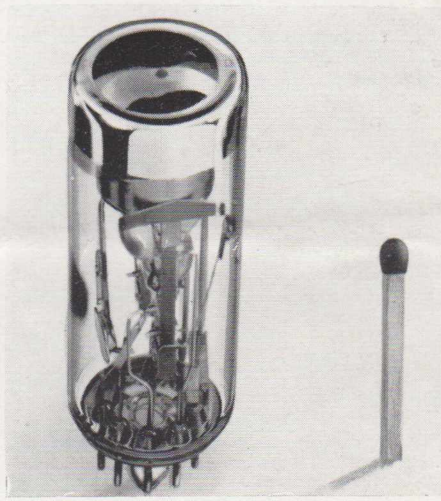
for $1.00 each plus $0.11 for packing in a cardboard mailing tube to avoid damage and $0.09 postage. ■

Cheques, money orders and postal notes should be made payable to "Mullard-Australia Pty. Ltd."

FOUR-STAGE PHOTOMULTIPLIER

TYPE XP1114

The XP1114 has an overall gain of 4mA/1m and a cathode sensitivity of 40μA/1m. Because of its small size and rugged construction it is particularly suitable for missile and space-vehicle instrumentation.



These features also make it especially useful in geophysical exploration where together with a sealed neutron generator a multiplier could be lowered down a bore hole to determine the nature of the strata.

The range of Mullard Photoelectric Devices is tabulated in Volume 4 of the Mullard Technical Handbook. ■

CURRENT LIMITING MODULE

The MY5051 current-limiting module has been designed to be used in conjunction with existing thyristor firing modules and stacks.

The MY5051 enables single-phase or three-phase control systems to provide automatic correction for load current variations or short circuit conditions as well as start facilities for motor controls.

When the module is connected in a feedback circuit between a current transformer (or another current sensing device) and a thyristor module, the onset of the current limit occurs when the input to the MY5051 is 2.6V r.m.s. At lower inputs the MY5051 has little effect on the control circuit, but at higher inputs the trigger angle of the thyristor is rapidly increased. ■

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