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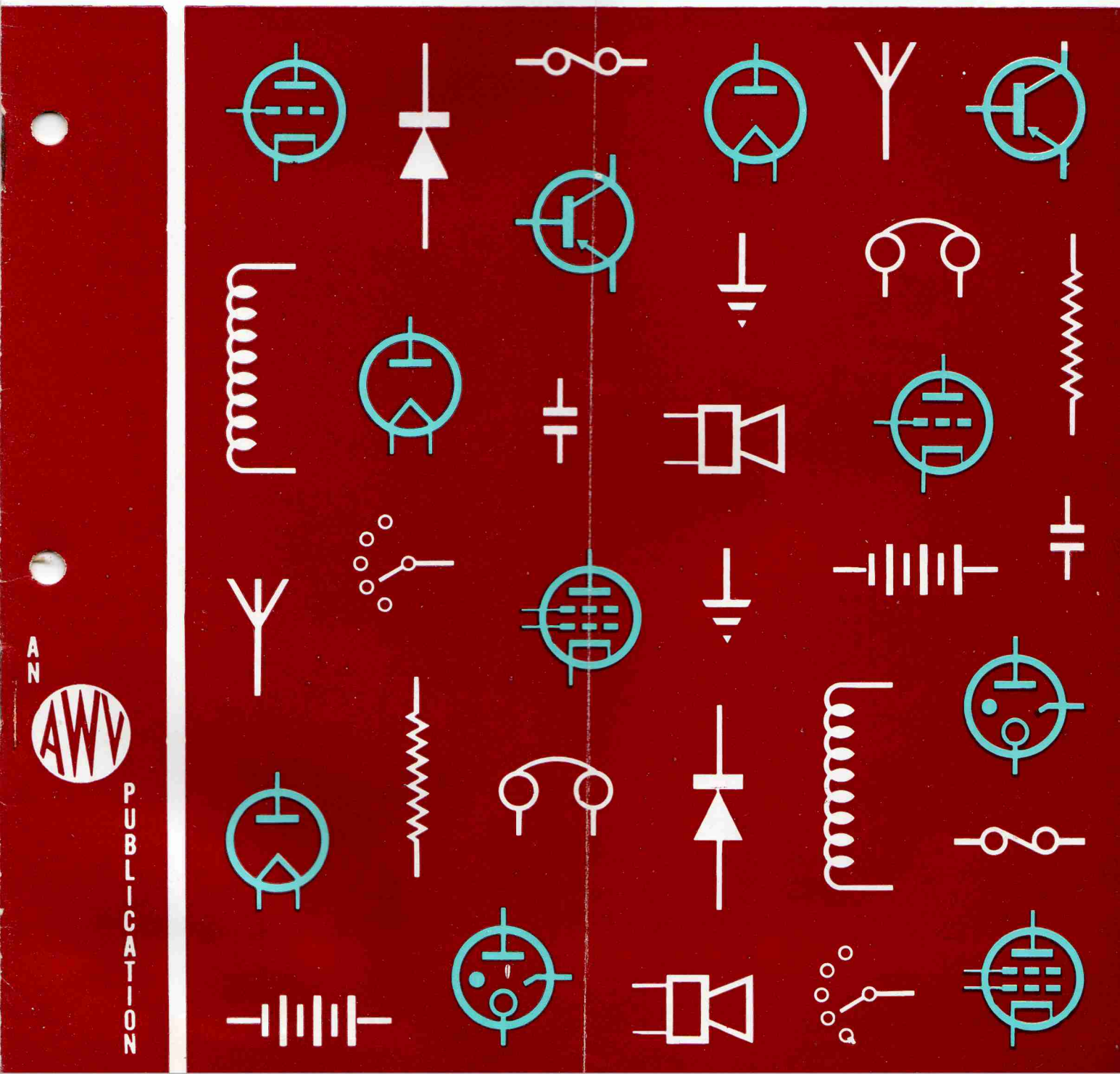

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RADIOTRONICS

Vol. 26, No. 10, 1961

Editor, Bernard J. Simpson

IN THIS ISSUE

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MEDIUM-FI STEREO

A Low-Cost Stereo System of Acceptable Quality

INTRODUCTION

In this issue of "Radiotronics" we are making history in a small way by presenting in these pages not only an amplifier design for home construction, but a complete home-music system for record reproduction. We hope at a later stage to present further such systems of varying complexity to suit different tastes. This first system in the series is intended to provide "acceptable" quality of reproduction at a very reasonable cost. It is not a hi-fi system as such, and is not intended to be. It will, however, within the limitations of cost, provide pleasant record reproduction. Furthermore, and provided the specified components are used, no difficulty should be experienced by the home builder in putting this unit together and getting it to work.

It would of course be possible to devote a complete article to the considerations leading to the formulation of the final prescription as presented here, but this would serve little purpose. It should however be mentioned that in this system cost of construction was treated as a big factor, and was kept to the minimum that would in the author's opinion provide acceptable quality of reproduction.

The final arrangement took the form of a single amplifier unit carrying two three-stage channels and the power supply complete with all controls; a changer or player using a crystal or ceramic cartridge, thus eliminating the need for a pre-amplifier; and a pair of small but high-performance speakers in low-volume vented enclosures. At a later stage we hope to present a simple radio tuner unit for use with this system.

A rough estimate of the cost of this complete system, but excluding cabinet work, is £60 to £65. It will be seen therefore that the requirement of low cost has been met. If you do your own carpentry you should build the set for £70 to £75, depending on finish. In many cases individuals will of course be able to better these figures.

THE AMPLIFIER

The amplifier itself is based on a well-known and well-tried circuit using a 6AU6 and a 6AQ5 in a resistance-capacitance coupled circuit. The basic design appeared in these pages some years ago when only monophonic reproduction was required, and turned out to be a good old friend to several readers who constructed it. So as a start we took two of these and put them on the same chassis. Unfortunately, in its original form, the amplifier needed about 350 millivolts to load up to full output, and this sensitivity of course is too low for a stereo pick-up.

To provide a little more gain, one half of a 6CG7 was used in each channel, resulting in a sensitivity of about 50 millivolts for 3 watts output. Approximately 18 db of negative feedback is employed in the final stages in each channel, from the voice coil to the cathode circuit of the 6AU6. Feedback is also used between the plate and grid of each 6AQ5 for reasons explained later.

The input to the amplifier is controlled by a simple three-pole, four-position switch; this allows four conditions to be set up, STEREO, STEREO REVERSED, MONOPHONIC, and RADIO. The first two positions are self explanatory, the MONO position parallels the two portions of the crystal pick-up cartridge and delivers the combined input to both channels, whilst the RADIO position connects the radio tuner input to both channels in parallel. Where only one channel is required for monophonic or radio reproduction, the unwanted channel can be faded out by rotating the balance control to one of its two extreme positions.

Controls

The GAIN and BALANCE controls require no explanation. There are two tone controls provided, one being labelled SLOPE and the other TOP CUT. On first listening tests, these two controls may appear to produce similar results. This is not so in fact, as a more extended testing will show. The SLOPE control forms part of the feedback network between the voice coil and the 6AU6 cathode. The TOP CUT control selects the degree of feedback between the plate and cathode of the 6AQ5 output valve.

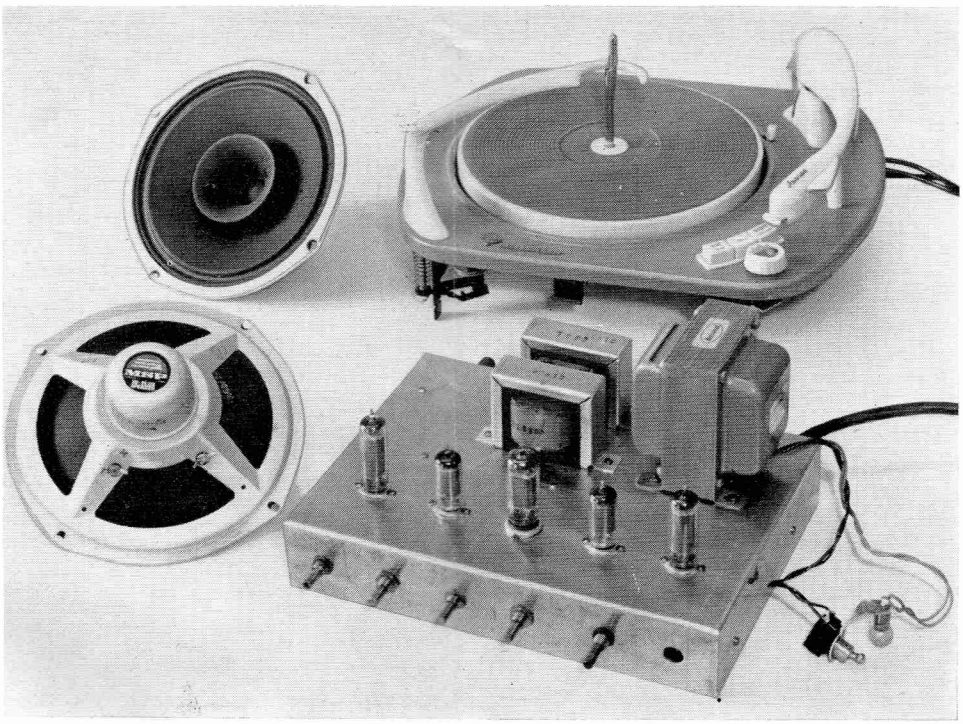
In a simple arrangement of this kind, and without feedback, the response of the amplifier will fall off at the low and high-frequency ends of the audio range. Substantially flat response would be achieved only over a small portion of this range, perhaps over 500 to 2500 cycles. The voice coil feedback of course flattens the response over the whole range and brings it within reasonable range of the ideal. A frequency-selective RC network is used in the feedback line to correct the characteristic.

In the SLOPE control, a slightly different approach is used which provides quite an effective control. In the bass position of the control. virtually the whole of the audio range passing the output transformer is fed back in the ratio determined by the circuit values. The presence of the capacitor in the feedback circuit means that a greater proportion of the higher frequencies is fed back than of the lower frequencies. This results in a reduction in gain over the higher portion of the audio spectrum and a treble-cut (bass) reproduction. In the flat or treble setting of the control, the amplifier characteristic is substantially flat, and this is achieved by by-passing the higher frequencies out of the feedback circuit, allowing the amplifier to operate at those frequencies with a lower degree of feedback, and consequently with higher gain.

The operation of the SLOPE control is shown in the diagram of the amplifier response, being drawn for approximately 50%, 25% and 12½% of rotation from the treble or flat end of the control. The reason for the naming of the control will be obvious, especially when compared with the operation of the TOP CUT control.

Playing Older Records

The main function of the TOP CUT control is to cut off the upper part of the frequency response at progressively lower frequencies. In the original design these frequencies were (at the —3 db points) 10 Kc, 7.5 Kc and 5 Kc. The 10 Kc or "flat" position of the control puts the response 8.5 db down at 15 Kc, with an increasing slope as the frequency increases above that figure. This is in the nature of a safety precaution. Frequencies above about 10 Kc or so contribute



The basic component parts of the system, consisting of the amplifier unit, Telefunken record changer type TW562 and two M.S.P. type 50081/8TAX/15 loudspeakers. This photograph also shows the above-chassis layout of the amplifier.

little in a system of this kind, and in fact form a potential danger to the general quality of reproduction. This device removes them entirely.

The other two positions of the TOP CUT control are intended to assist in the playing of the older or more badly worn records, where either the original recording quality or the subsequent wear would make the reproduction impossibly bad. This system does not provide as sharp a top cut as more complex methods, but seems to work very well. It is suggested that the 7.5 Kc position be used for 78's and worn 33's and 45's, and that the 5 Kc position be used for earlier 78's and all badly worn records. You may find that even some quite new records, apart from the top-quality lines, may sound better on the 7.5 Kc position.

The amplifier is shown here in a typical case to show what can be done if you decide to retain the idea of separate units for the system. A plan of the case is not provided as everyone will have his own ideas on the subject.

These may sound rather drastic frequency cuts in relation to the widely advertised frequency ranges of some amplifiers. You will find however, that even with a top-quality brand new record, the removal of the top register has remarkably little effect on the reproduced sound, except where such instruments as cymbals and finger bells are featured in the recording. So don't be dismayed by the figures, but trust your ear; after all, that's what you are using to listen with. If you have not used an amplifier of this kind before, and have a collection of records built up over the years, stand by for a shock when you first play some of them. The disadvantage of a slightly wider range system such as this is that imperfections or wear, which are not noticeable when the records are played on inferior equipment, obtrude strongly; the only cheap method of dealing with them is the top cut filter.

Power Supply

The high-tension power supply uses two 1N1763 silicon diodes in a full-wave voltage doubling arrangement, trading peak inverse voltage rating by making use of their high current rating. The cost of these two units is slightly higher than that of a valve rectifier, but the saving in valve holder and a simpler mains transformer is expected to more than offset this.

Performance

The bass response of the amplifier is lifted about 2.5 db over the 40 to 150 cycles portion of the characteristic. This difference is hardly noticeable, as far as the ear is concerned, but it helps the bass response along a little, remembering that we are trying to get bass out of small loudspeakers. The response of the speakers themselves is peaked over this region by the vented enclosure, combining to form the sort of characteristic that the majority of listeners find most pleasing. The response at 30 cycles is about 9db down to reduce rumble, always a problem with crystal and ceramic pick-ups.

In a system of this kind, built to a price, there is little to be produced in the way of impressive performance figures. The maximum output in each channel at 1,000 cycles is 3 watts for 5% total harmonic distortion. The amplifier therefore comfortably reaches the nominal 2.5 watts rating. Under normal listening conditions in a home, the average level is likely to be of the order of 100 to 250 milliwatts, at which levels the distortion will be correspondingly lower. If the amplifier is driven over the 3-watt level, the distortion increases considerably. Although it is not anticipated that the amplifier would ever be used in that region, the overload characteristic is smooth and shows no unusually objectionable effects.

The frequency response of the amplifier is more than adequate in relation to the rest of the system and the records that are likely to be used. The response curve shows what the unit does, the operation of the SLOPE control, and the effect of the three positions of the TOP CUT control. The top register response of the amplifier without the 10 Kc top cut is shown dotted for the purpose of comparison, although this region is of little interest.

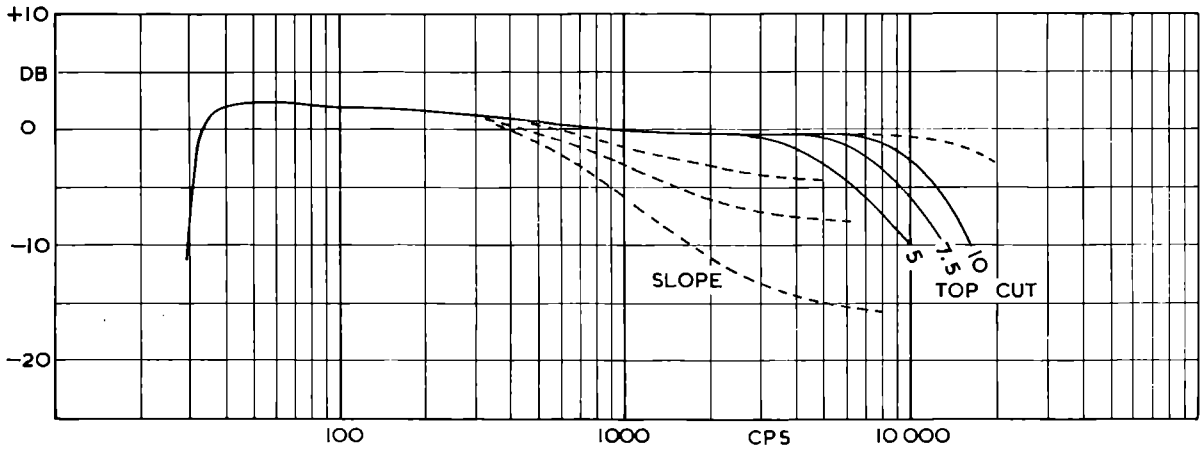
Listening tests have been carried out on this amplifier under actual home conditions over a period of time and using all types of material, ranging from some 78's originally issued over 30 years ago to brand new 33's. The assessment of performance under these conditions was good in relation to size and cost.

Construction

The output transformers for the amplifier are standard units of better-than-average quality, M.S.P. TX1 series, 5,000/15. These are readily available, but in case of difficulty contact M.S.P. direct at Box 2516, G.P.O., Sydney. These transformers perform very well, and there is no point with a system of this kind in having a specially wound job. The power transformer is of simple design, and although our sample was specially made up it is understood that similar units have since become standard stock items.

The chassis chosen for the amplifier is a standard 8" x 11" aluminium chassis, readily available anywhere. Aluminium was chosen because it is easy to work and requires no plating after drilling and cutting. This can be done with a comparatively low-gain amplifier where hum and noise are no great problem, and the extra screening provided by a steel chassis can be dispensed with.

The accompanying diagrams and photographs show the layout of the amplifier and the placement of components. Most of the smaller components are mounted on two tag strips, the



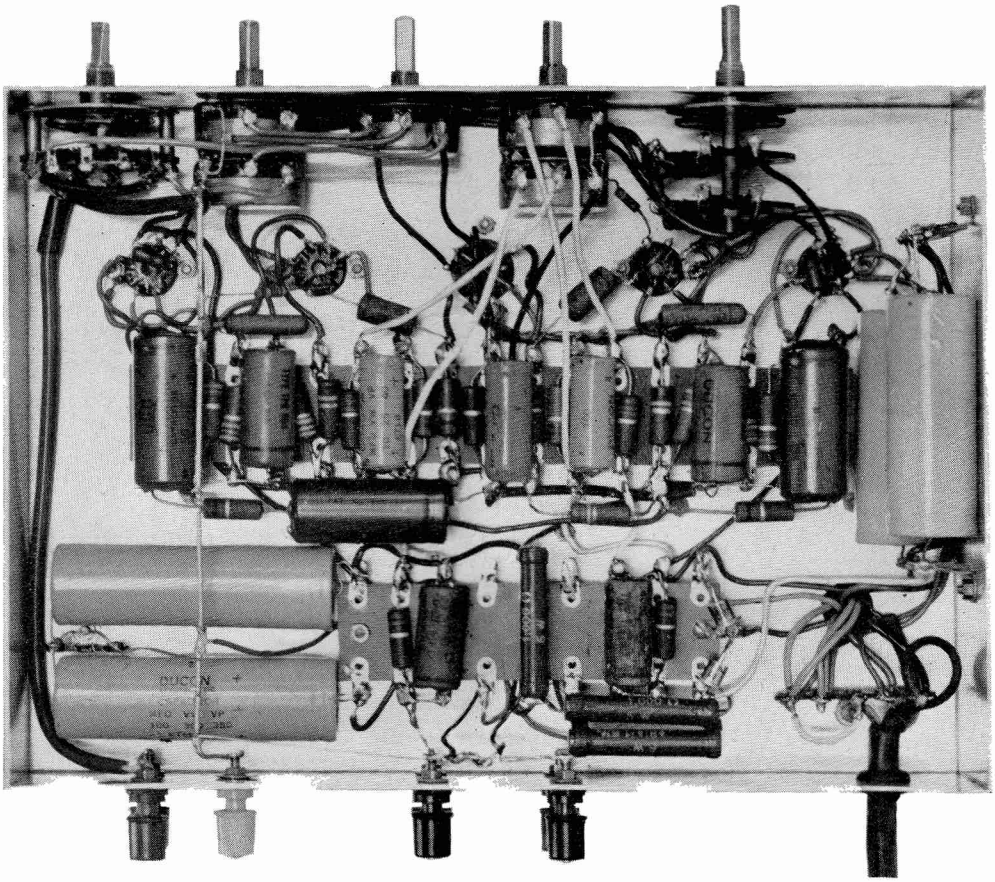
Response and performance curves of the amplifier unit. The operation of the SLOPE control is shown for about 50%, 25% and 12½% of rotation from the treble end of the control. The operation of the TOP CUT control is also shown. This diagram readily shows the function of the two tone controls.

In constructing this amplifier, you may find that you will have to wait a few days for some of the components, but they are all manufacturers' standard items appearing in current catalogues. The dual-ganged volume and tone controls may come in this category. Incidentally, some thought was given to using dual concentric controls in these positions to allow independent control in the two channels. The idea was discarded because of the possibility of getting some peculiar results with the differential adjustment of the controls in each channel; with a simple unit of this kind, ease of operation is a factor.

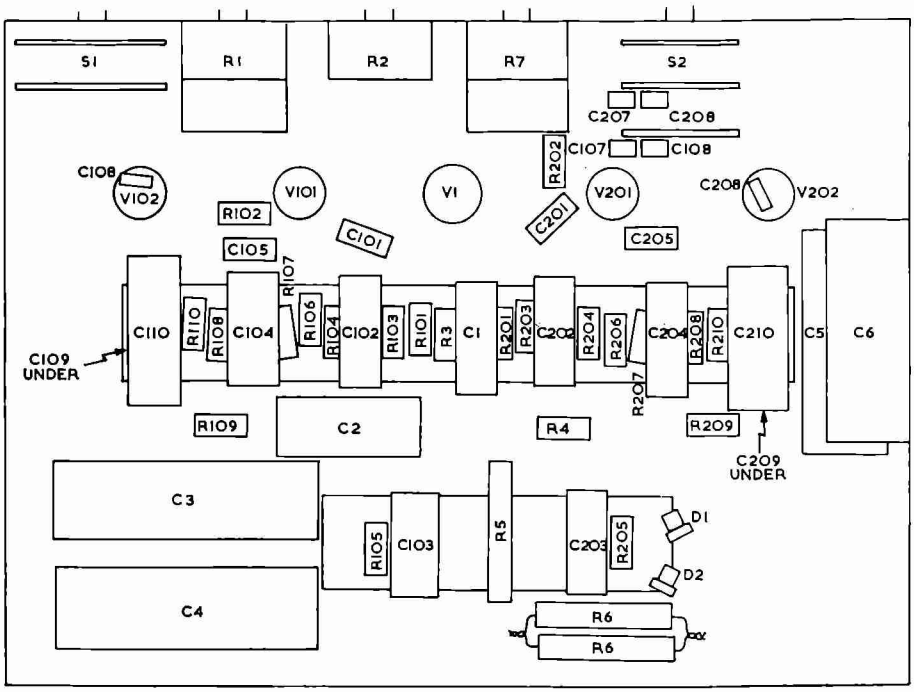
This unit has been put together especially for home constructors and even those with little or no experience should be able to make a job of it. The amplifier is very stable, in fact at no time during its development was instability encountered, which is a very good sign. Layout does not seem very important, although for the less experienced it would be advisable to adhere closely to the original, if only to save trouble. Make sure you use the parts and values specified.

main one having 17 pairs of tags and the smaller one nine pairs. In addition, three three-point tag brackets (centre tag earthy) and one five-point tag bracket (centre tag earthy) are used. The whole of the mechanical assembly can be completed before wiring the amplifier, with the exception of leads to the input (function selector) and top cut switches. In the case of these two switches, make all cross connections necessary on the switch, attach the necessary leads to wire up the switch and (in the case of the top cut switch) mount the four plate-to-grid feedback capacitors before mounting the switches in the chassis.

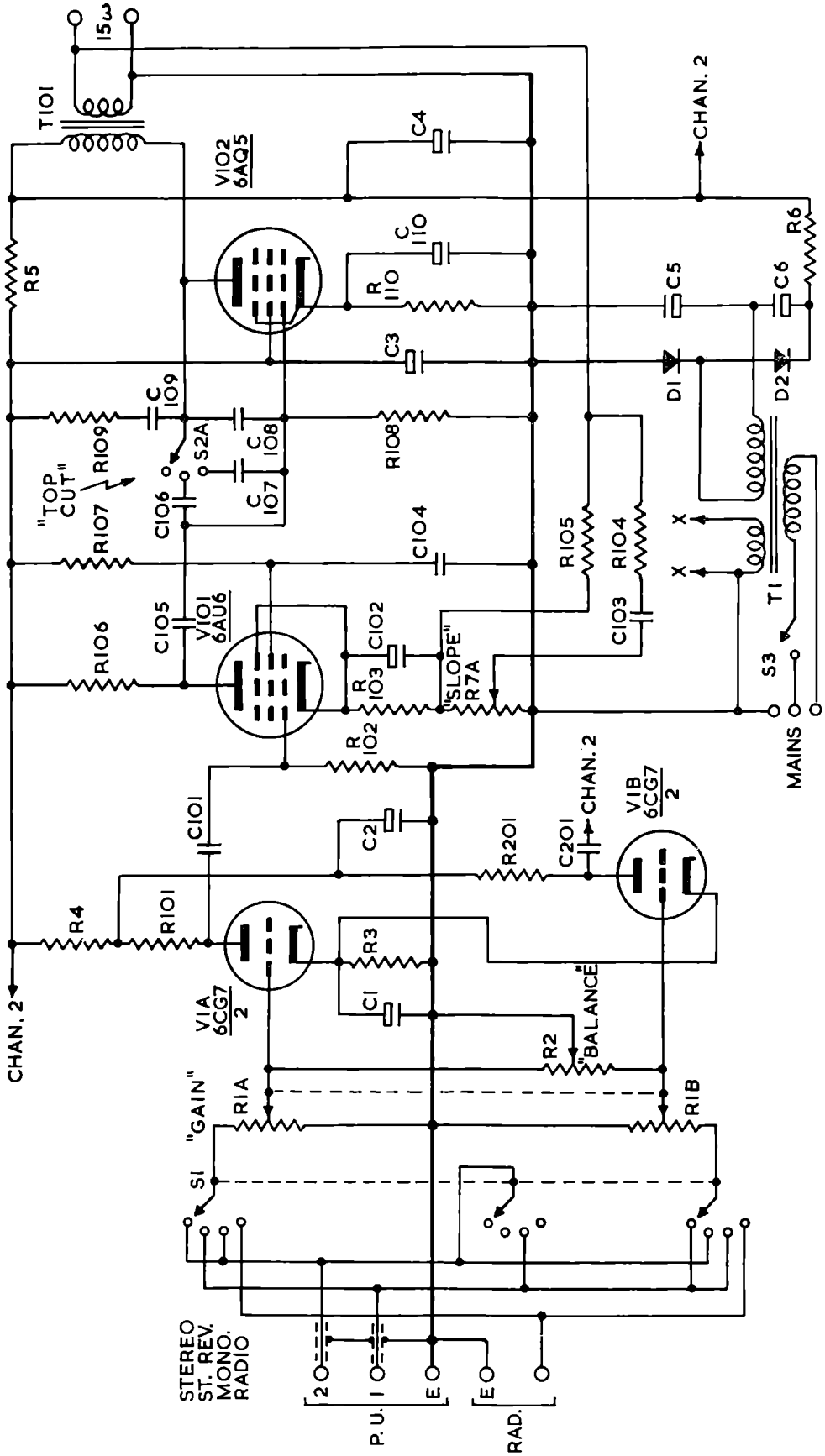
Make sure that the 1N1763 diodes are wired with correct polarity. To check the correct connection of the output transformer secondaries, a quick method is to remember that the correct connection reduces the amplifier gain. Removing the feedback should result in an increase in gain. Check this by shorting the top end of the appropriate section of the SLOPE control momentarily to ground; this should produce a considerable increase in gain and shows that the feedback is in fact negative.



An underside view of the chassis, showing the layout adopted for the model. Whilst the layout is not critical, adherence to the original will probably save time and trouble. For constructional purposes, refer also to the schematic diagram of the amplifier carrying the component identification code.



Component layout in the amplifier unit. It will be seen that most of the components are mounted on two tag boards, which could if required, be pre-assembled before being mounted into the chassis. This is however not necessary, and the model was completely wired up after the tag boards had been placed in position.



Circuit diagram of the amplifier unit. Only the one channel is shown, together with items common to both channels. Refer to the Parts List for the component coding scheme.

LOUDSPEAKERS

The choice of speakers was of course dictated primarily by good performance at reasonable cost, as explained in the preamble to this article. Other matters which had to be considered were the amount of space required by the speakers and their enclosures, and the cost of making the enclosures. This latter point may seem a trivial one, but with half-inch plywood at about 4/- per square foot, it was worth a thought.

The final choice fell upon a new extended-range type 50081/8TAX/15 eight-inch speaker recently introduced by M.S.P. This unit has a special hf cone attached to the main cone, extending the high-frequency range of the speaker appreciably. The M.S.P. Component Laboratory kindly assisted by producing a design for a small-volume vented enclosure for this speaker. the actual volume being a little under two cubic feet.

Enclosures

The enclosure box is of simple construction and unlike most such enclosures, no internal padding is required. The front face of the box is angled slightly, which not only improves the appearance, but helps to stop standing waves being set up in the enclosure. The final finish given to the enclosure is at the discretion of the builder. The unit could be affixed to a wall, mounted on short Swedish-style legs, placed on its side in a bookcase, or made to form an integral part of a larger cabinet housing the rest of the system.

No difficulty should be experienced in making up the box following the diagram supplied. If you are not very skilled in the carpentering art, the undercutting of the edges to provide neat joints is easily accomplished by marking off where the cut is to be made and then tacking a strip of wood along the mark; this strip of wood can then be used as a guide for a sharp tenon saw, which is used carefully to cut down through five of the seven plies. A sharp chisel is then used to remove the unwanted material. To assist those with no previous experience in making up such units, an assembly routine is given below, detailing the order in which the various parts should be fitted together. Note that screws are used instead of nails; nails or panel pins should never be used in work of this kind except for temporary fixing during assembly. All joints are also glued, the modern white resin glues being highly efficient and easier to use than the old-fashioned wood glues.

A further point about the box; you may want a box with a vertical front panel instead of the sloping panel, as for example where the enclosure is being built into a radiogram cabinet. In this case there is no reason why the design should not be modified to provide this, at the same time making the back panel sloping instead.

Assembling the Enclosures

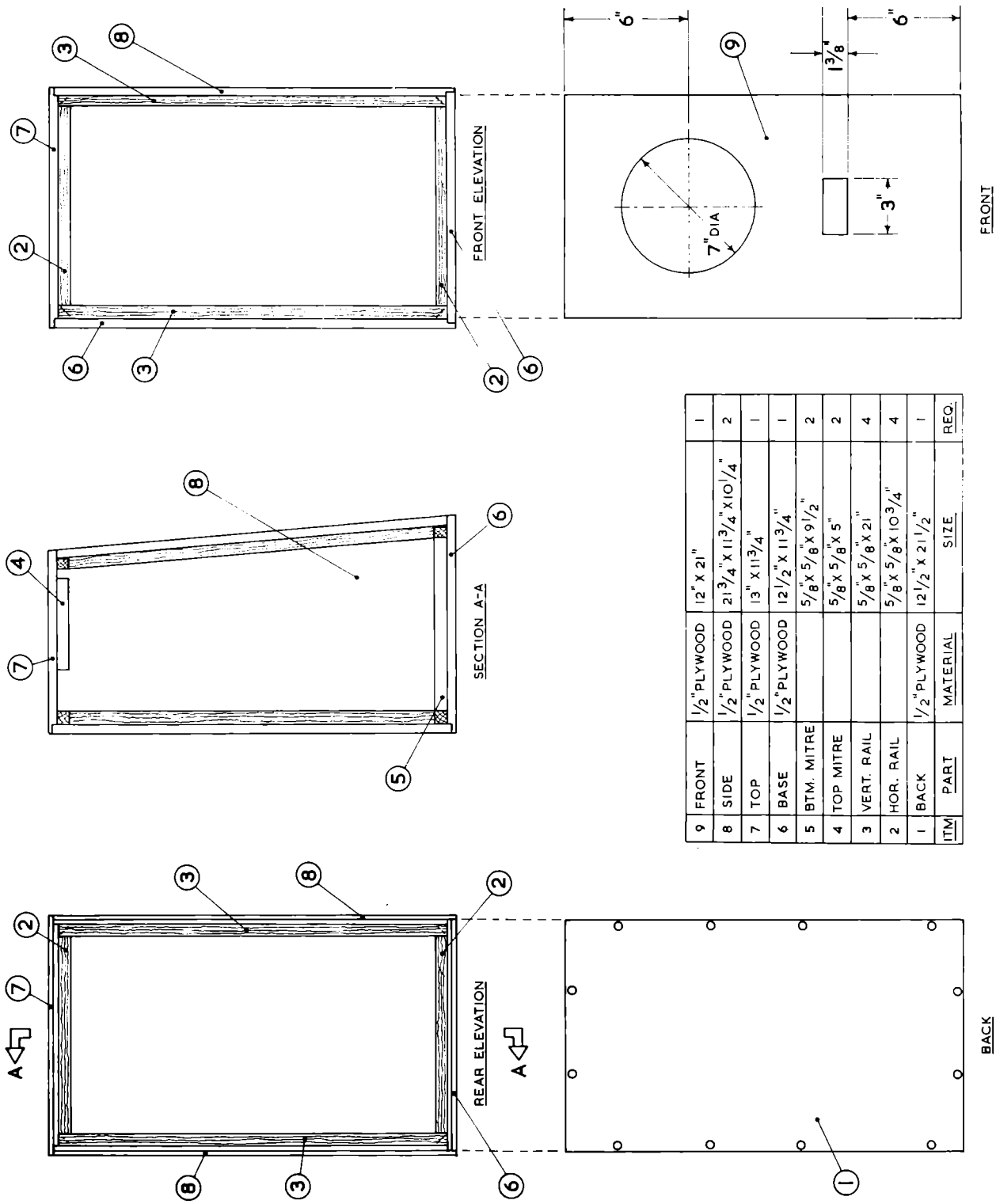
When all the necessary parts for the enclosures have been cut out and prepared, mark the four vertical rails for each box with the positions they are to occupy and then prepare the rails by drilling holes for the fixing screws. In the case of the two front rails, each rail will need four screws to hold the front panel, making eight screws in all. In the case of the two rear rails only four screws will be required initially, to fix the rails to the sides of the box. Then prepare the top and bottom horizontal rails in a similar manner, allowing three screws for each surface.

The first step in the actual assembly of a box is the correct identification of the two sides. Then glue and screw the front and back vertical rails to the inside surfaces of the two sides. These rails are the pieces to which the front and back panels will later be fixed. Make sure that the rails are so fixed that when the front and back panels are mounted on them the outer surfaces of the two panels will be flush with the outside of the box. This is easily achieved by using an off-cut piece of wood on edge as a gauge.

Now try the fit of the top and bottom panels of the box with the sides and mark the positions for the horizontal front and rear rails. The horizontal rails should now be glued and screwed to the inside surfaces of the top and bottom panels. Then assemble the two sides, top and bottom, to form the body of the box, making sure that the joints are well glued. A rope tourniquet around the outside of the partly assembled box will help to hold the whole thing together whilst the front panel is fixed and the glue hardens.

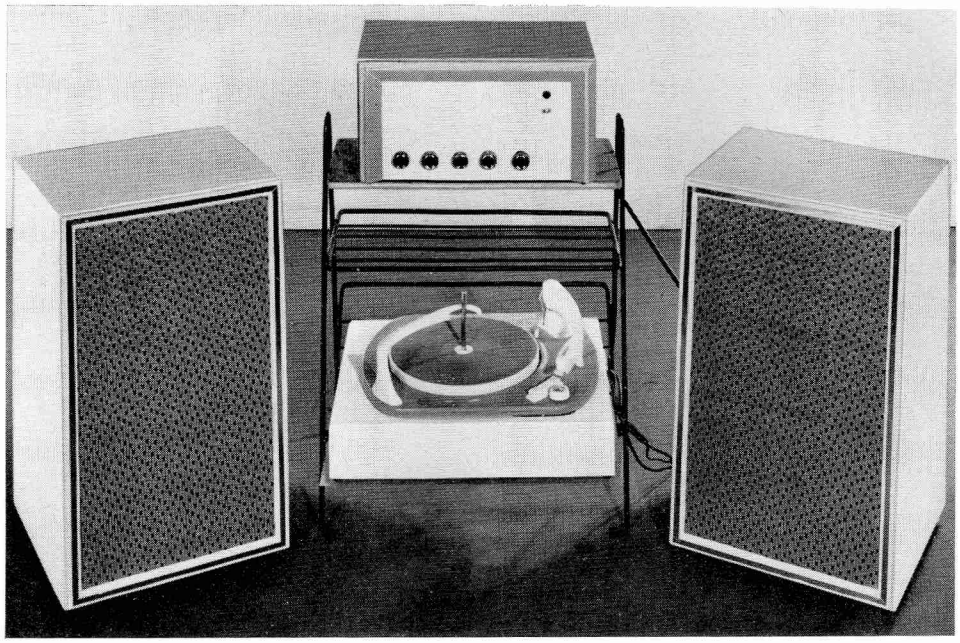
Now fit the front panel into the body of the box, gluing all the joints. Insert screws through the rails from the inside of the box into the rear of the front panel. You will now have quite a rigid assembly which may be put aside for the glue to dry. With modern resin glues drying is very quick and will be complete by the time you have got the other enclosure up to the same stage of assembly. The top and bottom mitre pieces may then be glued into place; they can be held in place by panel pins until the glue dries and of course the pins may remain in place afterwards.

The rear panel of the box may now be fitted. It is held in place by about a dozen screws. The final stage is to give the box a thorough sanding, finishing all the joints off flush with the outside of the box. The front of the box should be finished flush with the front panel.



ITM	PART	MATERIAL	SIZE	REQ.
9	FRONT	1/2" PLYWOOD	12" X 21"	1
8	SIDE	1/2" PLYWOOD	21 3/4" X 11 3/4" X 10 1/4"	2
7	TOP	1/2" PLYWOOD	13" X 11 3/4"	1
6	BASE	1/2" PLYWOOD	12 1/2" X 11 3/4"	1
5	BTM. MITRE		5/8" X 5/8" X 9 1/2"	2
4	TOP MITRE		5/8" X 5/8" X 5"	2
3	VERT. RAIL		5/8" X 5/8" X 21"	4
2	HOR. RAIL		5/8" X 5/8" X 10 3/4"	4
1	BACK	1/2" PLYWOOD	12 1/2" X 21 1/2"	1

Constructional diagram of the speaker enclosure. See text for hints on construction and assembly.



The completed system, showing the unitised approach which is so popular with this type of equipment today. The speaker enclosures were constructed in accordance with the data given in this article and the record changer is mounted in a simple type of playing desk. It is understood that playing desks or bases for the changer are available if required.

This completes the making of the box. The finishing is up to you, according to taste. At either the top or bottom of the box, where it will not be seen, fix a small two-way terminal block, running two wires through a small hole into the speaker. Fill the hole around the wires with plastic wood or some similar material. Just a word of warning about the final decoration of the front of the box. Before applying the grille cloth, the front face of the box must be completely blackened. This includes any screw heads and the light-coloured cardboard sealing ring around the edge of the loudspeaker cone.

This can best be done with a black wood dye, or in fact any really dark-coloured dye or stain, being careful not to get dye or solvent onto the cone of the speaker. The reason for this precaution in dyeing the front panel is that with the very open-weave cloths used for speakers today, the outline of the speaker and vent would otherwise be visible through the cloth and spoil the appearance of the unit. The grille cloth should preferably be one of the special plastic cloths produced for the purpose, although any material with a good open weave would do.

PICK-UP AND TURNTABLE

The type of turntable and pick-up used is of course at the discretion of the builder, but for the purpose of this system, in order to make it complete, we chose an imported Telefunken record changer type 562, which has a turnover crystal cartridge with sapphire styli, and is compatible for playing monophonic records. This is a good-quality unit with push-button control and four-speed operation. It is at the moment of going to press selling at the reduced list price of only 19 guineas, which is very good buying for this type of unit. A ceramic cartridge and/or diamond LP stylus are available as optional extras.

If you cannot obtain the 562, the 504 is available at the same price, and offers virtually the same facilities as the 562 except for the push-button control feature. In the 504 the required function is selected by means of a rotary switch. Make sure when buying these units that you obtain the correct mounting template for the motor board; if you do not have the template, it is very hard to work out where to cut holes for the unit. The templates for the two units are slightly different.

These two player units perform very well and the output cartridge has a more than adequate output for the amplifier. Full output is usually obtained with about a one-third setting of the gain control. These Telefunken units are marketed in Australia by M.S.P.

You may wonder why a record changer was chosen. The reason is rather anomalous in that one appears to be able to buy a reasonably good changer at a much lower price than one is asked to pay for a turntable and pick-up. The reason is probably that the changers are produced in quantities for radiogram manufacture and are therefore available at a correspondingly lower price. This of course is a case where another unit can be substituted if desired, provided it uses a crystal or ceramic cartridge. This amplifier does not have sufficient gain to operate from a magnetic or other low-level pick-up.

It is an inescapable fact that stereo poses problems of its own, particularly in relation to the turntable and pick-up. One of the biggest problems is centred around rumble, as it is called, and other mechanical noise in the turntable and its driving mechanism. These factors are not so important in monophonic systems, where the pick-up is required to respond only to lateral movement in the record groove. In the stereo system however, where the pick-up is also sensitive to vertical movement, the problem is more acute.

We have only to look around us to see that it is possible to pay quite a lot of money for a turntable that is claimed to be entirely noiseless. In any competitively priced item therefore, we are likely to be required to accept a compromise, and we aim at a unit with which the noise is so low as not to intrude during normal use of the equipment. By normal use I mean the use of the equipment to reproduce records in a living room, with the loud passages reaching the maximum level tolerable to the average listener. This is not a precise definition, but does convey the idea.

Under these conditions the unit chosen for this system is most satisfactory. No doubt there are other units which would also work well but there has been no opportunity to test them out thoroughly.

It has already been pointed out that the choice of a crystal or ceramic pick-up was dictated by cost considerations. It is unfortunate that this type of pick-up in general is more susceptible to noise troubles in the turntable. This was recognised and, as stated above, the units specified form an acceptable compromise.

The recommended load for the Ronette cartridge used in the Telefunken record changers is one megohm. The makers apparently call for no equalisation on this unit other than the provision of the required load. One very nice feature of these changers, incidentally, is the provision of muting switches which operate whilst the pick-up is being placed on and removed from the records and whilst it is at rest on its stand; this avoids all sorts of annoying crashes and clicks during the operation of the mechanism.

PARTS LIST

The component coding of this unit is divided into three branches, consisting of: (a) components which are common to both channels, designated by code numbers below 100, thus R1, C3; (b) components used in channel 1, designated by code numbers starting at 100, thus R101, C103; and (c) components used in channel 2, designated by code numbers starting at 200, thus R201, C203. Channels 1 and 2 use, of course, identical components.

S1—Switch, 4-pole, 4-way, M.S.P. AK19224.
S2—Switch, 3-pole, 3-way, M.S.P. AK19213.
S3—Switch, S.P.S.T., Cutler Hammer 8280K15.

D1—AWV 1N1763.
D2—AWV 1N1763.

V1—Super Radiotron 6CG7.
V101—Super Radiotron 6AU6.
V102—Super Radiotron 6AQ5.
V201—Super Radiotron 6AU6.
V202—Super Radiotron 6AQ5.

T1—Mains transformer, 240 V primary, HT secondary 120 V at 120 ma, heaters 6.3 V at 3.0 amps.
T101—Output transformer, M.S.P. TX1/5000/15.

R1—2 x 1M ohm, variable, log.
R2—1M ohm, variable, linear.
R3—2,200 ohms, 1 watt.
R4—330K ohms, 1 watt.
R5—1K ohms, 5 watt, wirewound.
R6—500 ohms, 10 watt, wirewound. (2 x 1K, 5 watt in parallel.)
R7—2 x 100 ohms, variable, linear.
R101—10K ohms, 1 watt.
R102—47K ohms, 0.25 watt.
R103—1,200 ohms, 1 watt.
R104—560 ohms, 0.25 watt.
R105—5,600 ohms, 0.25 watt.
R106—220K ohms, 1 watt.
R107—470K ohms, 1 watt.
R108—470K ohms, 0.25 watt.
R109—10K ohms, 0.5 watt.
R110—470 ohms, 1 watt.

C1—4 mfd., 12 VW, electrolytic.
C2—8 mfd., 350 VW, electrolytic.
C3—100 mfd., 300 VW, electrolytic.
C4—100 mfd., 300 VW, electrolytic.
C5—50 mfd., 350 VW, electrolytic.
C6—50 mfd., 350 VW, electrolytic.

C101—0.012 mfd., 400 VW, paper.
C102—10 mfd., 25 VW, electrolytic.
C103—0.068 mfd., 200 VW, paper.
C104—0.1 mfd., 400 VW, paper.
C105—0.012 mfd., 400 VW, paper.
C106—15 pf., 400 VW, ceramic.
C107—47 pf., 400 VW, ceramic.
C108—15 pf., 400 VW, ceramic.
C109—0.0018 mfd., 600 VW, paper.
C110—50 mfd., 50 VW, electrolytic.
C201-C210, R201-R210, T201 } As for C101-C110, R101-R110, T101, above.

SOLID TANTALUM CAPACITORS

The new capacitors mark RCA's entry into the semi-conductor "passive component" field, according to Dr. Alan Glover. Vice President and General Manager of the RCA Semiconductor & Materials Division. The capacitors are expected to find wide use in space vehicles as well as computers, data processing, communications and airborne equipment, he said.

Dr. Glover pointed out that the new capacitors, featuring a flat, rectangular case with parallel leads, are so designed that 24 can be mounted on a printed circuit board in an area the size of a postage stamp.

"Until now capacitors have not kept pace with the steadily diminishing size of associated components. Consequently, they have often been a limiting factor in the overall size reduction of complete electronic systems using them. RCA will offer electronics manufacturers a dramatic answer to this problem — one that will provide them with a solid tantalum capacitor matching the size, performance and reliability of such active components as transistors and semiconductor rectifiers," he stated.

Robert E. Koehler. Manager of the Divisions' Micro-electronics Department at Somerville, N.J., where the capacitors have been developed, said the higher-rated new capacitors have twice the capacitance-voltage capability per unit of volume and the weight is one-half to one-sixteenth that of comparable units currently on the market.

Higher performance levels for electronic circuits within presently established space limitation were foreseen today through the use of miniature solid tantalum capacitors just developed by the Radio Corporation of America.

NEW RCA OSCILLATOR FOR AIR-TRAFFIC TRANSPONDERS

A new low-cost oscillator for air-traffic-control transponders has been reported by engineers of the RCA Electron Tube Division. Speaking in New York before the American Institute of Electrical Engineers, P. W. Gipslis outlined the design features and performance characteristics of an economical 1090-megacycle cavity oscillator. This frequency is in the L-Band, recently selected by the U.S. Federal Aviation Agency for air traffic usage.

Mr. Gipslis said the developmental oscillator is an integral pencil tube-and-cavity similar in design to the cavity oscillator now in use in radiosonde systems. It weighs less than 1.5 ounces and excluding leads, tuning screws, and rf connector measures approximately $3\frac{1}{2}$ inches in length by $\frac{7}{8}$ inches in diameter. Power drain for both heater and plate is less than 5 watts in typical applications.

Extensive test results, the engineer stated, have demonstrated that this light-weight economical oscillator meets, with considerable safety margin, all of the transponder application requirements. Mr. Gipslis described the plate power efficiency that can be expected from the pencil tube at L- and lower S-Band frequencies in plate-pulsed service. At 1100 megacycles, he said, an efficiency of approximately 40 per cent has been obtained in an optimized adjustable test cavity. The maximum peak power output at this frequency is approximately 1.35 kilowatts.

In the design of the L-Band oscillator, an inductive feedback is employed similar to that successfully developed for RCA radiosonde pencil tube-and-cavity units. The grid disc of the pencil tube is supported within the cavity by means of a special grid disc clip. The open spaces around this clip form an inductive feedback path. In addition, feedback probes are used for fine feedback control. This design permits the feedback circuit to be properly optimized for each particular frequency in the L-Band.

Additional features of the oscillator assembly include a temperature-sensitive frequency compensator, adjustable power probe for varying the output coupling, a frequency-adjustment screw, and all-mica insulation for high-voltage breakdown resistance and best dielectric properties. The entire unit is compact in size yet does not require special cooling in operation because of the low power drain and low dissipations of the pencil tube.

NEW RELEASES

CX1140, FX297

EEV announces the introduction of two new hydrogen thyratrons, CX1140 and FX297, for applications in radar transmitters, linear accelerators and other pulse switching equipments. The CX1140 is designed for use as a pulse modulator switch and the FX297 as an inverse diode. Both valves have a new design of hydrogen reservoir, which is electrically in series with the heater and which enables the correct hydrogen pressure to be maintained. With this system an auxiliary controlled reservoir supply is, therefore, not required, and a considerable increase in the operating life of the thyratrons is achieved. The other characteristics are in no way inferior to the earlier range of non-reservoir tubes.

N1044

EEV announces the introduction of a 400 Mc quadrupole amplifier ("Adler tube") for use in applications where a very low noise figure is a necessity. The tube is packaged with a focusing solenoid and may be supplied complete with an associated power supply unit if required. With the addition of the new tube, the English Electric range of quadrupole amplifiers now comprises the N1036 for operation in the 200 Mc region, the N1037 600 Mc tube and the N1044.

The N1044 is a transverse field device in which an electron beam interacts with an rf field transverse to the normal path of the beam. Under large input signal conditions, the tube is cut off, and this affords complete protection to any following stages. Circuit paralysis or recovery time is extremely short, following the application of an excessive input signal overload.

A gain of 20 db is available with a bandwidth. to 3 db gain points, of 50 Mc. The noise figure is less than 2 db over a bandwidth of at least 25 Mc and the tube has a saturation output power of 50 μw. The centre frequency of the N1044 is 408 Mc and the tube operates with a magnetic focusing field of 147 Gauss.

6GK5

The 6GK5 is a high-mu triode of the seven-pin miniature type. It is particularly for use as a grounded-cathode rf-amplifier in vhf tuners of TV receivers. The 6GK5 utilises a frame-grid construction, which makes it possible to achieve the very high transconductance of 15,000 micromhos at relatively low plate voltage and a large gain band-width product. The 6GK5 has a variable-mu characteristic which permits substantial reduction of intermodulation distortion.

6GN8

The 6GN8 is a high-mu triode with sharp cutoff pentode of the nine-pin miniature type. It is especially useful in video-output-amplifier, sync-separator, sync-clipper, phase inverter and sound-if-amplifier stages of TV receivers. The pentode unit has a transconductance of 11,500 micromhos, plate-dissipation rating of 5 watts and a controlled knee-current characteristic. These features facilitate the design of video-output-amplifier stages capable of providing excellent picture quality. The triode units of both types have a high amplification factor of 100.

5820-A

This new camera tube in terms of quality, versatility and dependability, supersedes its prototype the 5820 and promises to become the new "standard" image orthicon for black-and-white studio or outdoor pickup. The 5820-A has improved assurance levels in such characteristics as signal-to-noise ratio, resolution, sensitivity, uniformity of sensitivity and uniformity of background. The sensitivity of the 5820-A is equivalent to photographic film having an ASA exposure index of 8,000.

7587

This new member of the celebrated nuvistor family in combination with its companion medium-mu and high-mu industrial triodes (7586 and 7895) gives the equipment designer vastly expanded flexibility in the design of equipment for critical industrial and military applications where extreme compactness and very high packaging densities are essential requirements. The 7587 is one third the size of conventional miniature pentodes and consumes substantially less heater power. The 7587 sharp-cutoff tetrode embodies all the well-known advantages of the nuvistor design.

7868

The 7868 is a Novar high-perveance power pentode designed especially for use in the output stages of high-fidelity audio amplifiers, phono-

graphs and radio receivers. In push-pull class AB_1 af power-amplifier service, two 7868's can deliver a maximum-signal power output of 44 watts (5% total harmonic distortion) with a dc grid-No. 1 voltage of —21 volts, plate voltage of 450 volts and peak af grid-No. 1-to-grid-No. 1 driving voltage of only 42 volts.

8051

The 8051 is a new $1\frac{1}{2}$" high resolution vidicon camera tube. The outstanding feature of this new tube is its resolution capability of 1,200 TV lines, a figure unmatched by any other vidicon presently in the field. This new tube is designed for broadcast film pickup in either black-and-white or colour cameras, for data transmission and for other high-definition closed-circuit TV applications.

8054

The 8054 is a three-inch, 10-stage head-on type multiplier phototube specially designed for scintillation counting. Ratings and performance characteristics of the 8054 are specifically measured with a light source having a spectral distribution closely matching that of typical scintillators. Design features include a semi-transparent photocathode having a minimum useful diameter of 2.59 inches, a first dynode having large area, a flat window to facilitate the mounting of flat phosphor crystals and 10 dynode (secondary emitter) stages. The 8054 has a median radiant sensitivity of 1.5×10^4 amperes per watt at 4,400 angstroms (approximately 20 amperes per lumen) when operated at a supply voltage of 1,500 volts. The median equivalent anode dark current input of the 8054 is 5.5×10^{-13} watt at 4,400 angstroms (approximately 4.4×10^{-10} lumen) at a sensitivity of 7,200 amperes per watt. The S-11 spectral response of the 8054 covers the range from about 3,000 to 6,500 angstroms. Maximum response occurs in the blue region at approximately 4,400 angstroms.

5762-A

The 5762-A is a new forced-air-cooled power triode for vhf service in television and CW applications. The 5762-A is unilaterally interchangeable with the 5762/7C24, having improved qualities for FM applications and increased ratings. It has a maximum plate dissipation of four kilowatts and is rated for operation up to 220 Mc. In broad-band TV service at 216 Mc, the 5762-A can deliver a synchronising level power output of 6.35 kilowatts when supplied by a driving power of 0.96 kilowatts.

2N2015, 2N2016

The 2N2015 and 2N2016 are two new silicon n-p-n power transistors providing extremely low saturation resistance and power dissipation up to 150 watts and designed for operation at case temperatures ranging from —65° C to +200° C. These new high-temperature silicon transistors now offer circuit designers a replacement for germanium transistors of comparable power ratings. The 2N2015 and 2N2016 feature the very low saturation resistance of 0.25 ohm maximum, a minimum h_{FE} of 7.5 at $I_C=10$ amperes, collector-to-base voltage ratings up to 130 volts and the very low thermal resistance (junction-to-case) of 1.17° C/watt maximum.

2N404-A

The 2N404-A is a germanium p-n-p alloy-junction transistor for switching applications in military and industrial data-processing equipment. The 2N404-A has all the features of the popular 2N404 plus the following increased ratings for use in applications requiring such high ratings:

- Collector-to-base voltage rating, 40 volts.
- Collector-to-emitter voltage rating, —35 volts.
- Emitter-to-base voltage rating, —25 volts.
- Collector-current rating, —150 ma.
- Emitter-current rating, —150 ma.

SUBSCRIPTION RENEWALS

At the request of readers, we are reverting this year to our old method of calling for subscription renewals, by inserting a subscription form in this copy of the magazine. If your subscription expires this December, your renewal is due now — the closing date for renewal applications is December 1st.

If you are not sure whether your subscription for 1962 has already been paid, a self-addressed stamped envelope will make sure. Remember, the responsibility for renewal is yours, so don't be disappointed.

If your subscription is not due for renewal, why not tear out the subscription form and hand it to a friend?

COMPUTERS

Do you own a computer? I do. It is a computer of the analogue type, admittedly not electronic, but basically the same in the methods used. Furthermore, my four-year-old son also owns a computer, but of a different type. His computer is a digital type, also non-electronic, but embodying the essentials of the digital computer. Let me hasten to explain that I own a slide rule and my son has an abacus.

This is, perhaps, a light-hearted way to talk on the subject of computers, but it does very quickly remove the fear of the unknown and put their operating methods into perspective. The abacus was reputedly invented by the Chinese untold centuries ago. The slide rule was a direct result of the invention of logarithms by John Napier at the beginning of the 17th Century. Mr. Napier had a hand, also, in digital computers, because he invented a system of numbered rods of different length, which formed an elementary device for adding and subtracting. I believe a similar device is used in some schools today.

Before going further, it will be wise to find out just what are the basic differences between the two types of computer. After all, they both calculate, and the fact that the modern, high-capacity machine is built around electronic circuits instead of wheels and cams and levers is really immaterial.

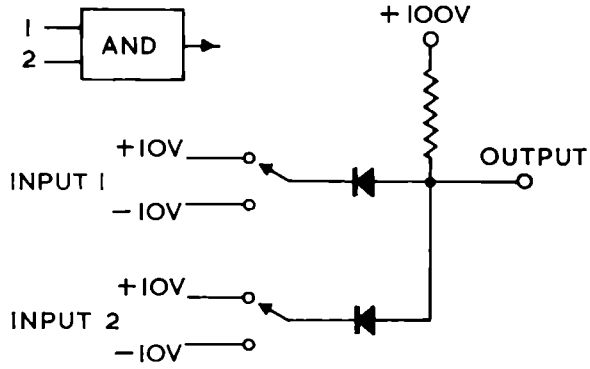
The word "analogue" provides us with an in-built clue, being so nearly related to the more familiar word "analogous," meaning "similar or parallel to." The root of the word consists of two Greek words, which conjointly mean "up to, proportion," and it is the word "proportion" that is the operative word in this case. The analogue computer represents numbers by something else, something analogous, which can be length along a scale, voltage, angle of rotation, magnetic flux, current, or any property, the magnitude of which can be used to represent a number. This is done in the slide rule, where distance along a scale represents the logarithm of the number. Since adding the logarithms of two numbers gives the logarithm of the product of multiplying the two numbers, multiplication and division is carried out simply by adding or subtracting lengths on the scale.

The digital computer, on the other hand, hands discrete numbers, in the form of digits. Admittedly, the numbers are re-arranged into a binary system to simplify the procedure, but the basic operation is still one of simple arithmetic. The scales of the analogue computer are, in effect, continuously variable, so that an analogue computer should be able to produce an analogy for a quantity that cannot be expressed as a finite number, e.g., $33\frac{1}{3}\%$. The digital computer, however, would see this as 33.3333333, etc., and, however many extra circuits were provided, could never represent the quantity accurately.

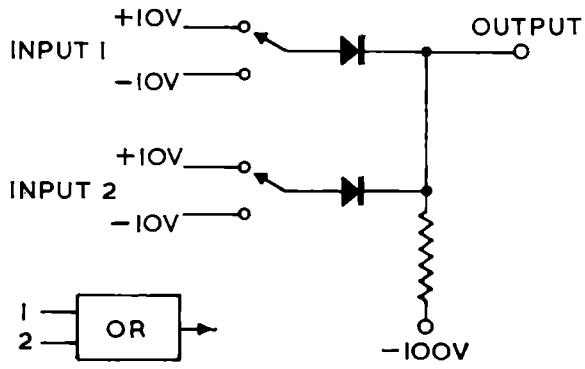
This may seem to indicate that the analogue computer will be the more accurate of the two types, but this is, in fact, not so. Consider the problem of adjusting a potentiometer, with a potential of 10 volts applied across the outer terminals, in such a way that the voltage between one end and the slider represents pi, i.e., 3.1416, etc. By the time we got down to the third significant decimal figure we would have a major problem on our hands, especially when we consider that this operation may have to be carried out hundreds of times an hour in an actual computer.

With a digital computer, however, although only discrete numbers can be handled, we have to remember that the machine is actually made up of a number of units, each of which represents a series of numbers to a specified power. By providing the necessary number of units, we can arrange the digital computer so that it will handle decimal figures down to any power we choose. Such a machine, therefore, could not only handle the number specified with a greater accuracy, but could accommodate as many more decimal figures as we care to provide for.

In a short note of this kind it is not possible to delve into the types of circuit used in the two types of electronic computer. Several full-length



A simple form of an AND circuit. Both inputs must be +10 volts to raise the output from −10 volts to +10 volts.



A simple form of an OR circuit. The output will rise from −10 volts to +10 volts when either input is taken to +10 volts.

articles would be required to do this. We have so far discovered that there ARE two types and also what is the basic principle of operation of each of them. These machines are very similar to an automatic telephone exchange, portions of which are, in fact, a digital computer. Although the complex of apparatus is very large, we find on closer inspection that considerable portions of the installation do, in fact, consist of a comparatively small and simple piece of apparatus, which is repeated hundreds or thousands of times.

It is the same with computers. Certain basic circuits which handle a small function are built up one on the other until the result is a complex machine of the size, speed and capacity required. Two such common circuits are the AND and OR circuits. The functions of these two simple little circuits are very elementary. The AND circuit has two or more inputs, but provides an output only when the input signals are coincident. The OR circuit on the other hand, with two or more input signals, provides an output when ONE OR MORE input signals are present. A little reflection will show the simple movements in arithmetic which can be reproduced in these circuits.

There is, of course, more than this. In addition to the operations of arithmetic, some storage capacity is usually provided in a computer, if only to hold partial results until they are wanted in a later stage of the computation. In the same way, unless we have prodigious memories, we need a pencil and paper when using our slide rule with several multiplications and divisions interspersed with additions or subtractions.

Other apparatus is also required to make the computer a really functional unit. Information has to be fed into these machines in a form which they can handle, which calls for programming of the input. Programming, besides making the material acceptable to the computer, also instructs the machine as to the functions to be carried out. It follows from all this that some type of read-out of the results is also required. In the simplest units, of course, this may merely take the form of a dial or counter from which the result can be read directly. In more complex operations, the results are presented by the machine in a form which requires "de-coding" and intelligent analysis.

In computer operation it is usual to apply checks on the accurate operation of the machine at various stages in the computation. These checks are many and varied but a simple example will serve as an illustration. In a digital computer, one type of check is to feed the data through the machine shifted by one or more decimal place. The result is then compared with the computation proper and would show up any simple arithmetic malfunction. Other types of check are, of course, considerably more involved.

The advent of the electronic computer has opened up a completely new field of endeavour and introduced a new branch of technical language or jargon if you prefer. All this is very exciting, especially when viewed in the light of the immense benefits that will accrue in the future.

B.J.S.

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AWV