RADIO TELEVISION AND HOBBIES

2/6

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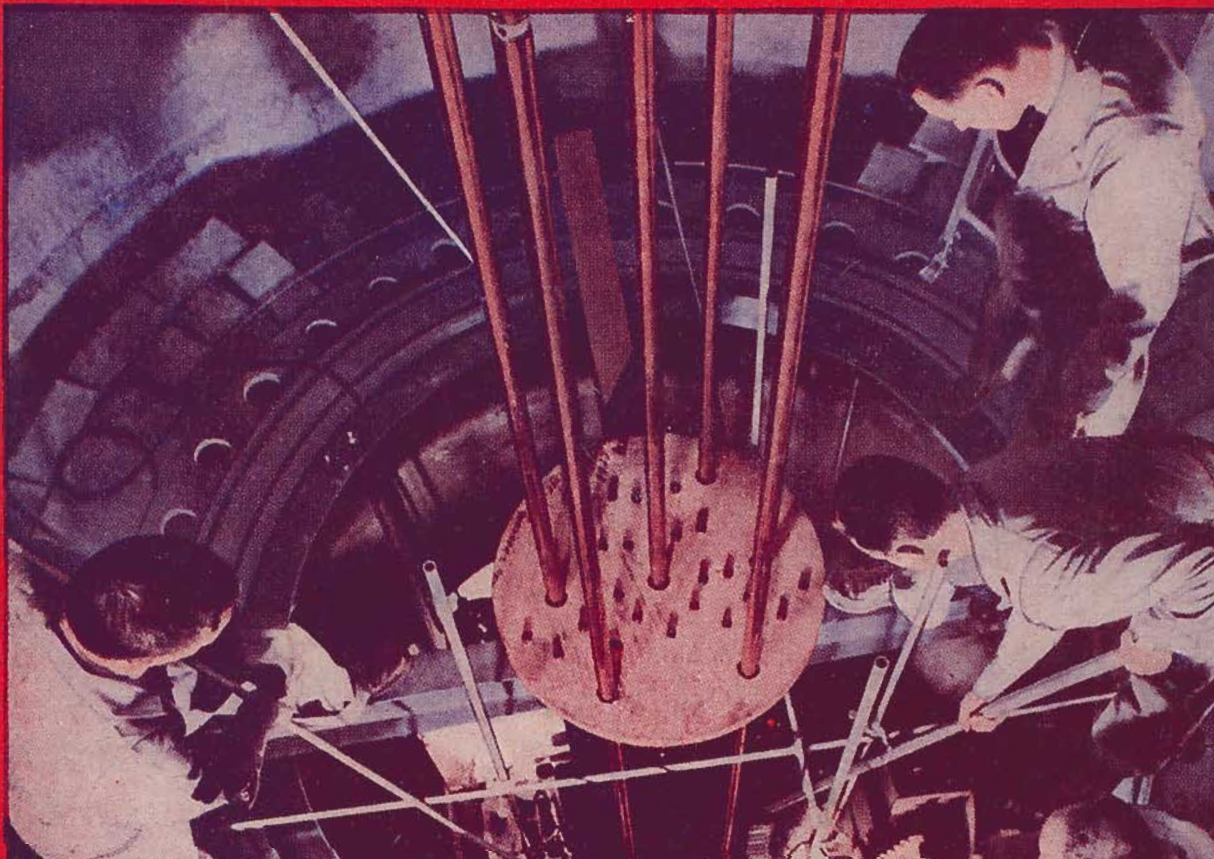

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EDITORIAL

AS the date for large-scale release of stereo records draws nearer, interest overseas is stepping up almost to fever heat in the record world.

The recent Audio Fair held in London saw desperate efforts by all interested manufacturers to show something allied to stereo.

In America, publicity is mounting in much the same way as it did when the LP record was first introduced. Articles are appearing in topical magazines, not primarily interested in such matters, explaining to all and sundry what stereo is and how it works. Most of these are authentic and quite extensive.

About September of this year I expect the silence of the big firms to be broken with their first overseas releases, and I equally expect them to be very good. Before the end of the year, such records, and some equipment to play them, should be available in Australia. After that I expect interest and development to proceed very rapidly.

I feel fairly certain of this for a reason I have mentioned in earlier issues. The impact of TV, despite all the hopeful thinking and best efforts in the world, is being felt throughout the entire entertainment field, which includes both records and radio.

It is significant that, co-incident with the rise of stereo records, comes announcement of practical schemes for stereo broadcasting.

Experiments with stereo methods for radio are now being conducted in various parts of the world. These include not only the use of separate channels for AM and FM, but a system of multiplexing on FM which allows two channels to be radiated from a single station.

This method has something in common with one already projected for records, but which has been suspended by its sponsors through a desire not to confuse the present stereo program, which is world wide, and because its difficulties might be too many to overcome its advantages.

Stereo increases the dimensions in listening which at the moment TV cannot match visually, and the industry expects it to revitalise the world of sound.

Its importance is even greater when we realise that, from now on, the vast majority of listening will be done by some form of reproduction as against live performance. The introduction of stereo will bring possibilities for exploitation which will affect every aspect of it.

John Moyle

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RADIO ★★ TELEVISION AND HOBBIES

A NATIONAL MAGAZINE OF RADIO, TELEVISION HOBBIES AND POPULAR SCIENCE

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Vol. 20 No. 3

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OUR COVER PICTURE

Looking into the heart of an experimental reactor during a reloading process shows the arrangement of fuel rods typical of the design. This one is attached to an American research institute.

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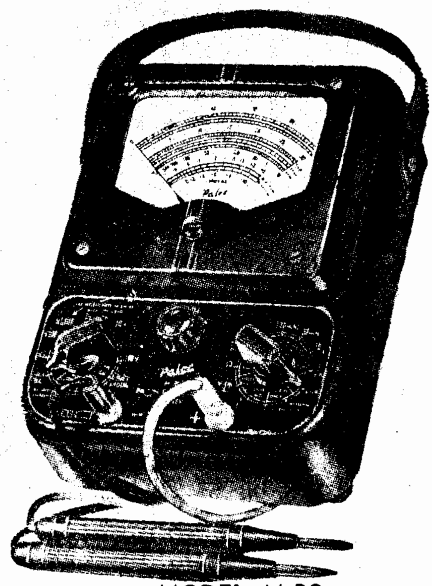

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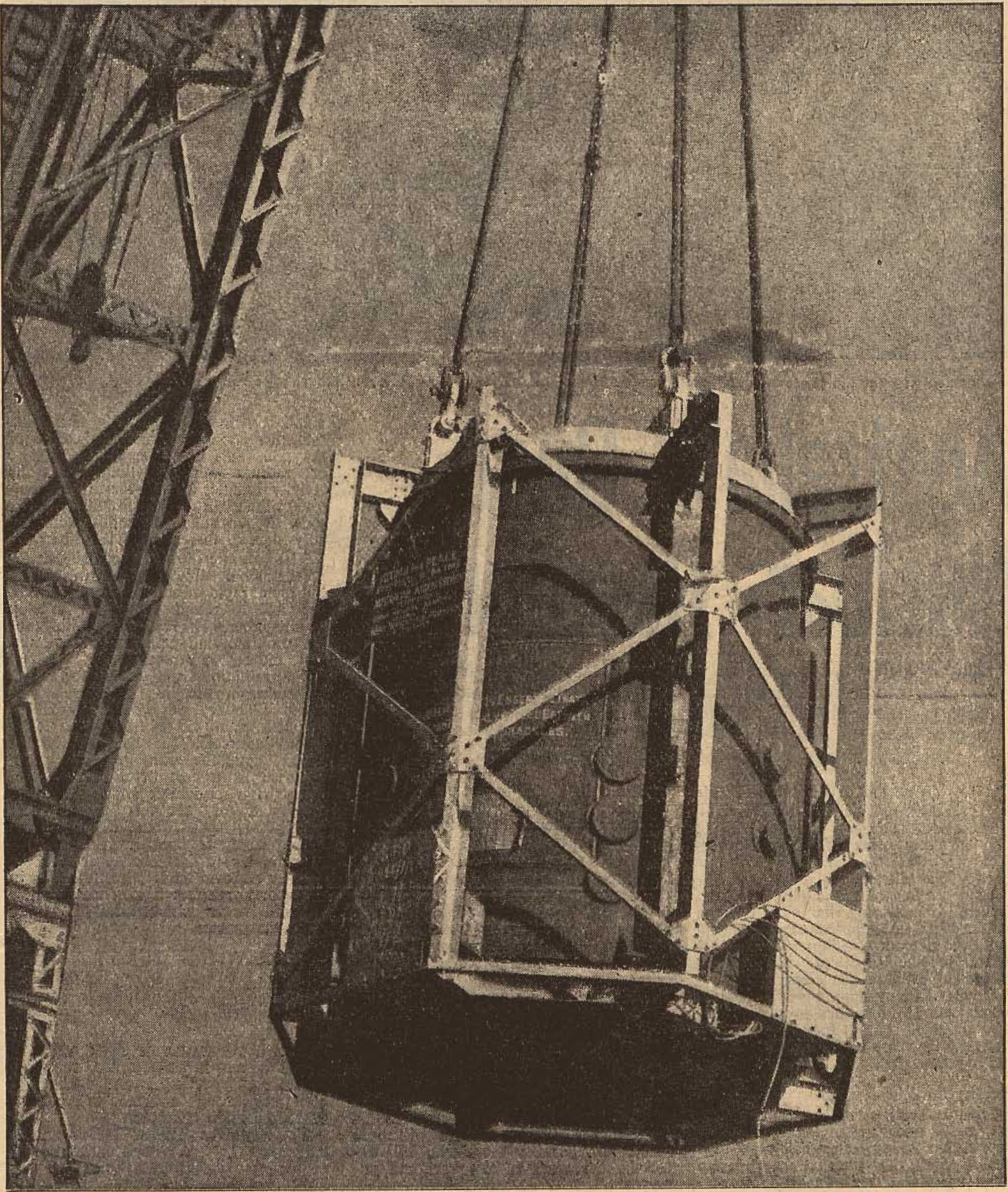
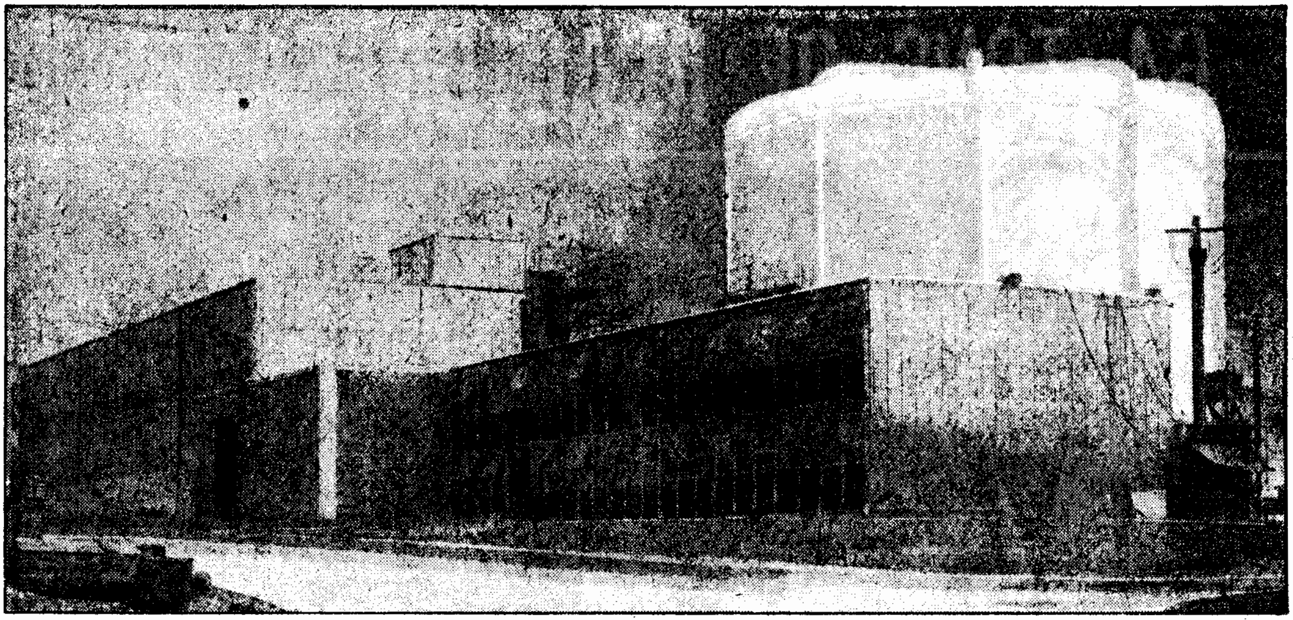
64 TONS OF REACTOR CASING



The steel tank in which the atomic reactor will operate is shown being unloaded from the freighter which brought it from Britain. It was supplied by Head Wrightson Processes Ltd. London and weighs 64 tons. It is 13ft high and has a diameter of 12ft 6in, with a four-inch thick lead lining inside. It holds the actual reactor, and is now embedded in a heavy concrete shield and outer reactor casing. This heart of the reactor is actually the smallest section of all—mostly the building is taken up with controls, cooling circuits, etc. (See story on next page.)



A general view of the Lucas Heights reactor and surrounding buildings. The reactor is the circular, white structure at the right.

Australia's Own Nuclear Reactor

Nuclear energy has become so vitally important in the modern world that Australia cannot afford not to build up its own resources of knowledge and material facilities. Cheap, nuclear power is just as important to us as to anyone else. We will lag badly unless we can compete with other countries and adapt discoveries to our own uses.

ON April 18 the Prime Minister (Mr Menzies) opened the experimental atomic reactor at Lucas Heights, N.S.W., and virtually commenced the practical work of the Australian Atomic Energy Commission.

To date most of the activity has been occupied in clearing the site, erecting buildings, assembling test apparatus and staff, and of course building the HIFAR reactor for the benefit of which all this effort and expense has come about.

It will be many months yet before the reactor can do more than produce a token amount of energy, for such a potent instrument cannot be turned on and off like a water tap.

PROGRESSIVE TESTS

Scientists will carry out innumerable test runs under changing conditions, stepping up the power as their work progresses and the installations become more complete, until finally it is safe to use the full 10 megawatts capacity of HIFAR.

The reactor itself is not primarily a heat reactor of the type used to boil water and run turbines. It is intended to supply a source of radiation for the treatment of samples which are inserted into it. It does produce a great deal of heat in the process, but this is purely incidental. The heat is carried away and dispersed in a cooling system, although it could probably be used for some other purpose not directly connected with the reactor.

HIFAR means High Flux Atomic Reactor, a phrase which describes its character. It is in fact almost a duplicate of the DIDO which went into operation at Harwell two years ago, and many of HIFAR's research team have already had experience at the Research Establishment in England.

This is Australia's first reactor, but it certainly will not be its last. Rather than contemplate the necessity of buying industrial reactors in the future from overseas, Australia expects to embark on projects to design and build her own.

One of the jobs set down for HIFAR is the development of techniques for this purpose, for conditions here will pose special problems to those who will undertake the work in this vast and important field.

The fuel used in HIFAR is Uranium U238 enriched with some U235. It comes from overseas in flat slabs made up into rods each 2ft long and contained in aluminium sheaths for protection. The composition of these rods in detail is one of the few secrets about the reactor, which requires 25 of them when fully loaded.

To start up the chain reaction, a small container about as big as a fountain pen is lowered into the centre of the pile. This container has a mixture of radium and beryllium, and its activity initiates the movement of neutrons which "fires" the uranium in the rods. When the reaction has been suitably started, this nucleus is withdrawn.

The atomic fire is controlled by means of moveable cadmium rods which, by their rapid absorption of neutrons, are able to retard activity or to stop it altogether. The relative positions of the uranium and cadmium rods determine the degree of activity.

The radiation from the reactor is prevented from escaping first by a surround of heavy water, then by 2ft of graphite, then 4in of lead and finally 5ft of concrete. The heavy water, of which 22,000lbs were imported from America at a cost of £277,200 acts firstly as a moderator which slows the movement of neutrons to a more manageable speed, and as a coolant which conducts heat away from the uranium into a heat exchanger. The exchanger removes the heat from the heavy water and transfers it to a moving flow of cold water which carries it away from the reactor.

LARGE WATER SUPPLY

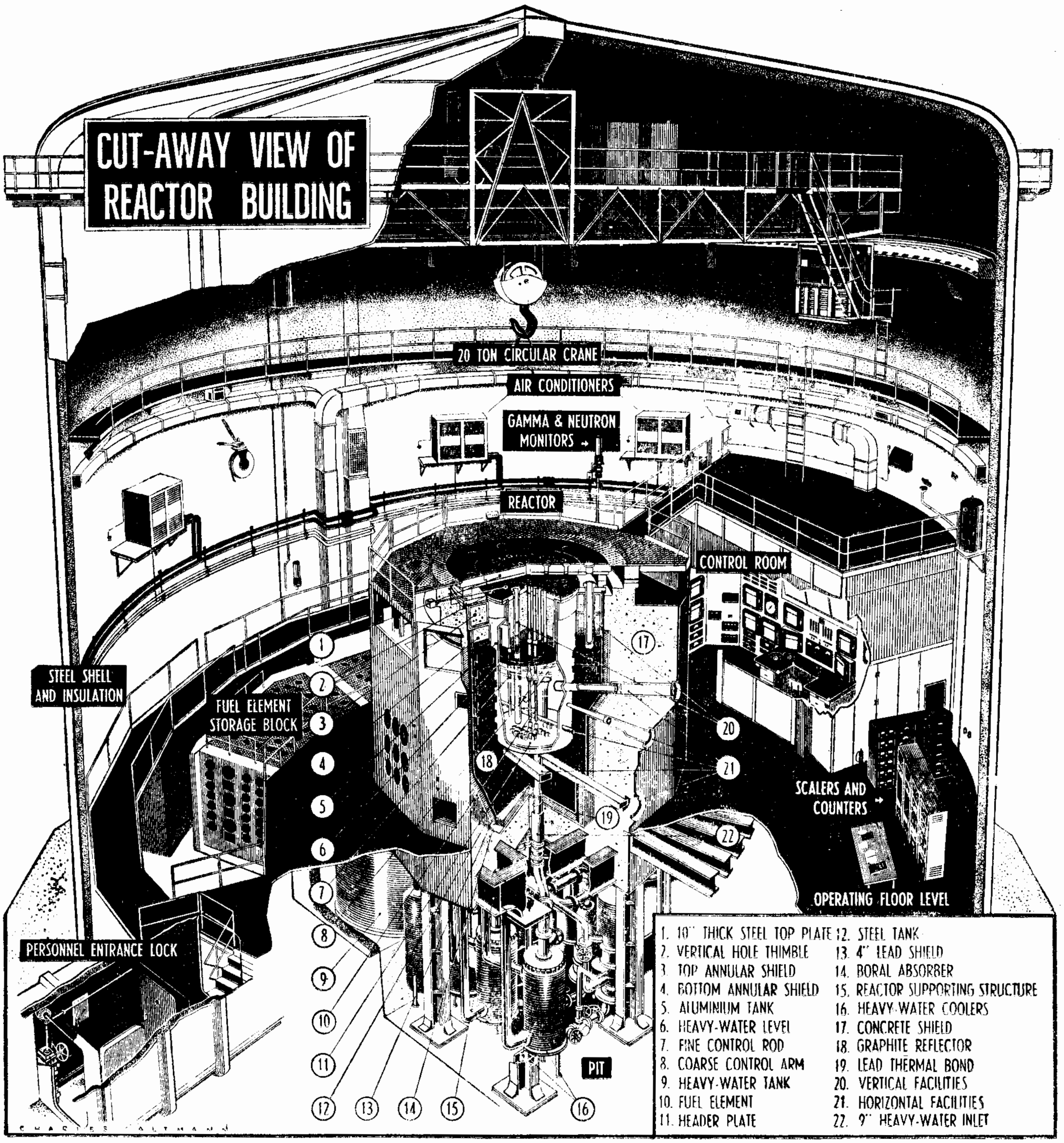
Something like 80,000 gallons of water per day will be needed to cool the reactor—ordinary tap water from the mains.

The heavy water is kept within a closed circuit in the reactor, returning to the "hot spot" again and again as it circulates through a pattern of pipes beneath the main chamber.

The High Flux part of HIFAR's name indicates that the concentration of neutron movement in its heart is very high, something like 10,000 billion per square centimetre per second. Burning uranium can attain a temperature of several millions of degrees—one pound of it could boil three million gallons of water. Such temperatures are not permitted within HIFAR.

The high flux concentration will allow very potent isotopes to be produced when the reactor is operating at full power.

CROSS SECTION DIAGRAM OF NUCLEAR REACTOR



This cross-section of the reactor illustrates its construction in detail.

The reactor housing itself is a steel structure 1in thick, 70ft high and 70ft across. It is coupled to an adjacent building and is entered by an air-lock through which operating staff must pass under controlled conditions when it is operating.

Inside this shell stands the reactor itself, 30ft high, 20ft across, with 10 flat sides.

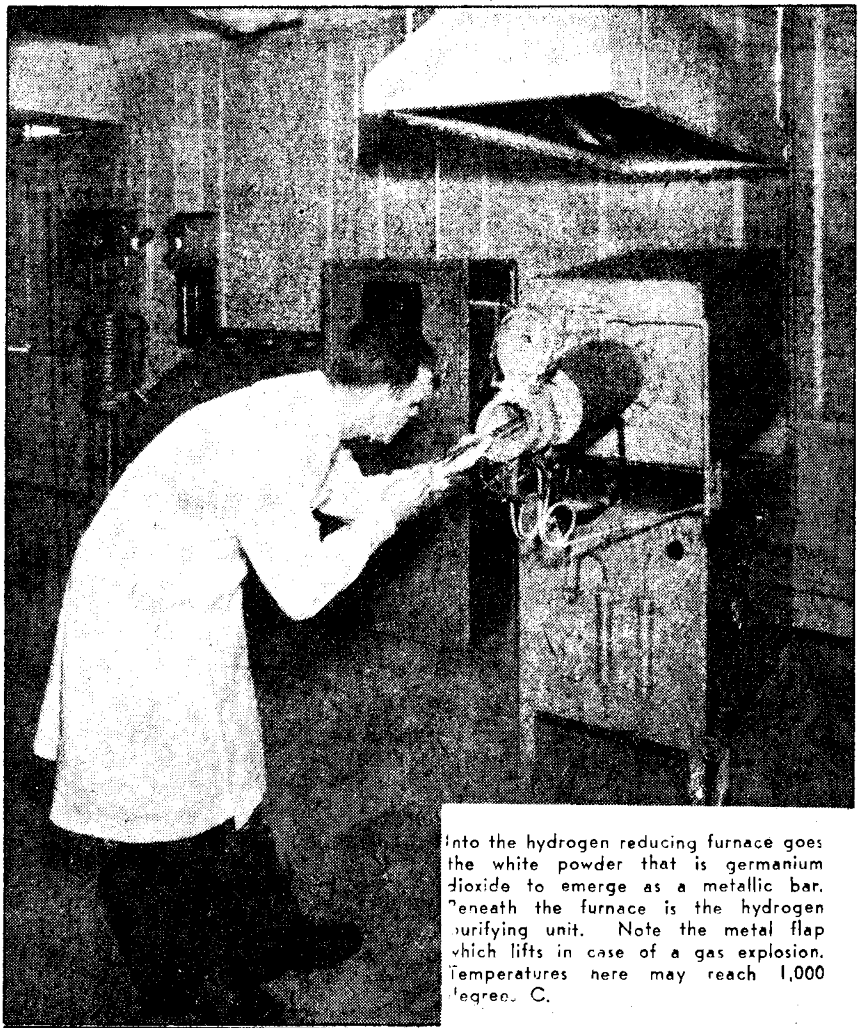
Above it is the moveable crane and the well-like hole through which the rods are inserted. Beneath it is housed ancillary equipment such as the heat exchanger.

On a wide landing which surrounds the reactor are banks of meters and racks of instruments to check and control its operation. In a glass-covered room is the control console at which a summarised picture of the reactor's condition can be seen at any moment. This is the nerve centre of the entire operation. Emphasis is on temperature, for a change one way or another can indicate danger or failure.

In this room is the famous "Scram" button which, when pressed, shuts down the reactor, alerts all personnel, and sets an extensive emergency drill into operation.

Attached to the reactor is a collection of laboratories and training facilities at which engineers and scientists from all over Australia can make use of its facilities. The total cost of more than £6-million is high, but the value received on a national basis cannot be measured in money.

AUSTRALIA MAKES TRANSISTORS



Into the hydrogen reducing furnace goes the white powder that is germanium dioxide to emerge as a metallic bar. Beneath the furnace is the hydrogen purifying unit. Note the metal flap which lifts in case of a gas explosion. Temperatures here may reach 1,000 degrees C.

This is a transistor year for Australia. The first transistor receivers are now on sale in the shops, and before 1959 appears there will be many more. Transistor production in this country has now begun, and soon there will be a number of firms engaged in this important new industry. Mounting production will eventually remove the biggest drawback of the present time—relatively high price. There is a great future ahead for this mighty little midget.

AT its Alexandria factory, Standard Telephones and Cables Pty. Ltd. is now making transistors, and is the first Australian company to do so. Those manufactured at present are for use in audio circuits, but later on others will be added, including a range intended for use in R.F. circuits.

At the present time, R.F. types are imported from overseas, but it should not be very long before Australian receivers can be fitted entirely with Australian-made transistors.

The photographs shown in these pages were taken at the STC factory, and we have used them to illustrate various steps in the manufacturing process.

Fundamentally this is not particularly complicated, but it does include a number of operations which require very accurate production control, and a high degree of factory cleanliness.

Most of the world's supply of germanium, the metal which forms the heart of the transistor, comes from the Belgian Congo, its exact source being a great heap of waste slurry built up at a plant used for zinc refining. Because it was considered to be rich in various mineral deposits, the heap had been preserved for further examination.

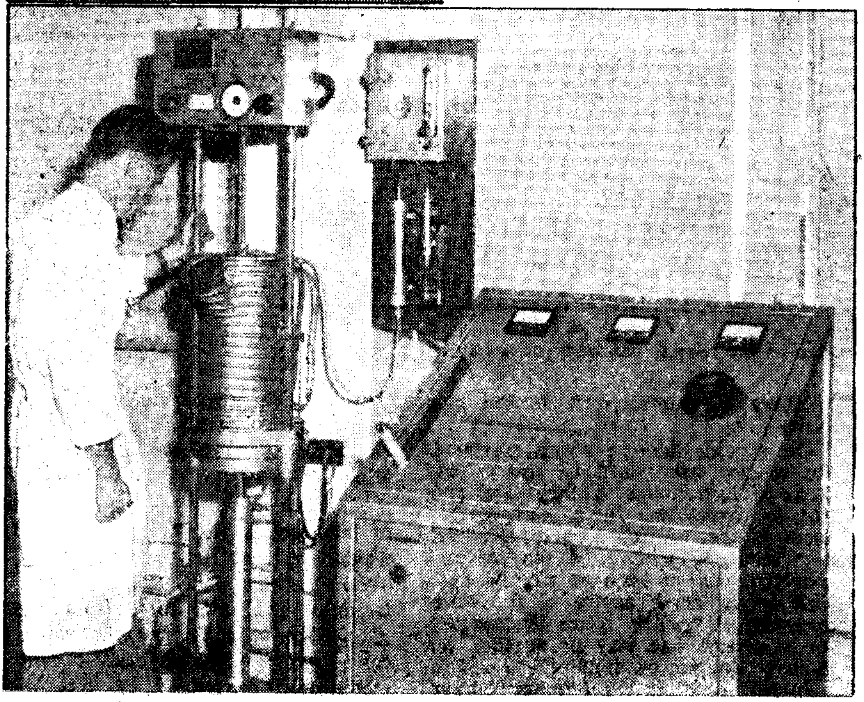
A WHITE POWDER

Eventually it was found to be rich in germanium dioxide, which is extracted in the form of a white powder.

Although a metal, germanium combines easily with other elements, and is rarely if ever found in its natural state. Canada has a limited supply, and strangely enough it is found in certain kinds of chimney soot, which has proved the source of a small quantity extracted in Great Britain.

Germanium dioxide used for transistors must be refined to a very high degree, and for this purpose, the Belgians ship their treasure trove to Europe for processing, and thence to factories in other countries which draw upon this supply.

It is probable that other sources of



This is the crystal-growing unit through which the operator watches the conversion of the metal bar. Accurate temperature control is essential here. The seed crystal is slowly withdrawn by the mechanism above the unit.

METAL MUST BE COMPLETELY PURE

germanium will eventually be discovered. It is present in coal, for instance, and the importance of transistors is so great that every effort will be made to search for it.

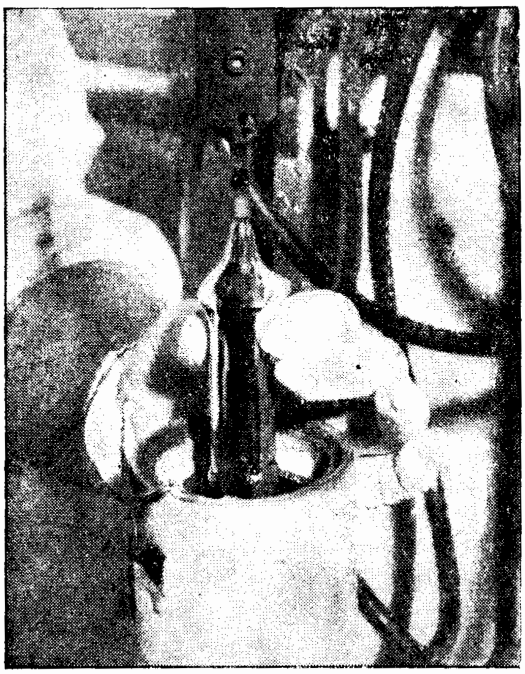
The first step in the manufacturing process is to convert the dioxide into pure germanium. The powder is therefore passed through an electric furnace which heats it to a very high temperature, in the vicinity of 1,000 degrees Centigrade.

Physically it is contained in a long shallow **"boat"** made of chemically pure graphite which acts as both a container and a mould to shape it into billets or bars about 12 inches long and 1 inch square section. The graphite must be pure to avoid contaminating the germanium.

The furnace operates in an atmosphere of hydrogen which combines with the oxygen of the germanium dioxide leaving the pure metal behind. Commercial hydrogen is not "clean" enough for the purpose, so the gas passes through a purifier on its way into the furnace.

Here it exists as an atmosphere at low pressure to prevent any air from entering to form an explosive mixture.

Here the germanium bar is travelling through the quartz tube with its six heater coils to purify the germanium. Nitrogen cleaning unit is below the bench, the RF heating unit at the right. The boat is drawn through the tube by the quartz rod emerging through a gas-tight joint at the end.



A close-up of the germanium crystal being drawn from the furnace by the rod to which the "seed" crystal is attached. This is the interior of the crystal-growing unit shown on opposite page.

The open end of the furnace is closed with a metal flap, so that, if an explosion should occur, the blast will be free to escape without causing any serious damage.

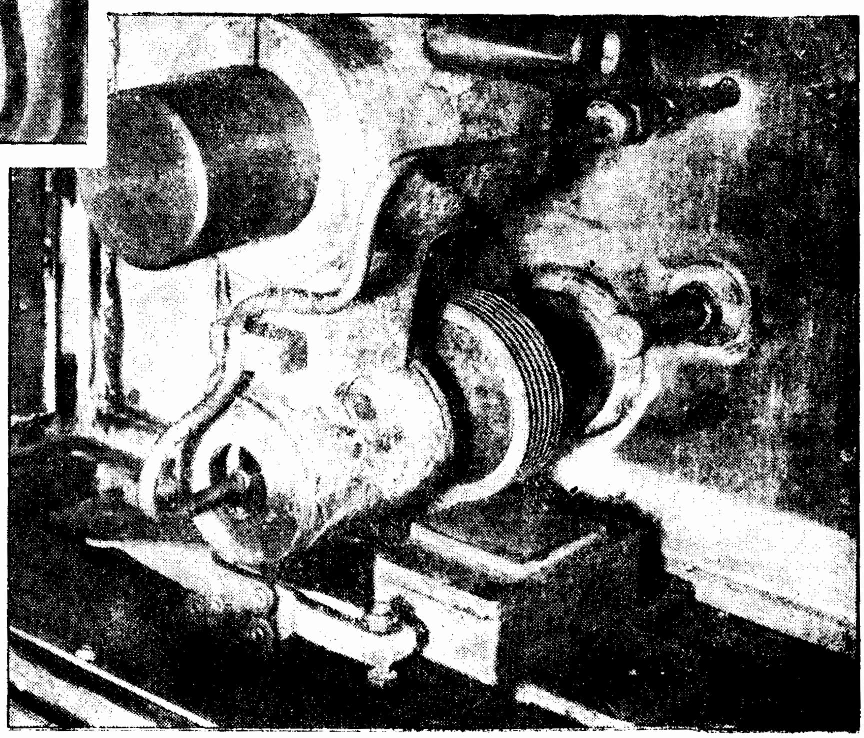
At the end of the hydrogen reduction process, we are left with a bar of germanium metal.

The next step is to pass the bar through a final cleansing process known as "zone refining" to remove any trace of contamination. This is so effective that, at the end of it, the amount of foreign matter remaining is estimated at no more than .0000001 per cent.

This almost unbelievable standard is reached by passing the germanium, still in its graphite boat, through a tube of quartz which is surrounded by an R.F. heating coil arranged in six sections. The coil is fed from a huge R.F. oscillator with an output power of 20 kilowatts generated by two water cooled valves.

The boat is pulled through the tube from one end to the other by a quartz bar attached to a length of steel wire and operated by an electric motor.

Each time a section of the bar passes through one of the heating coils, it becomes molten by the heating action of the R.F. power. As this molten section is pulled out of the coil, it solidifies, only to be melted again as it comes within the field of the next coil.



Close-up of the ganged wheel which cuts the crystal slabs into small dices. The thin slab is attached to a ceramic tile to support it for cutting.

Thus the whole bar melts and solidifies six times as it is slowly pulled through the complete coil, a process which takes five hours. In effect, a succession of six molten waves moves along the bar from the front to the rear as it crawls along the quartz tube.

The reason for this molten wave motion in the germanium is that any impurities in the bar remain in the molten sections, and do not resolidify with the metal. As a result, they move along the bar to the far end during the six cycles. When the bar has completed its journey, these impurities are collected in a small portion of the bar at the end which last emerges from the heating coil.

NITROGEN ATMOSPHERE

Not all metals behave in this way, but germanium is one of them, and it is this convenient characteristic which allows such an effective and ingenious method to be used.

The quartz tube is filled with nitrogen gas at low pressure, again to provide an atmosphere, but this time an inert one, mainly to prevent oxygen and other gases in the air from recombining with the germanium and defeating the purpose of the whole process. The nitrogen also helps to cool those sections of the bar which are solidifying between their molten periods.

The end of the bar in which the impurities are concentrated must now be cut away, and the problem is to determine how much should be removed. This is done by making a conductivity test of the bar with four probes which measure the specific resistance of its cross section.

When the impure portion is reached by the probes, the specific resistance changes, and at this point the bar is cut.

The discarded ends are later reprocessed to avoid waste of a very expensive metal.

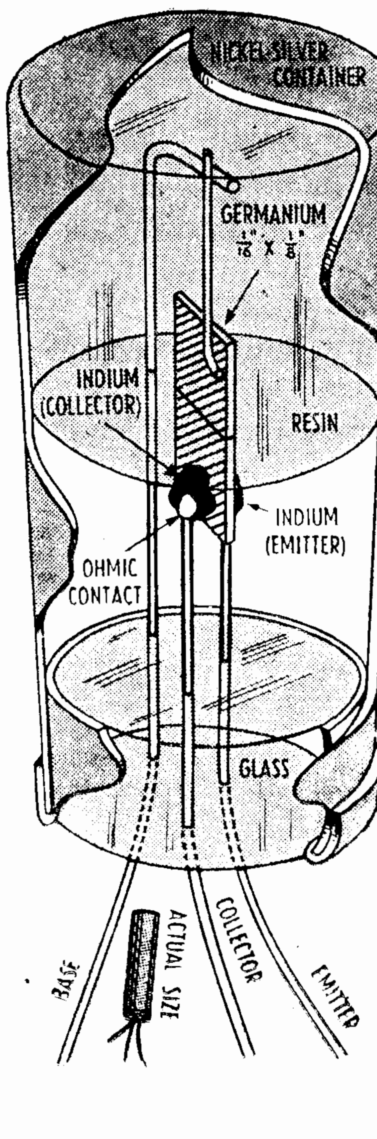
As used in a transistor, the germanium must be in crystalline form, and so the next step is to grow a large crystal from the metal.

For this purpose the bar is placed in yet another electric furnace and heated until it is just molten. This requires a heat control which is accurate to within about 0.2 degree, an extremely difficult task at a temperature of 1,000 degrees C, the melting point of germanium.

TEMPERATURE CONTROL

The control circuit includes a thermocouple which feeds a DC amplifier controlling a servo mechanism to adjust the current flow to the furnace—a type of feedback circuit which automatically stabilises the temperature.

While in this furnace, a small, accurately controlled amount of some suitable element, such as antimony, is added to the molten germanium, its exact nature and quantity depending on the type of transistor and the special techniques developed by the manufacturer. Most of them don't issue too much information on their methods as used here,



This drawing shows the assembly of a transistor. Indium pellets are fused to the crystal slab on each side, connecting leads emerge from the glass base. There are many variations in the actual arrangement of leads and supports, and of dimensions. Note actual size of typical transistor.

FINAL CHECKING AND ASSEMBLY

Transistors are so small that microscopes and precision gauges are freely used. At left, an operative checks a completed assembly; at right, another measures the thickness of a germanium wafer. Behind her is the furnace in which the indium pellets are fused to the germanium crystals.

for they involve very deeply the quality of the finished product.

To start the crystal growing, a small seed of crystalline germanium fastened to the end of a rod is allowed to lightly touch the surface of the metal. It is then slowly rotated and withdrawn, bringing with it the top end of the gradually crystallising metal in solid form. When the bar is entirely lifted from the furnace, it is a complete germanium crystal.

It is interesting to note that practically all the "seeds" used to initiate this process came from the original crystal made by the Bell Telephone Laboratories in the early days of germanium production. It is important that this crystal should be perfect in its form, otherwise the large crystal grown from it will repeat its imperfections and be ruined.

The time taken for this step is about 4½ hours, at the end of which we have a bar about 9in long and a triangular cross-section measuring about 1in.

CUTTING THE CRYSTAL

The germanium crystal is now cut into tiny rectangular pellets. It is first sawn into slices about 20 thousandths of an inch thick, and lapped on both sides to ensure flat surfaces, a process which reduces them to half their original thickness.

Each slice is then attached with wax to a ceramic tile and diced by ganged diamond-tipped cutting wheels into rectangles, measuring 1-8in x 5-32in.

The final step is to attach the tiny

dots of indium to each side of the crystal, together with the connecting leads.

From now on, operations must be carried out under conditions of extreme cleanliness. This part of the factory is thoroughly air-conditioned, and dust removed from the air by precipitron units, as the germanium is very easily contaminated. Sticky rubber mats cover the floor to catch any dust particles which remain, the operatives using special lint-free clothing. The factory is vacuum-cleaned twice each day, the collected dust examined by one of the engineers and chemically analysed as well. All doors have air locks as a protection against the outside air.

An assembly jig is loaded first with the crystals, now chemically etched and reduced in thickness thereby to 5 thousandths of an inch. Next follow the indium pellets of about the same dimensions, which have been punched to size. Included, too, is a nickel connecting tab for the germanium, ready tinned with solder for the purpose.

ALLOY FURNACE

For the last time, the embryo transistor passes through another hydrogen furnace and is heated to the melting point of indium, which is thus fused to the surfaces of the germanium. The depth of penetration is governed by the temperature which thus gives some measure of control over this operation.

All that now remains is to mount the transistor on the stem assembly, a glass bead contained in a metal shell. Through it emerges the nickel tab attached to the crystal, and the two nickel wires, 5-thousandth of an inch in diameter, which are soldered to the indium pellets with special low melting point solder (130C).

At this stage the transistors undergo a preliminary test, and are then enclosed in a can filled with epoxy resin, which not only ensures good thermal conductivity, but locks the whole assembly in place.

The base of the can is soldered by concentrated RH heating at the flange, for too much heat applied to the complete assembly at this stage would possibly damage the transistor.

A 24 Kw heater is employed which does the job during a pulse of 1 second duration.

METAL RECOVERY

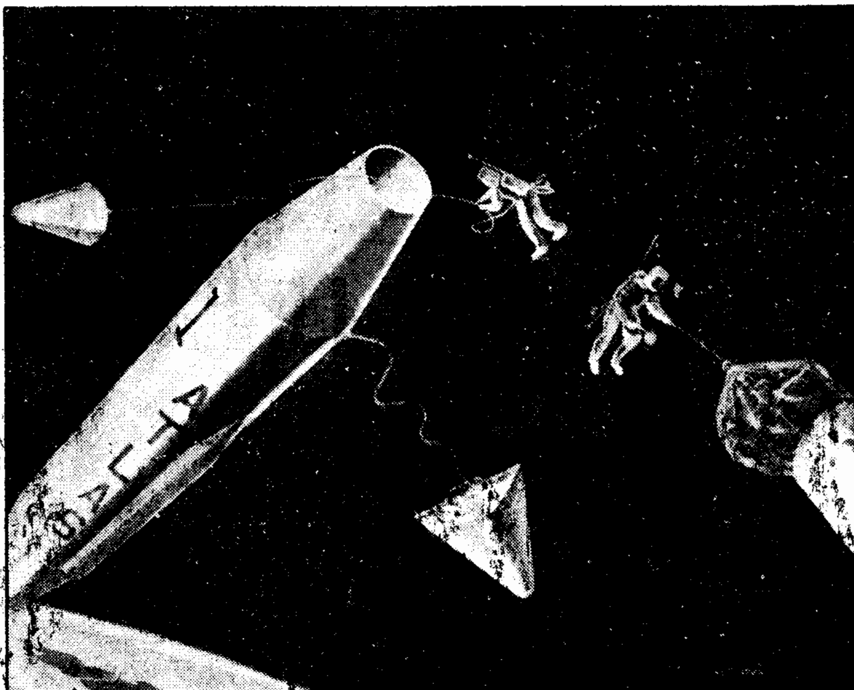
It will be obvious that, during this succession of events, a good deal of the original germanium metal bar has been used up by so much cutting, grinding and etching.

But the waste metal is all carefully gathered up, recovered, and reprocessed, so that much of it goes "through the mill" many times before finding its way into the finished product. It is estimated that only 10 per cent of the bar remains after the first processing, and as germanium is so costly, this recoverage is a highly important matter in the factory that makes these tiny but vastly important midgets.

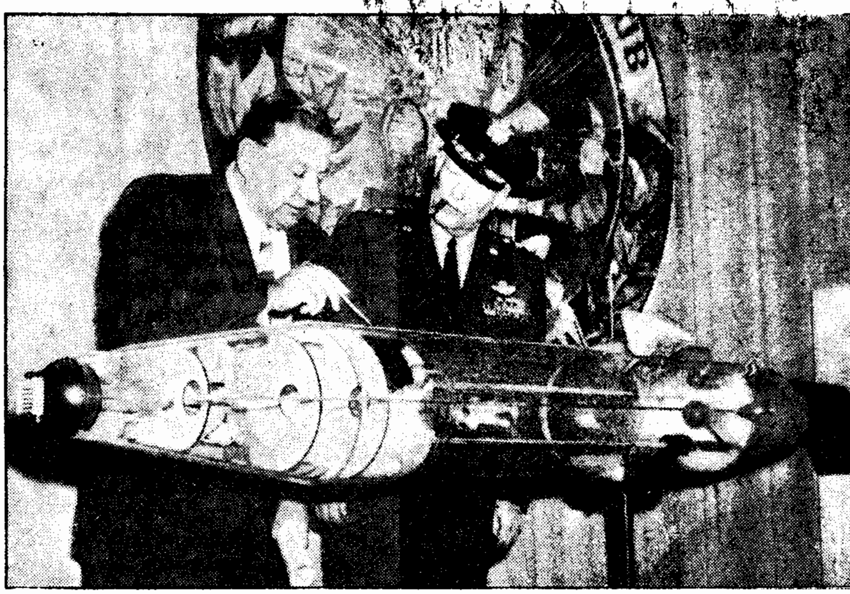
Up to the crystallising step, all germanium processing is the same, but from this point there are many variations to suit different types of transistors. Those described are diffused alloy P-N-P types as used for audio work. Transistors for RF work are made differently—for one thing the germanium crystals are very much thinner.

In this issue will be found the second part of an article which outlines the theory behind the operation of transistors, the first part of which was published in last month's issue. Our picture story will be complete if you refer to this article, for it will tell you just why they are made this way, and how they are able to give results which are rapidly changing the pattern of so much electronic equipment.

WILL OUTER SPACE BE LIKE THIS



With dreams of space travel coming nearer to reality, engineers and scientists are continuing their plans for the great day. This is an artist's conception of the intermediate stage in establishing an "Atlas" space station 400 miles above the earth. Its sponsors say that the station would provide an early capability for proving long-term existence in space. The basic structure of the station, the propellant tanks of the Atlas, is in orbit at the left. Its cap is removed for access. Crewmen have arrived in a glider, bottom centre, launched into the space station orbit as part of the upper stage of a modified Atlas. The rubber nylon inflatable capsule which will form the living quarters aboard the space station is being removed from the cargo ship, right.

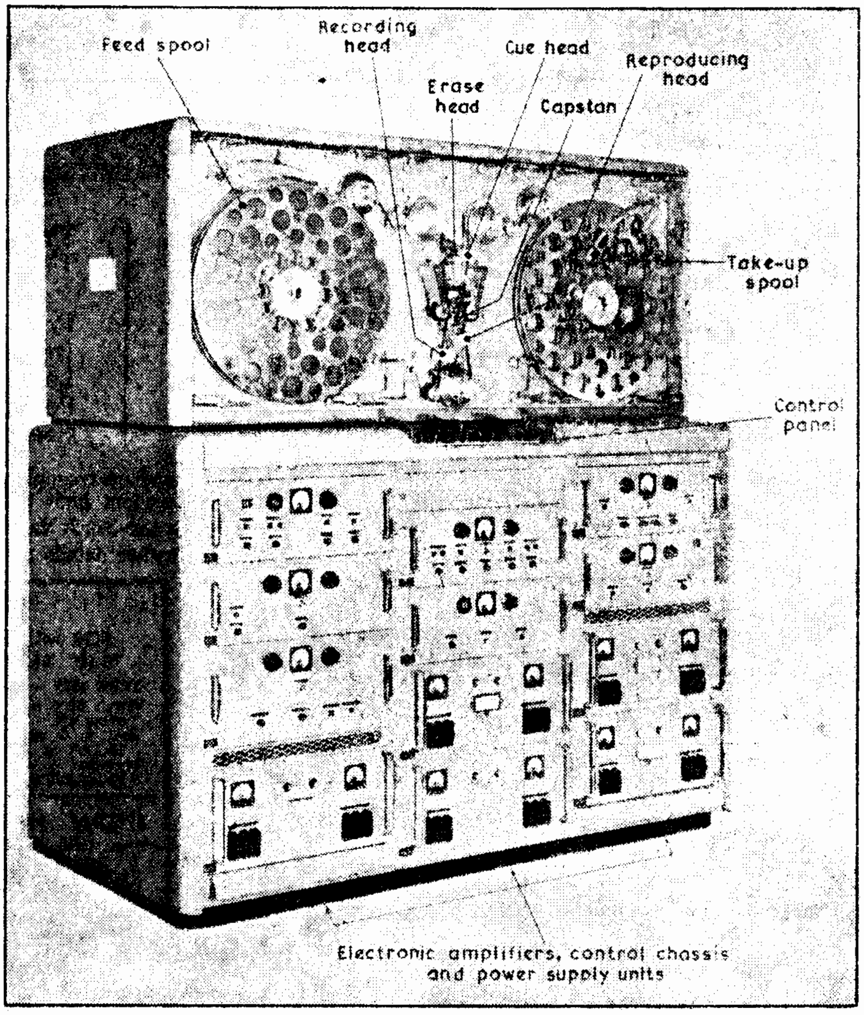


Krafft Ehriche, Convair space expert, explains the crew quarter details of a model four-man space station to a U.S. Air Force officer. The station would provide a four-level crew quarters including a washroom at left, eating-recreation room, sleeping facilities and control room.

BBC HAS TAPE RECORDER FOR TV

NEW TECHNIQUE GIVES HIGH PERFORMANCE

The B.B.C. has developed a completely new equipment for recording TV programs on tape. This article, prepared from a talk by Dr Peter Axon of the B.B.C., and from official reports, describes how it works. It is quite different from proposed American systems and marks a big step forward in technique.



UNTIL recently the recording of television pictures has been carried out entirely by using a motion-picture camera, and photographic film. This, when processed, reveals a series of separate pictures along its length. When the film is used for a subsequent broadcast, the pictures upon it must be turned into the form required by the television system. Each picture along the film is, therefore, analysed in a machine such as a flying-spot scanner which puts the information in it into the correct form.

A live picture on a television screen is built up of a series of electronic impulses which, in live sequences, come from the television camera. Each picture is made up of a series of horizontal lines which are traced across the screen by the electron beam inside the television tube. The intensity of the beam, and hence the light from the screen, is made to correspond at each point with the light intensity in the original picture.

SYNCH. SIGNALS

Now the electron beam has to be instructed when to commence each picture and each line within it. This is achieved by sending out from the camera a regular series of synchronising pulses. The television signal therefore consists of synchronising pulses and picture information lying between them.

In the new magnetic recording of television pictures no photographic process is involved, and the signals recorded are those from the television camera itself, that is the synchronising pulses and the interleaved picture information. The information is established immediately and no processing of the tape is required. The recording can be reproduced immediately the tape has been rewound.

When it is no longer required, the tape may be wiped and used again to record new programmes. Clearly, the system can provide economy and immediacy, two important features in a television service. Although this is all very simple in principle the engineering arrangements required to provde a satisfactory picture are very complicated and in recent years a great deal of research has been devoted to solving the technical problems.

The first lies in the frequency spectrum required to carry the picture information. High-quality sound recording involves the recording of frequencies up to about 15 thousand cycles per second. Television picture recording involves the recording of frequencies up to about 4.5 million cycles per second and even higher.

TAPE PROBLEMS

A second group of problems arises in connection with the tape itself. This consists of a plastic backing which is coated with a finely-powdered oxide of iron. In the recording and reproduction of high frequencies it is essential that the effective separation between tape and head surfaces is small and that this separation is not subject to sudden increases, as would arise from agglomerations of particles or dust in the coating. Great care must, therefore, be taken in the manufacture of tapes.

The third group of problems is concerned with the transport of the tape past the recording or reproducing heads. Here again the difficulties are much greater than in normal sound recording for the speed constancy required for satisfactory television recording is very much higher. If a steady picture is to appear on the television screen the synchronising pulses and the information between them must follow at a steady rate.

HOW IT WORKS

The B.B.C. Vision Electronic Recording Apparatus is shown herewith. The channels which are to be put into service will consist of two such machines which can be controlled from a central control desk. The machine employs half-inch magnetic tape and a reel (20¼in diameter) such as those shown will accommodate 15 minutes of programme.

Continuous recording is possible by the use of two machines and the control desk. The tape speed employed in the present model is 200in/sec and the magnetic tape used may be a normal thin-base sound-recording tape of good quality.

The machine employs a three-track system of recording, two of the tracks being devoted to the storing of the video signal and one to the storing of the

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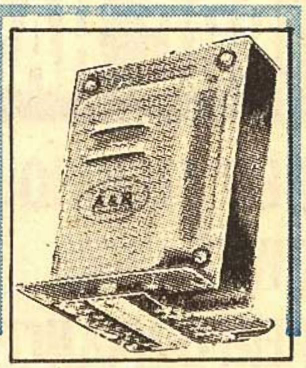

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TYPE 4000—15 3.75 or 15 ohms.

SPECIFICATIONS

Prim. 8000 ohms U.L. Taps
Inductance. 140 H at 10v. 50 c/s
Leakage Ind. Less than 7 m.H.
Power Response. 10w. 30-30,000 c/s
Feedback phasing C required Nil.

Tested by Mullard-Australia Ltd., who say, "the power frequency response (—3db at 28 c/s) is, we feel, more than adequate for a domestic amplifier and coupled with the excellent high frequency transient performance," etc.

Watch for the Silver Grey transformer with the Black and Gold nameplate.

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TYPE 931-15: 20 watts.
Prim.: 4500 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-60,000 cps.
Valves: EL37, KT66 6L6 etc.
19% Screen Taps.

TYPE 931-8: 20 watts.
Prim.: as 931-15.
Sec.: 2 or 8 ohms.
Resp.: As 931-15
Valves: As 931-15.
19% Screen Taps.

TYPE 921-15: 20 watts.
Prim.: 6600 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-60,000 cps.
Valves: 807, KT66, etc.
19% Screen Taps.

TYPE 921-8: 20 watts.
Prim.: As for 921-15.
Sec.: 2 or 8 ohms.
Resp.: As 921-15.
Valves: As for 921-15.
19% Screen Taps.

TYPE 916-15: 12 watts.
Prim.: 8500 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-50,000 cps.
Valves: 6BW6, 6V6, KT61, etc.
19% Screen Taps.

TYPE 916-8: 12 watts.
Prim.: As 916-15.
Sec.: 2 or 8 ohms.
Resp.: As for 916-15.
Valves: As for 916-15.
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TYPE 949: 12 watts.
Prim.: 8000 ohms P.P.
Sec.: 2, 8, 12.5 and 15 ohms.
Resp.: 10-50,000 cps.
Valves: 6V6, 6BW6, KT61, EL84, etc.
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HIGH FIDELITY

FOR MULLARD "5-10" AMPLIFIER

TYPE 2525 — 12 watts
Prim.: 8000 or 6000 ohms CT.
Sec.: 8: 2 or 8 ohms
15: 3.7 or 15 ohms
Response: + — 1 db 10-100,000 cps.

SPECIAL HI-FIDELITY
+—, 1db 20-40.000 cps
OUTPUT TYPE

TYPE 870 — 6 watts.
Prim.: 10,000 ohms P.P
Sec.: 2 or 8 ohms.
(for "Rola" 120X)

TYPE 871 — 12 watts.
Prime.: 10,000 ohms P.P
Sec.: 2 or 8 ohms.

TYPE 872 — 12 watts.
Prim.: 10,000 ohms P.P
Sec.: 3.7 or 15 ohms.

HIGH FIDELITY
+ - 1db 30-15,000 cps
OUTPUT TYPE

TYPE 763 — 15 watts.
Prim.: 5000, 3000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

TYPE 920 — 15 watts.
Prim.: 5000, 3000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

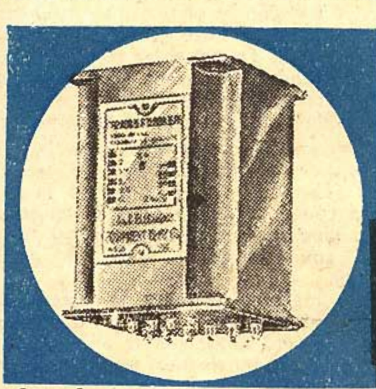
TYPE 897 — 15 watts.
Prim.: 10,000, 8000 ohms P.P.
Sec.: 500, 250, 166, 125 and 100 ohms.

TYPE 896 — 15 watts.
Prim.: 10,000, 8000 ohms P.P.
Sec.: 15, 12.5, 8, 3.7 and 2 ohms.

MEDIUM FIDELITY + — 2db 50-12,000 cps

Type	Watts	Primary	Secondary
809	15	500 ohms	15, 12, 8, 3.7, 2 ohms
914	15	5000, 3000 P.P.	500, 250, 166, 125 and 106
915	15	5000, 3000 P.P.	15, 12.5, 8, 3.7 and 2
917	15	10,000, 8000 P.P.	500, 250, 166, 125 and 100
918	15	10,000, 8000 P.P.	15, 12.5, 8, 3.7 and 2
922	25	8000 P.P.	500, 250, 166, 125 and 100

Type	Watts	Primary	Secondary
891	35	6600 P.P.	500, 250, 166, 125 100, 83 ohms
892	55	3200 P.P.	500, 250, 166, 125, 83, 62 and 50
928	5	7000, 5000 S.E.	12.5, 8, 3.7 and 2
929	10	4000, 2500 S.E.	15, 12.5, 8, 3.7 and 2
930	10	4000, 2500 S.E.	500, 250, 125
932	7	10,000 P.P.	15, 12.5, 8, 3.7 and 2



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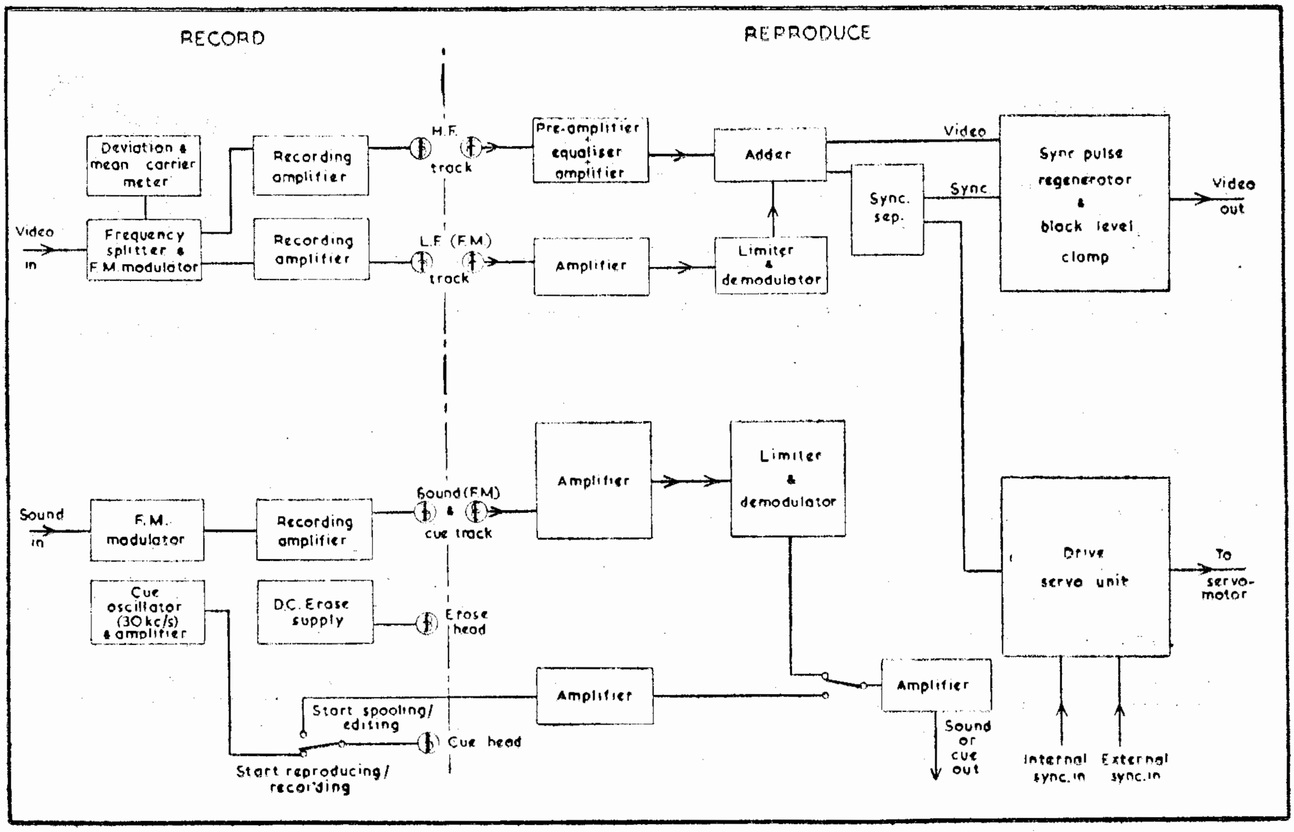


Block schematic of principal electronic units

sound signal. Separate recording and reproducing head-stacks are employed, each stack containing three identical heads separated from each other by copper screens and aligned to the accuracy required in the manufacturing process. Continuous monitoring of the recorded signal during the process of recording may be carried out.

TRANSPORT SYSTEM

In the tape transport system embodied in the machine most of the power required to drive the tape is supplied by the spooling motors which are arranged to move the tape past the heads at a speed just below the chosen recording speed of 200in/sec and close to the constant tension required, even when the drive motor is not engaged.

This result is obtained by varying the power fed to the spooling motors in accordance with (a) their torque/speed characteristic and (b) the amount of tape on the reels at any particular moment, the latter determining the speed of rotation required of the reels. When the drive is engaged the drive motor is, therefore, required to supply only a limited amount of power to bring the tape speed up to 200in/sec.

The drive is engaged by lowering two rubber idlers on to a common capstan so that a loop of tape, largely isolated from transient effects in the reels by these idlers and other mechanical filtering elements, is formed. Inside this loop lie the recording and reproducing head stacks.

The erasing head is placed at a convenient point which lies outside the loop and precedes the recording head.

A "Velodyne" system of speed control and correction of the driving capstan is employed. During recording periods the servo driving motor is made synchronous with the mains frequency whilst on reproduction the output of the machine is frame-synchronised to station synchronisation signals. The machine is fitted with the usual facilities for braking and for spooling the tape backwards or forwards at a variable speed when the drive system is not engaged.

A block schematic diagram showing the connections of the principal electronic units embodied in the machine is shown here. For storing the video signal the two video tracks are associated, on the recording side, with a band-splitting system in which the video signal is divided into two frequency bands of approximately 0-100 kc/s and 100 kc/s-3 Mc/s. The 0-100 kc/s video band is made to frequency-modulate a carrier and this frequency-modulated carrier is recorded on one track.

The low-frequency content of the video signal is thereby transferred to a frequency band corresponding to shorter wavelengths so that both the low-frequency and the long-wavelength difficulties inherent in the conventional magnetic-recording system are avoided.

LIMITING CIRCUITS

In addition, the amplitude-limiting facilities normally associated with the reception of frequency-modulated signals may be incorporated in the reproducing chain to eliminate undesired amplitude fluctuations and overcome almost all "drop-out" difficulties, even when employing thin-base sound-recording tape not specifically manufactured for video or instrumentation purposes. The higher vision band, from 100 k/cs upwards, is recorded simultaneously on the second video track in a conventional manner.

On reproduction the output from the frequency-modulated video track is limited, demodulated, and added to the output from the higher-frequency track to reform the composite television waveform. Before transmission to line the synchronisation information, including line and frame synchronising signals and suppression periods, is extracted, reconstituted and added back into the video signal.

HF BAND AFFECTED

It is, of course, obvious that the higher-frequency video band, which employs a conventional recording/reproducing system, will be subject to the same unwanted amplitude-modulation which is being eliminated by the frequency-modulation system of the lower frequency video band. It is, however, an important finding that in practice this does not appear of major importance, for as long as the synchronisation signals and the main brightness structure of the picture, represented by the 0-100 kc/s band of the video signal, are maintained intact, reasonable variations in the higher-frequency band do not noticeably degrade the subjective result.

All the low-frequency and long-wavelength difficulties which, in the case of the lower video frequency, are overcome by the use of the carrier system, will also be manifest in the sound channel if a conventional recording of the sound signal is attempted under the higher tape-speed conditions dictated by the video-signal requirements. The difficulties are, however, overcome by an identical technique to that employed to store the lower video frequencies. Accordingly the sound signal is, before recording, made to frequency-modulate another carrier which is recorded on the third track. On reproduction the carrier is limited and demodulated to provide a sound signal of high fidelity exactly synchronous in time with the video information reproduced from the other two tracks.

As in other forms of picture or sound

(Continued on Page 85)

For nearly 40 years, the skull of the "Piltdown Man" was thought to be a relic 600,000 years old, unearthed in Sussex in 1912. In 1949, a dentist of Clapham suspected that it was not genuine, and a fluorine test verified the suspicion. It was a hoax—the skull may date back 50,000 years, but the jawbone came from a modern ape, stained and treated to simulate antiquity. Here is the dentist, Alvan T. Marston, with the skull.

Science Is Helping Archeology

Modern archeology is now a more exact science thanks to the assistance of physics, chemistry, geology and astronomy. By the application of modern techniques some astonishing things have been found concerning ancient relics.

by Calvin Walters

IN the wastes of the African jungle, in the burning sands of deserts and the thick forests of Mexico, men and women are daily risking their lives against fevers, wild animals and reptiles, digging and seeking for relics of civilisations and peoples of ages long past.

Some time ago I asked one of these people why archeologists undertook such hazardous occupations and, of course, I got the usual reply of "thirst for adventure" and so on. To an archeologist the seeking of lost temples and buried cities has the same appeal as the climbing of Mount Everest had to Sir Edmund Hilary.

I suppose it is all right for those who like that sort of thing, and it is probably just as well that there are people like that.

But not for me.

If I am to do any digging I prefer the safety of my own back yard, and even that is a hazardous occupation. Think of all the risks of backache for one thing. Why, it could be quite easy to slip a disc in the spine. One could easily run a garden fork through one's foot. Blisters could easily become septic, and one could then die of blood poisoning if it happened to be a Sunday and no doctors were around and the car was out of order and the ambulance was too busy to come and you couldn't get to a hospital. All those risks for a few measly flowers or some cabbages which can usually be bought for a quarter the price that they cost to grow taking into consideration time, labour and insecticides.

One house I lived in must have been built on the site of an ancient garbage dump. Every time I tried to dig the garden a lot of things came up that I never planted in the first place. That experience made me very cautious for all time. Nowadays I find it much simpler to sit at my typewriter earning the few measly "bob" which the Editor reluctantly pays me and which I pay out to the poor bloke who now excavates in my back yard.

ANCIENT STUDY

The term archeologist has nothing to do with feet. The man who looks after your arches is a chiropodist, just the same as a fishmonger is a fishologist or a fyshician.

The word archeology was derived from the Greek word "arkhaios" meaning "ancient." So the word archeology means a study of human antiquities, of the art, customs, and beliefs of the most ancient peoples.

A little over a hundred years ago the belief was widespread that the world came into being somewhere about 4004 B.C.

I am not going to buy into any arguments about this. People have their own opinion on these matters. This is an article on the science of archeology and I will merely propound the principles on which that science is based and leave it to my readers (if any) to believe it or not.

But PLEASE don't get me into any arguments about religion versus science and start writing letters telling me I am an atheist or something. I am merely an "artologist" (one who writes articles).

Somewhere about the year 1780 geologists began to learn more about the formation (not the creation) of the earth. Investigation showed that it was made up of a series of layers of rock, gravel, sand, clay, decaying or decayed vegetation and so on. They called these layers "strata" and a study of the manner in which similar layers are formed today gives some indication as to how previous ones were formed many ages ago.

Right through a series of cataclysms during which the earth began to solidify from a mass of whirling gases, it was progressively subjected to violent contractions and upheavals. As the earth cooled, the land masses were in turn invaded by masses of ice which ground their way over the surface and left marks on the walls of deep valleys and ravines. Severe floods and alternating periods of cold and heat all left evidence in the layers of silt and rock, clay and sand, which were deposited by these upheavals.

So the geologists have divided these layers into periods, which they have classified into a "geological time" scale beginning about 2,000 million years ago with the Pre-Cambrian period layer. This is deep down in the earth below 40,000 feet and is of unknown thickness.

EARLIEST TIMES

Above this is the Cambrian layer of 40,000 feet thickness deposited between 420 and 520 million years ago. Then there is the Ordovician, of 40,000 feet thickness, deposited between 350 and 420 million years ago. Next the Silurian, 20,000 feet, 320-350 M. Y. A. (million years ago), the Devonian, 37,000 feet, 275-320 M.Y.A., followed in turn by the Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Eocene, Oligocene, Miocene and the Pliocene. The last four belong to what is termed the Tertiary period and were formed between one and seventy million years ago.

The Pliocene layer is about 18,000 feet thick, formed one M.Y.A. Above this layer are the Pleistocene and Holocene about 4,000 feet thick. Concerned with this is the period up to 500,000 years ago called the "Quaternary" or the Age Of Man, for, it is estimated that it was during this period that man began to occupy the earth.

Now the question is, "How much of this estimated age of each layer is guesswork and how much truth? On what do geologists base their estimates?"

Let us go a bit further into matters. About 600,000 years ago, according to the geologist, a series of changes took place which were called collectively the Ice Age. Four times during that period the greater part of northern Europe, Asia and America was covered in vast, thick ice. The huge glaciers below the ice ground their way southward carrying with them the crushed rocks and earth which they ground out from the sides of the valleys which they formed. These rocks and material were deposited in turn along the sides of these valleys.

VAST FLOODS

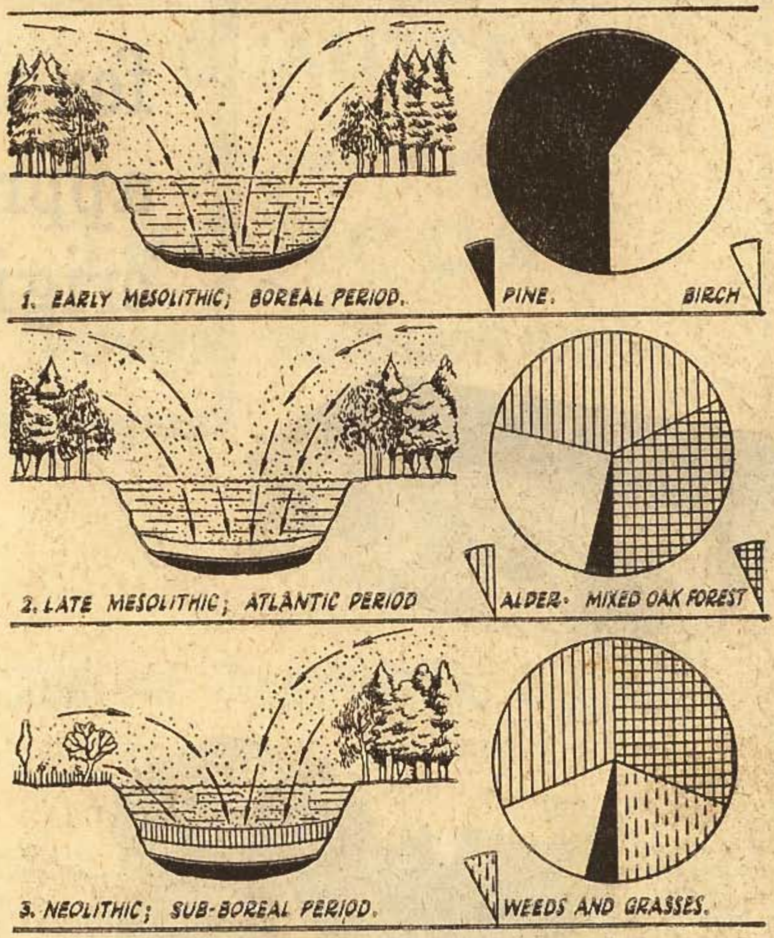
Then, as the ice period ended, the glaciers melted and the resulting floods carried vast quantities of soil and silt and gravel which were deposited on the floors of the valleys.

Thus there were four periods, at least, of cold and ice alternating with warmth, in this lapse of 600 million years.

During the cold periods, cold-loving creatures came south with the ice. During the warmer periods they retreated north, and warmth-loving creatures came into regions which were previously cold.

So their remains lie in the various layers left by the four glacial periods

POLLEN DEPOSITS WRITE HISTORY



Pollen analysis—the reconstruction of ancient vegetation. Left—The formation of pollen deposits at the bottom of a lake. Right—Pollen spectra in which different forms of vegetation are expressed as percentages. The change from 1 to 2 is caused by increasing warmth of climate. That from 2 to 3 is due to man's forest clearance for agriculture, marked by the appearance of weeds and grasses. (From "Down to Earth").

as mute evidence of the fact that the four Ice Ages did in fact occur.

Now, about this time factor. In igneous rocks, which are rocks created by fire or heat, there are certain radioactive minerals. At a specific stage of cooling these minerals begin to radiate and change into a new substance. This change occurs at a constant rate. Uranium, for instance, eventually changing into lead.

Where these minerals have been found in the various layers, the time taken for them to turn into lead can be calculated and translated into terms of millions of years. This will be the time which has elapsed since those rocks were formed.

This method is very important where igneous rocks have intruded themselves, when in a molten state or by pressure, between two layers of sedimentary rock which might contain fossils of creatures or plants.

SETTING DATES

It will be seen that, if it is possible by means of radio-activity to date the igneous rock, the surrounding rocks and fossils will also be automatically dated.

When the ice retreated at the end of the last ice period, trees and other vegetation began to spread to the north once more. The end of the last glaciation of the ice age has been fixed at 7900 B.C., and as more and more bare land was exposed it became covered with vegetation because of the seeds which were carried on the winds.

An ingenious method of "pollen analysis" has been devised by means of which scientists can tell what plants were growing at any particular period and thus an estimation of the temperature can be made.

POLLEN DEPOSITS

The air at all times contains countless millions of grains of pollen from plants. These not only settle on the surface of the earth but also float on the surface of lakes and finally sink to the bottom.

Circumstances often allow the pollen grains to survive, and if they are taken from the bottom of a lake they can be recognised as pollen from a given plant.

Prehistoric lakes therefore can be expected to contain layers of pollen of the

for the closest approach to the original sound

Acoustical QUAD II AMPLIFIER

The criterion, as always, is that the reproduced sound shall be the closest approach to the original—that the enjoyment and appreciation of music may be unimpeded. This is reflected throughout the design of the QUAD II. It is reflected, too, in the straightforward and logical system of control, achieved without the sacrifice of a single refinement or adjustment capable of contributing to the final objective.

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plants which existed at any given period This was found to be the case.

By taking, in a specially devised tube, a column of samples of the layers from the bottom of a prehistoric lake in the North of Europe, the scientists found in the lower layer pollen from trees and grasses that thrive in cold places and which were deposited by the water from the melting glacier. The upper layers contained deposits of pollen of plants which grew in warmer climates. The very top layer contained pollen of plants which thrive at the present time.

To calculate how long it took for these changes to take place, geologists use the fact that the water from melting glaciers which flow into lakes carries gravel during spring floods which settles on the bottom of the lake in distinct layers.

The coarse gravel settles on the bottom and the finer gravel above, with fresh layers being added after every spring flood.

OTHER METHODS

A Swedish scientist discovered that a certain lake in Sweden had been drained in the year 1796. By working back from that date he was able to calculate the position of the edge of the glacier for each successive year. He also dated the various forests which grew on the shores as the climate became warmer when the ice retreated.

Astronomy has also been brought into the matter to calculate back and find the irregularities in the solar system which scientists hold responsible for the various Ice Ages of the earth.

When archeologists find some old bones at a site great care is taken that proper estimates and analyses are taken before any pronouncement is made regarding the age of the find.

Anatomy plays a great part in this, because the study of bones of present day people compared with those of people who existed during the periods of written history quickly reveals any difference with those dug up from any ancient site.

As mentioned above the method of dating rocks also helps in dating any fossils embedded therein.

However, a recent method called the "fluorine test" can prove whether bones found together in the same site are of recent origin which have become mixed by flood or other disturbance with bones of greater age. This is important because such cases could easily occur.

Sometimes careless excavation at a *site could cause a fall of upper layers* of soil into lower layers and the two become hopelessly mixed.

EXCAVATION CARE

How disconcerting it would be to find some broken pieces of a gramophone record of Elvis Presley which someone had, in desperation, smashed up, mixed with remains of a dinosaur which existed thousands of years ago.

It has been found that the longer a bone lies in the earth the more of the gaseous element fluorine it absorbs. Bones also tend to lose nitrogen the older they are. Thus the longer they have been buried the more fluorine and the less nitrogen they contain.

Another test applied to remains of living things is the Radio-active Carbon test. This substance which comes from outer space is absorbed by living things plant or animal. Upon death the content of radio-active carbon decreases at a constant rate ultimately being reduced by half in 5,700 years. Special instruments can measure the amount of radio-active carbon remaining in the relics of living things, and by comparison with comparable items of modern times, calculations can reveal how long ago death took place.

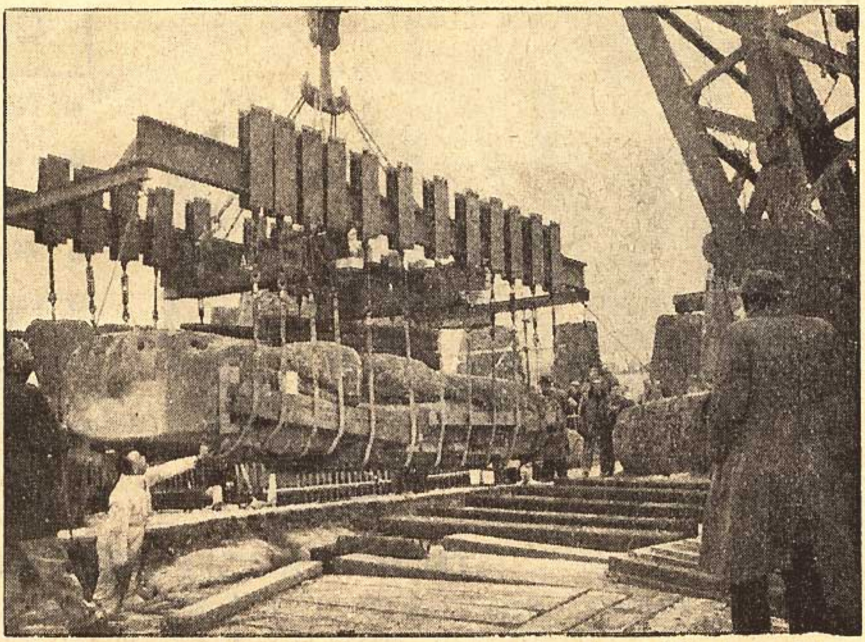
When searching for sites in which to dig, aerial surveys play a very important part. Sites which have been otherwise obliterated may become quite visible when viewed from the air.

Photographs are usually taken at sunrise or in the evening when shadows are longest. In this way burial mounds which have been flattened by cultivation will cast shadows which are visible on a photograph from the air.

An extraordinary feature of aerial photography is that ancient ditches which have been filled in become quite visible. The greater depth of soil in the

(Continued on Page 121)

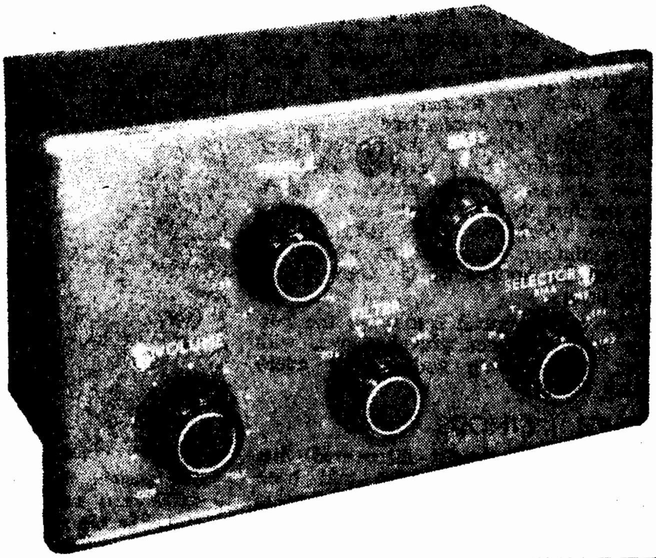
The ancient structure of Stonehenge, one of history's wonders, dates back nearly 4,000 years, and is apparently a sun-worshippers' temple erected by a long-vanished race. The big sarsen stones are more than 16ft. high and weigh over 50 tons. No one knows how they were erected, or transported 200 miles to the plains of Salisbury. This picture was taken during the snows of 1957.



The Department of Works is endeavoring to raise fallen stones at Stonehenge into their original positions. Here a 60-ton crane lifts stone 58 from a hole. It is one of *the uprights of a Trilithon and has lain half buried for many years. Radio-active* tracers were used to test the condition of a crack in the stone before it was lifted. The lump on the end is part of a mortice and tenon joint which fitted the lintel resting on each pair.

NEW RD JUNIOR

High Fidelity System



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- Output Transformer with grain orientated laminations.
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- Unique "Impedance Plug" speaker matching.
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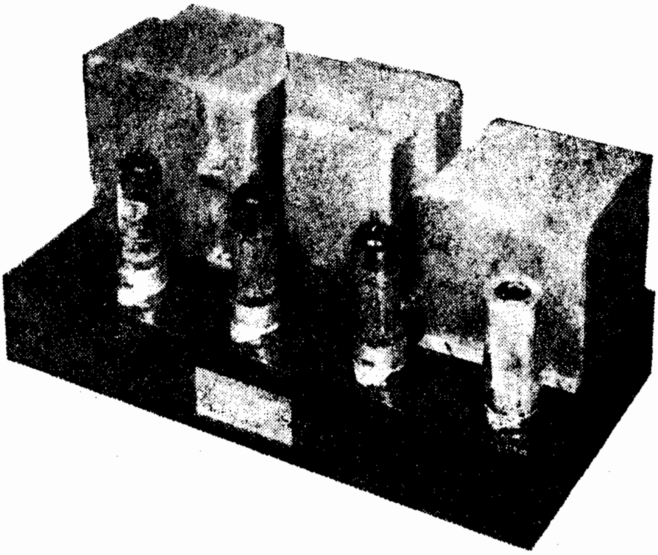

CONTROL UNIT

- Four Record Characteristics.
- Two Radio Inputs.
- Provision for microphone.
- Simplified pick-up matching.
- Tape Record and Replay sockets.
- Switched Bass and variable Treble controls.
- Ultra Compact.
- Independent continuously variable low pass filter.

TECHNICAL SPECIFICATIONS

Frequency Response: + or - 1 db 30-20,000 cps. 10 watts 12% at 1 kcs 12 watts 2% at 1 kcs.

Hum and Noise: - 85 db below 8 watts

Output Impedance: 12-16 ohms 6-8 ohms. 2-3 ohms.

Spare Power: 285V. at 40 m/A. 6.3V. 2.5A.

Overall Dimensions: 11" long, 6" deep, 5¼" high.

Weight: 15 lbs.

Operating Voltage: 200-230-250V. 50 cps.

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Technical Review

TECNETRON — COMPETITOR OF THE TRANSISTOR?

This article originally appeared in Tout le Radio, a French journal published in Paris by M. E. Aisberg who prepared it. The device described, neither a spacistor nor a transistor, shows the greatest promise on ultra-high frequencies.

Hardly a month passes nowadays without the announcement of some "sensational" new amplifying device. The great majority of these startling inventions, after their brief flurry in the popular and technical press, disappear into oblivion. But we believe that the Tecnetron, just announced in France, has a brilliant and enduring future.

The most remarkable feature of this device is that its transconductance increases with frequency, unlike more common semiconductor amplifiers whose performance falls off as frequency increases and becomes very low as the cutoff frequency is approached.

Up to the present, frequencies in the order of 500mc have been attained with the Tecnetron. And, as further work and research make it possible to reduce the capacitances of the contacts and other parts of the montage, there seems to be nothing to prevent it from functioning at 1,000mc or even higher.

It has been possible—with a Tecnetron working in class A at 500mc—to obtain a power output of 30mw, with a dissipation of 125mw. Since the characteristics of individual Tecnetrons are very consistent, one can envision the paralleling of several identical units to obtain watts—or even kilowatts—of power. This may make it possible to use Tecnetrons in applications requiring heavy currents.

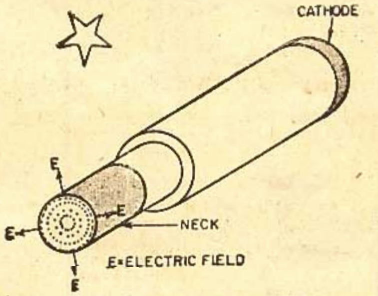
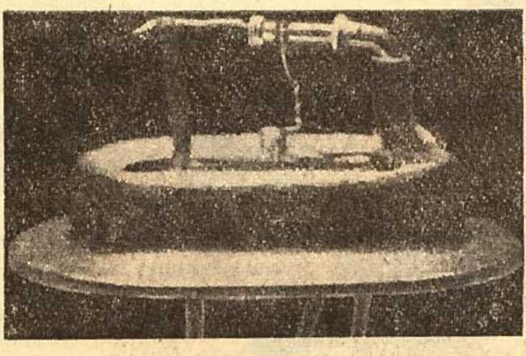


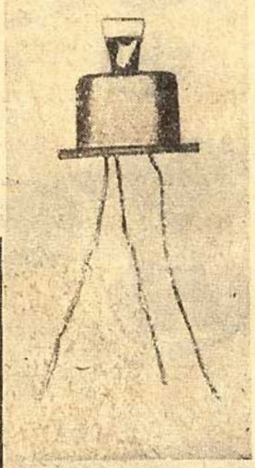
Fig 1—Tecnetron cut to show cross section of the neck. The space charge E tends to drive the conducting area toward the centre of the rod.

In addition, the Tecnetron—though using germanium—is less sensitive to high temperatures than the transistor. It will operate at temperatures 20 degrees Centigrade higher than will transistors. This should extend its field of applications considerably.

Below—A close up view of the Tecnetron the construction of which is not the same as that of the transistor.



Right—The Tecnetron as finally made up in its metal case with connecting wires.



Neither is it a fragile experimental device that works only under laboratory conditions. Pilot production by regular industrial methods had begun on a small scale at the time of its announcement.

About 700 units per month are being produced, and indications are that production could quickly be increased to the thousands.

WHAT IS THE TECNETRON?

First, why is it the Tecnetron? The first syllable of the name begins as does that of its inventor, S. Teszner. The initials CNET follow. These stand for the Centre National d'Etude des Telecommunications (National Centre for the Study of Telecommunications), that great ensemble of research laboratories sponsored by France's Ministry of Posts, Telegraphs and Telephones. And of course the final syllable is the conventional one for such electronic devices.

Now, how is the Tecnetron constructed? It is a small rod of n-type germanium, 2mm in length and 0.5mm in diameter, provided with two contact electrodes at the ends. These must be of such material that they act solely like electrical conductors and not like transistor junctions.

The germanium rod is reduced in diameter at its centre (Fig. 1) to form a "bottleneck" of very small diameter (about 30 microns). Around this neck is placed a cylinder of indium. This makes a metal-to-semi-conductor barrier-layer contact of excellent characteristics. The ratio of forward-to-back resistance is greater than a million to one.

A relatively high potential (50 volts or more) is applied to the electrodes at the end of the rod. These may be called the cathode and anode. The cylinder of indium might be called a grid, for it plays exactly that role. The inventor prefers to call it the "bottleneck" or simply the "neck" to indicate its method of action better.

The neck is polarised negatively with respect to the cathode, and the circuit of a stage of amplification (Fig. 2) is like that of a tube triode, with the load resistance placed in the anode circuit in series with the supply voltage.

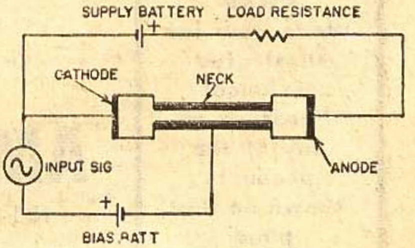


Fig 2—Schematic of Tecnetron hook-up.

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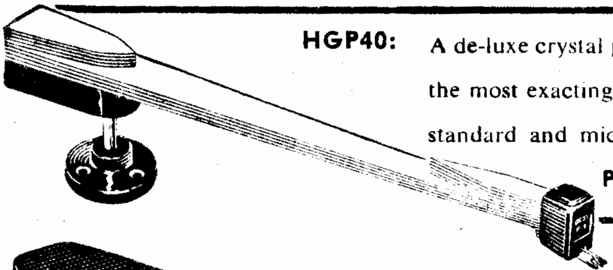

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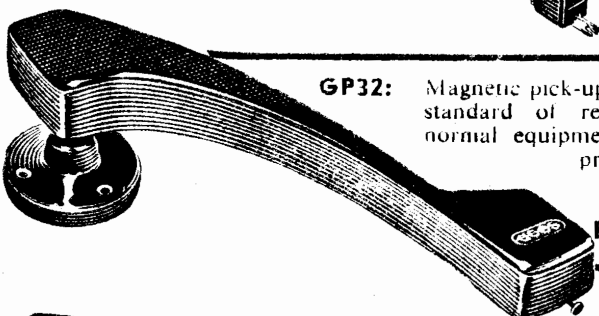

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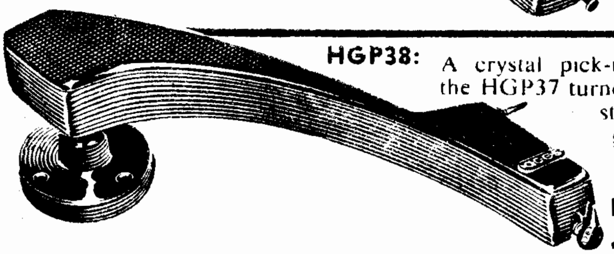

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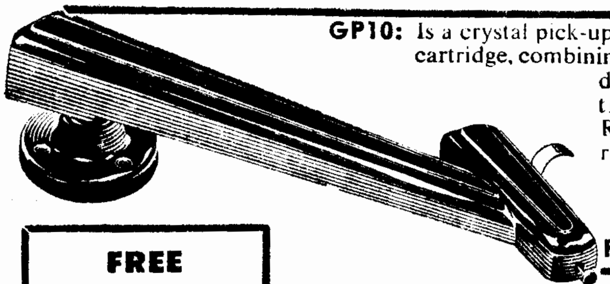

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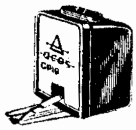

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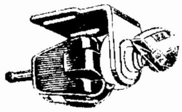

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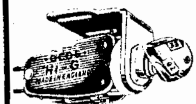

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Is this device not essentially that which Shockley called a "field-effect transistor" which he described in the Proceedings of the IRE (November, 1952; Vol. 40, pp. 1365-76) and with which he was not able to obtain appreciable gains above 2 mc? Like Shockley, Teszner has turned to the field effect, discovered by Lilienfeld in 1928. Here the resemblance ends.

Whereas Shockley worked with plane surfaces (or a parallelepiped), Teszner has utilised the cylindrical configuration.

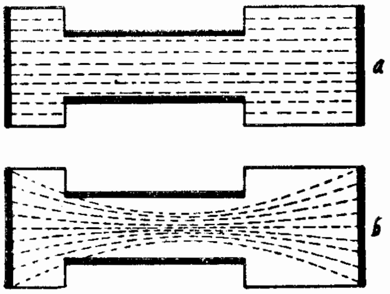

Fig 3a—Distribution of charge carriers (electrons) with neck unbiased; 3b—reduction of current path caused by negative bias on the neck.

transforming a linear effect to a quadratic one by applying a radial electric field.

What is the field effect? Our readers know of the Hall effect, due to which charge carriers in semi-conductors can be deflected from their paths under the action of a magnetic field. The Lilienfeld effect is analogous to the Hall effect, but is based on the action of the electric instead of the magnetic field.

In semi-conductors such as germanium, charge carriers (electrons or "holes") can be deflected from their paths by the action of such an electric field.

THE TECNETRON ACTION

The neck of the indium cylinder creates a concentrated electric field in the interior o fthe rod, depending on the charge on the cylinder. With no charge whatever, the current is propagated evenly through the whole area of the neck. As one applies a negative voltage to the cylinder, the electrons are deflected toward the centre, occupying only a reduced section of the rod (Fig. 3). Thus the apparent resistance of the rod increases as the active section—through which electrons pass—decreases. This action is proportional to the square of the radius.

Note well that this is a variation in the total resistance, not in the specific resistivity which remains constant.

The voltage applied to the indium cylinder causes the neck to act as if its diameter were decreased. Thus the cathode-anode current is varied, causing the voltage across the load resistor to reproduce faithfully the changes in the voltage applied to the neck, but at a greater amplitude.

The best analogy of the Tecnetron is without doubt a flexible rubber hose through which flows a current of water. If the hose is compressed more or less by the hand, the flow decreases in the same ratio. If the hose is compressed circularly—from all sides toward the centre, as by an encircling thumb and forefinger—the diminution of current will follow the square law. This centripetal constriction is an essential characteristic of the Tecnetron.

If we analyse these actions carefully, we note that the variation in resistance is accompanied by a variation in capacitance between the part of the germanium occupied by the electrons and the indium cylinder.

As the cylinder becomes more negative, it drives the electrons further from it and toward the centre of the rod, thus reducing the capacitance between the current-carrying portion of the rod and the cylinder.

As the voltage becomes less negative, the electrons flow through a larger section of the germanium and the capacitance increases. The Tecnetron acts like the equivalent circuit of Fig. 4.

These variations of capacitance, which are increased by the cylindrical configuration of the device, have an effect on the current through the external circuitry similar to that which the variations of resistance have on the flow of electrons through the germanium.

These two actions are synchronous and reinforce each other, thus increasing the gain. There is of course a very slight detuning effect in resonant circuits due to the instantaneous variations in capacitance produced by the signal. These are very small, since the total input capacitance is a fraction of a micromicrofarad and the detuning is proportional to the square root of the capacitance change

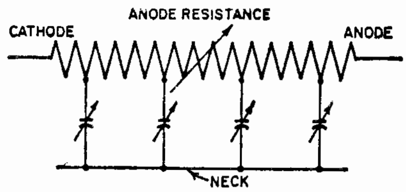

Fig 4—The Tecnetron can be considered as a variable resistance and a distributed variable capacitance.

Practically, according to the inventor, it manifests itself as a slight enlargement of the passband.

The capacitance effect, with its reduction of impedance as frequency increase, is one of the reasons for the high transconductance at high frequencies (Fig. 5) and the fact that the Tecnetron's figure of merit continues to increase with frequency. The figure of merit is the product of the gain by the width of the passband over which the gain is maintained at plus or minus 3 db.

TECNETRON AS AMPLIFIER

We have seen that the neck which acts as a control electrode is polarised negatively with respect to the cathode. Thus no appreciable direct current can flow in the cathode-neck circuit, because of the extension of the barrier layer into the n-type germanium.[1]

Under these conditions, the input resistance is several megohms. The input capacitance is in the order of 2 uuf.

The output impedance is generally higher than 1 megohm, and the load resistance thus may be chosen as high as it is practically permissible to set it; usually between 2,500 and 250,000 ohms.

If we plot the characteristics of the Tecnetron by measuring the anode current as a function of the anode-cathode voltage at various values of neck voltage, we obtain a family of curves which resemble strikingly those of a pentode tube (Fib. 6). Which is to say, that we have here an excellent voltage amplifier. The chart shows experimental results obtained at various frequencies.

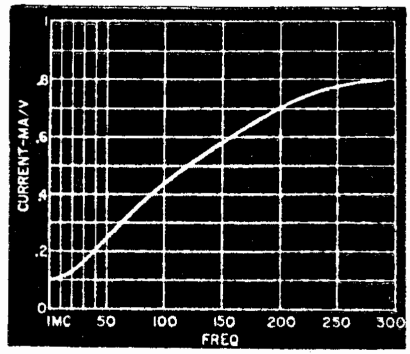

Fig 5—Variation of the transconductance as a function of the signal frequency.

MANUFACTURING THE TECNETRON

It was necessary to develop special technical methods to manufacture the Tecnetron. This was one of the major achievements of M. Teszner and the CNET researchers who aided him.

For part of the work, the classic procedures of transistor production could be followed. Then a whole series of new mechanical operations intervened; cutting the refined crystals into plates, then into little rods. This last operation was performed with ultrasonic cutting apparatus.

The constriction for the neck was made by a procedure of electrolytic etching perfected especially for the purpose. The indium was also deposited by electrolysis, with the rod in continuous rotation during the process. More conventional techniques could be used in applying the terminal (cathode and anode) contacts.

Up to the present, procedures already

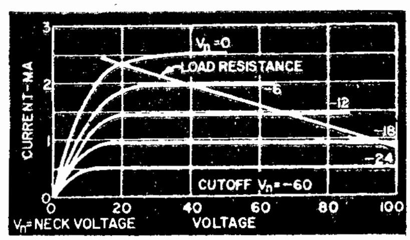

Fig 6—These Tecnetron static characteristic curves show the variation of anode current as a function of anode voltage for several neck voltages

Freq. (mc)	Gain (db)	Voltage ratio	Passband (mc)	Figure of Merit
110	22	12.9	1.7	21
200	16	6.31	6	37
460	9	2.818	29	80

developed permit manufacture on a large scale. Research is continuing, however, and the next step is the creation of a power Tecnetron and another model especially for ultra-high frequencies. Special arrangements which will permit continuing still further up the frequency spectrum are also under study. And, as always, as the area of actual accomplishment is increased, the greater become the prospects of future progress.

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MINIATURE FERRITE TUNER FOR BROADCAST BAND

Rotary-axial tuner consists of two pairs of ferrite cups with ground D-shaped centre cores ganged to produce linear frequency variation from 500 to 1,600 kc with mechanical motion. Operating frequencies can be extended to 15 mc. Tuning sensitivity is reduced as each band is covered in 270-degree rotation rather than in the 180 degrees of normal capacitor tuning.

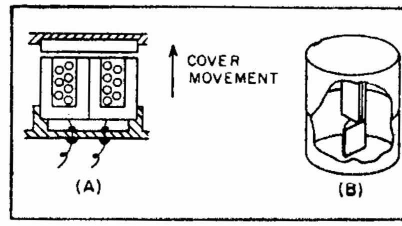


Fig. 1 — In gap tuner (A) inductance is varied by changing gap size in magnetic field path. Rotation of one cup of D-type tuner (B) with respect to the other changes length of the gap.

GROWTH in transistor use has spurred the search for miniature electronic devices.

Miniaturisation of an r-f tuner operating between 0.5 and 50 mc can be achieved with permeability rather than capacitance tuning.[1] Further, permeability tuning is free from vibration and shock troubles. A linear, permeability type tuner is described for which a 3 to 1 frequency range, maximum Q and minimum variation of Q with frequency are assumed to be desirable.

Present tuners may be classified as slug tuners, gap tuners, variometers and those that vary the number of turns on a core.

A permeability gap tuner is the best compromise between electrical and mechanical considerations. It uses the relative motion of two ferrite cups or a ferrite cup and cover plate or two C-shaped cores. Although the core material is always within the coil, the inductance is varied by changing the size of a gap in the magnetic-field path.

A gap tuner is shown in Fig. 1A. The tuning technique permits miniaturisation since the cover movement does not exceed 1/8-in. for a 3 to 1 frequency range.

NON-LINEAR

Frequency variation with cover movement is nonlinear. A 250-kc change occurs in the first 10 mils of travel, and at the upper end of the band, a 10-mil change may cause a 25-kc shift. A precise mechanical drive system is required to control the complete frequency range in a 1/8-in. travel.

Another gap tuner is shown in Fig. 1B. The centre section of the cups has the shape of a D. Rotation of one cup with respect to the other changes the effective gap length. Frequency changes of 2 to 1 are feasible with this device. Furthermore, since the complete frequency range covers a long rotary path the mechanical drive system is not critical.

The rotary-axial gap tuner takes advantage of the slow frequency variation of the D-type tuner and the wide frequency variation of the cup and cover-type tuner. It consists of two pairs of ferrite cups with ground D-shaped centre cores.

Tuner operation is described in the curves of Fig 2. Curve 1 is the frequency response obtained upon rotating two ferrite-cup cores with D-shaped centre cores without gap separation. Frequency initially varies slowly as the cups are rotated, increases to a maximum when the D figures are mirror images at 180 deg. and then decreases slowly. The curve is bell-shaped.

When separating two ferrite-cup cores without rotation, curve 2 is the frequency response obtained. The frequency varies rapidly and then reaches a point where increased gap separation has no effect.

When a tapered coil is used inside the core, the frequency response of curve 3 is obtained. Saturation frequency is 100 kc higher than in curve 2.

Composite curve 4 is obtained when both rotation curve 1 and axial-movement curve 3 are combined by a cam. Since the gap separation is small, rotation of the cup initially exerts the greater control over frequency. Therefore, the frequency varies comparatively slowly.

MECHANICAL PATH

During the first 250-kc change there is a long mechanical path of rotation rather than a short mechanical path of axial movement. As the cups are rotated 180 deg. with respect to each other, the gap separation increases until the D-shaped centre-core separation no longer affects the frequency change. Thus, the right half of the bell-shaped curve has no effect on the frequency. Beyond 180 deg. the frequency change results from gap separation, although the cups continue to rotate with respect to each other. The resulting curve 4 has a linear frequency variation from 500 kc to 1,600 kc.

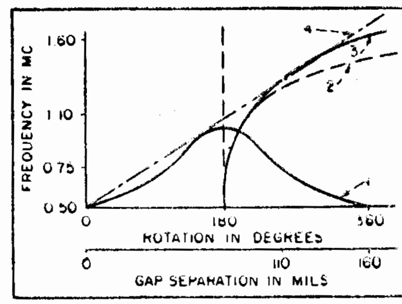


Fig 2 — Curve 4 is the linear frequency response of the rotary-axial tuner obtained by combining responses of curve 1 for D-shaped centre cores without gap separation and curve 3 for a tapered coil within the core.

By further tapering the coil the frequency range may be extended linearly to 1,700 kc. Maximum possible Q is 151.

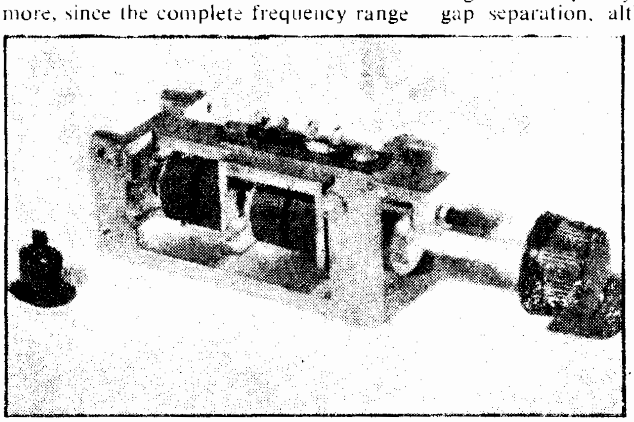
MECHANICAL DESCRIPTION

Axial motion of the cups is caused by the cam shown in the turner drawing of Fig. 3.

A cam follower is in contact with the cam. After adjusting the cam follower to provide initial positioning, it becomes a fixed element of the follower housing and provides linear movement of the axial cups in accordance with the cam form.

Linear motion of the axial cup without backlash is provided by a spring.

The portion of the shaft which is in



Rotary-axial tuner size A is indicated by comparison with transistor.

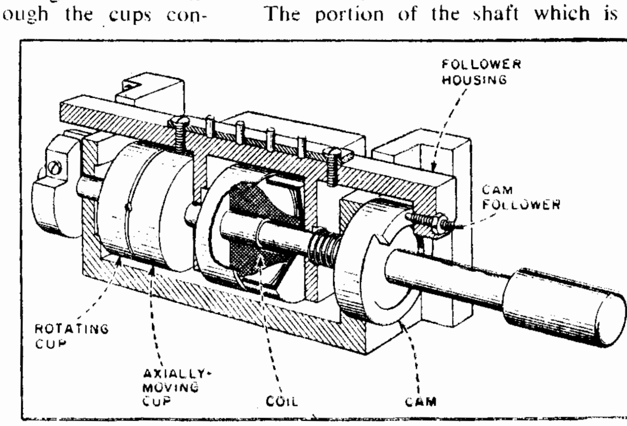


Fig. 3 — Cutaway view of rotary-axial tuner shows parts.

MINIATURE TUNER USES FERRITE CORES

(Continued from page 25)

the immediate area of both rotating and axial cups is made of a dielectric material.

Three-point tracking of the r-f coil is obtained by placing shunt and series coils, together with a new tuning capacitance, in parallel with the r-f coil. A 2 to 1 oscillator-frequency range results The oscillator tuning follows the r-f tuning curve as shown in Fig. 4.

To show the application of the tuner to transistorised circuits, the tuner r-f coil is connected by a capacitance divider to the input of the transistorised mixer circuit shown in Fig. 5. Mixed output is fixed tuned with a coil resonant at 455 kc.

The oscillator coil of the tuner is connected through two trimmer coils to the collector of transistor Q2 which acts as a Clapp oscillator. The oscillator signal is capacitance-coupled to the emitter of the mixer stage.

After making adjustments for stray capacitance, the tuner operates with the linearity and tracking characteristics of Fig. 4.

Tuners covering the ranges 1.5 to 5 mc and 5 to 15 mc have the same frequency slope as the broadcast-band tuner, and therefore can be used with the same cam. When the coils are successively tapped down after each rotation of the cam, a semi-continuous tuner can be constructed. A coil wound with several taps is placed in ferrite cups and tested in an r-f tuning jig. The bands from 0.5 mc to 1.5 mc and from 1.5 mc to 5 mc are easily covered by tapping down the coil. The highest band shows an upper-frequency limit of 7.3 mc. The total frequency ratio obtained is 14.6 to 1 with the same turner.—Electronics.

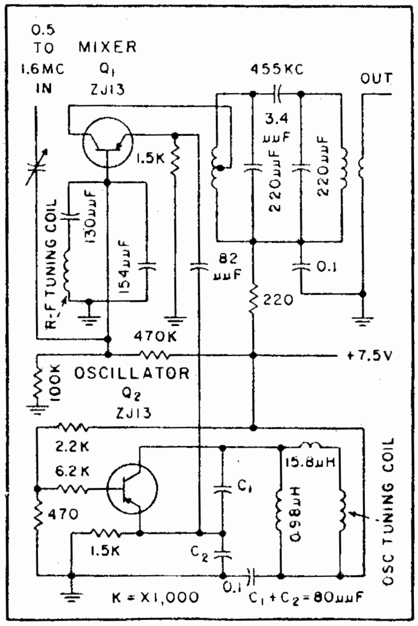


Fig. 5. — Transistorised circuit checks RF tuner whose linearity and tracking characteristics are shown in Fig. 4.

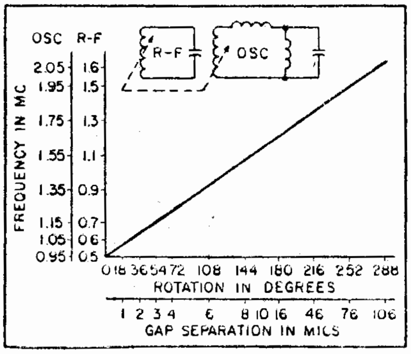


Fig. 4 — Straight-line tracking is achieved with rotary-axial tuner.

BIG ELECTRONIC PLAN FOR CITIES IN U.S.A.

Electronic systems such as VHF radio and automatic electronic control are being adopted on a wholesale scale overseas. For Philadelphia is planned the largest mobile radio system yet installed. Detroit plans traffic control aids.

Two cities—Philadelphia and Detroit—are making news these days.

Philadelphia recently invested $600,000 for what police officials call "the most extensive system of microwave communication in municipal use." Project will be done by RCA.

The system will include four primary and 12 secondary base stations, all attended. They are designed to be multiplexed in varying combinations to blanket the city. Special alarm systems for failure detection will be provided.

Mobile units will include 570 two-way radios and 250 public address amplifiers in patrol cars and other vehicles.

Unique features of the system will be a punch-card centre for recording and routing incoming calls, and a display board indicating location and availability of police vehicles.

This combination will allow central control dispatchers at city hall to send a patrol car to any location within seconds of receiving calls.

Installation of the system was begun this month. It is expected to be in full operation by mid-June.

WARNING SYSTEM

In Detroit, a new system for warning expressway drivers of impending danger through a series of electronically operated signs that flash traffic messages is now being drafted by the city's department of streets and traffic. The proposed experiment would cost more than $100,000.

The system would call for the signs to be built on the faces of expressway bridges where they would be used to warn drivers to slow down or leave the expressways.

The signs would be operated electronically from a central control room, which probably would be located in police headquarters. Blacked out when not in use, the illuminated signs would flash such messages as "Troubles Ahead," "Speed Limit 30" or "Use Next Exit." All three of any combination of the messages could be flashed simultaneously.

BBC TELEVISION CENTRE TAKES SHAPE

BRICKS and concrete are rapidly covering the vast skeleton of the B.B.C's Television Centre in West London which when completed will be the largest television headquarters in Europe.

When BBC Television—the oldest public television service in the world—first opened on November 2, 1936, it operated from two studios, small by modern standards, in the exhibition building called Alexandra Palace in North London, and through all the years of its enormous expansion it has never had a headquarters built specially for television and capable of housing the bulk of its requirements under one roof.

The new Television Centre stands on a thirteen-acre site, acquired by the BBC in 1949, and will consist of an impressive Main Block containing seven studios and several hundred offices; a Scenery Block, which has been in service for some years and includes workshops, storage space for scenery and about 200 offices; a Restaurant Block now being fitted out to accommodate 750 diners at a sitting; a Works Block; and eventually a "spur" or "tail" running out from the Main Block. The total cost, over eleven years, will be £9 million pounds sterling.

Four of the seven studios will be bigger than any television studio now in use in Britain and the largest (measuring 108 feet by 100 feet by 54 feet high) will have a pit which could be used for aquatic programmes, and a floor designed to carry heavy loads—for example, double-decker buses or parades of elephants. It will accommodate an audience of 600 people.

Each studio will have its air conditioning plant, and the studios have been so planned that they can be adapted for colour transmissions when these become practicable. It is expected that four of the studios will be in use in 1961. In addition to studios, there will be 120 dressing rooms on the ground floor and basement providing accommodation for about 550 people.

The Continental Control Point for Eurovision programmes shown on BBC television, which is at present at Broadcasting House, will also be housed in this "central wedge," while on the roof of the section there will be facilities for outdoor filming.

Offices, Wardrobe and Make-up Sections, the Music Department, and the club premises for BBC staff will all be included in the Main Block, on which 700 men are at present at work.

The block will contain 8 million bricks, 4,300 tons of steel, 2,500 doors and 55,000 tons of concrete. During construction concrete, already mixed, is being delivered by pipeline under air pressure all over the structure from central mixing points.

IRC
AUSTRALIA

HIGH STABILITY PRECISTORS

I.R.C. High Stability Precistors are supplementary to the well-known range of I.RC. Metallised Resistors, and are ideally suited for applications where resistance stability over long periods is important. Under normal load conditions it can be expected that the resistance change in value will be less than 1% over life. A range is available from local production.

These new I.R.C. resistors have been developed to meet the latest needs of modern electronic and electrical circuits, and also overcome inherent inadequacies of conventional-type resistors. They are ideally suited to critical circuity needs where stability over long periods of time is important. The high stability type of resistor is outstanding in its ability to provide permanence of resistance, low voltage and temperature coefficients, low capacitance and inductive reactance in high-frequency applications

I.R.C. high-stability resistors are particularly recommended for:—

1. **Circuits in which characteristics of carbon composition resistors are unsuitable and wire wound precisions are too large or too expensive.**
2. **Metering and voltage divider circuits requiring high stability and close tolerance of resistance values.**
3. **High frequency circuits where accuracy and stability are required but where wire wound resistors are unacceptable.**
4. **Loading of tuned circuits to improve band pass characteristics at high frequencies.**

Type	Commercial Rating at 40° Ambient	Resistance Values	Length	Diameter	Maximum Working Voltage
DCC	½-watt	75 ohms to 2 megs.	9/16"	5/32"	350
DCF	1-watt	150 ohms to 3 megs.	29/32"	19/64"	500
DCH	2-watt	300 ohms to 5.1 megs.	2-1/16"	19/64"	750

TOLERANCE: Precistors are available in standard preferred values only. Where specials are required we suggest the use of series or parallel arrangement of standard values to obtain the special value necessary. Tolerance: 1, 2 or 5% standard.
VOLTAGE COEFFICIENT: Type DCC is less than 20 parts per million per volt. Types DCF and DCH approximately 10 parts per million per volt.
TEMPERATURE COEFFICIENT: Between -.02% and -.08% per deg. C.

Contact your usual supplier for full details

Designed to combine accuracy and economy for close tolerance applications where long term stability is essential

Sole Australian Agents:

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126 SUSSEX STREET (near King St.), SYDNEY. BX 1131.

NEWS AND VIEWS OF THE MONTH

Russian nuclear plane

REPORTS indicate that Russia is planning to put a nuclear plane into the air this year.

A secret four-jet bomber, a new version of the unsuccessful Bison, is being adapted to carry a nuclear engine.

Reportedly heading the Soviet nuclear air power team is a former Cambridge professor, Peter Kapitza, the mastermind behind the sputniks.

He went over to the Russians from his Cambridge laboratory in 1935.

A nuclear plane could circle the world for days without landing or refuelling.

Unless it were denied air space over Western territories, it could show off its capabilities to every nation.

The Russians quietly forecast their nuclear plane two years ago.

★ ★ ★

Interference with TV

A RECENT report from the Post-Master General's Department listed 586 complaints about interference with reception of TV in Australia during 1956-7.

The main causes of interference proved to be—

- Poor installation of aerials.
- Receiver faults or improper adjustment.
- Induction from high tension lines.

But, in general, the interference problem does not appear to be a serious one. This is largely because of the high signal strength provided by the stations over a reasonable service area.

It is noteworthy that, in the list of interferences quoted, not one is due to the operation of an amateur transmitter.

This point is well worth mentioning, for at one stage it was thought that amateurs might have their own troubles in this matter.

And there used to be a standing tendency, now happily not so prevalent, to blame the amateurs for any strange noises which might appear in a radio set.

So far, they seem to have a pretty clean sheet, although they have their own active committees to co-operate with viewers in case of difficulties.

★ ★ ★

TV links in Australia

ACCORDING to the Postmaster-General (Mr Davidson), P.M.G. engineers are working on a research project to determine the most efficient and economical method of relaying TV programs throughout Australia.

The matter is becoming one of minor urgency, for quite soon work will commence on TV stations for other capital cities and centres in Australia. Without an adequate system of relays, TV stations will be greatly handicapped in their task of covering the Continent with spot news.

There are two main methods of carrying programs over long distances—co-axial cables and micro-wave links. The type of country through which communication must be made largely determines which method is the most economical and practical.

It is highly probable that a combination of both methods might be the best to use.

Radiation and flu

COSMIC radiation from outer space may be the mysterious factor which triggers off deadly world-wide epidemics like the recent Asian flu outbreak, according to the former deputy chief medical officer at the Health Ministry (Sir Weldon Dalray) in London.

His theory aroused immediate scientific interest.

Sir Weldon said the influenza virus normally did little damage, but cosmic radiation caused a deadly new strain to appear in many different places at once.

The director of the World Influenza Centre (Dr C. H. Andrews) commented: "I think this may be an important discovery—the theory would certainly explain baffling world-wide outbreaks."

★ ★ ★

New light on strokes

THE average man who suffers a stroke can expect another within two years, according to Irving Wright, an American heart specialist.

Doctors are now concentrating studies on cerebral strokes.

Some strokes are the result of a cut-off in the supply of blood to the brain, starving some brain cells from lack of nourishment.

Other strokes come from the bursting of a blood vessel and drowning of part of the brain in blood.

Doctors now understand that strokes are not isolated accidents, causing brain damage, but, instead, a sign of generalised disease.

POPULAR SCIENCE QUIZ

Q: What is the method by which a space rocket obtains its power? How can it operate like a jet motor when there is no air in outer space for it to push against?

A: This is an old one which crops up so often that the answer cannot be repeated often enough. Unlike an aeroplane which uses a propeller or air-screw, a rocket does not need air to send it along. The word air-screw, which is the correct name for an aeroplane propellor, presupposes the presence of air through which the whirling blades can literally screw themselves, and it is the resulting air pressures which are set up that make the aircraft move. Without air, such a machine could not move along, let alone fly in the air.

Jet aircraft use air pressure on the wings to keep them up, but the source of forward power comes from the principle that every action has an equal and opposite reaction, to state it in simple terms. The thrust of hot gases out of the jet engine proceeds with great force, and it is the reaction to this force which produces the thrust. In air, there is an added advantage for such engines in that it can be used to mix with the fuel, entering at the front of the engine and of course emerging at the rear. But as far as efficiency goes, the air is a nuisance, for it absorbs considerable power as the machine is forced through it. In outer space, there is no air to help combustion, so that a rocket must carry all its own fuel. But there is no air to impede progress, and little if any gravity either, so that virtually all the reaction forces from the motor are available to send it along.

Q: What makes the noise when a whip cracks? Surely a piece of frayed string isn't strong enough to do this?

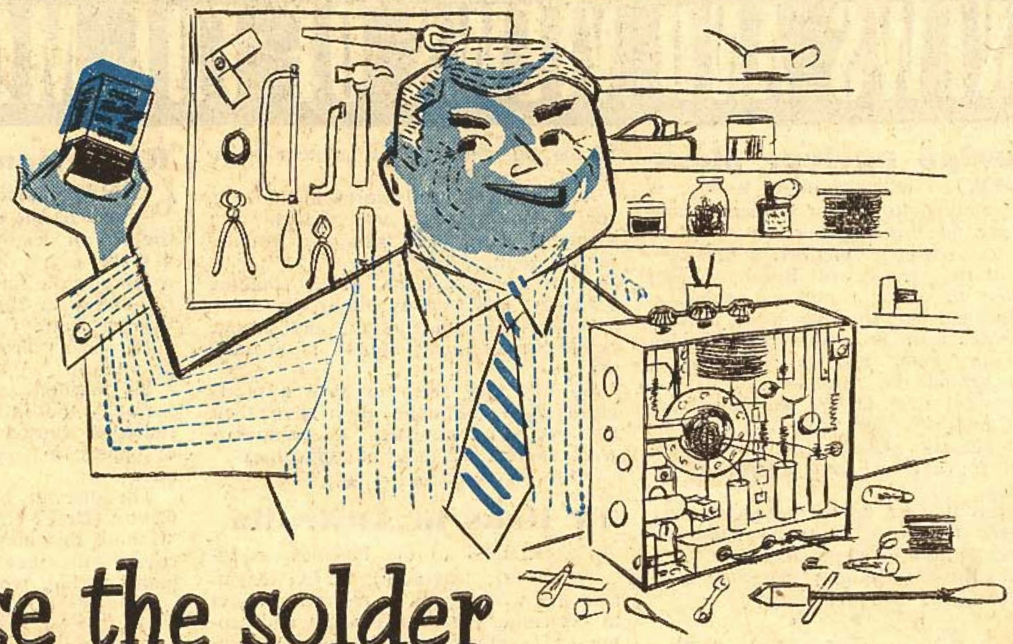
A: That's a point which has puzzled men for ages, particularly as some people seem to be able to crack whips more easily than others. Moreover loud cracks can be produced by comparatively little expended energy by some, while others flail the air to little avail.

Scientists have now discovered that the crack is caused by the tip of the whip moving so quickly that it literally breaks the sound barrier and produces a miniature version of the bang which occurs when an aircraft does the same thing. The aircraft bang is low pitched because as a rule it occurs some distance away, and like a thunderclap, loses most of its high frequency sounds travelling toward us.

But we are close to the wielder of the whip, and so we hear the sound as a sharp crack. It is estimated that, properly wielded, a whiplash, mainly in its sudden reversal of direction, can reach a velocity of 1000 miles per hour.

Q: Why doesn't the sun burn us up?

A: Because the earth's atmosphere absorbs enough of the harmful rays to prevent it. We must remember that we live in this atmosphere because our life has evolved to suit its conditions and these include the amount of radiation of all kinds received from the sun. We can, however, conceive of life forms which could perish very rapidly. Imagine, for instance, a skin structure so sensitive that it would burn in the presence of any ultra-violet. It would only be an extreme and opposite example of a skin which some people appear to possess, which makes them apparently immune from sunburn.



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I know Multicore. I know leading radio and television manufacturers in most countries of the world, including U.S.A. use it exclusively. For Multicore is the only solder with more than one core of flux built right in to the solder itself. Multicore has five!

This is complete protection against dry joints . . . and as Multicore uses only virgin metals, every inch is top quality.

I like the dispenser pack — the wire draws from the top without twisting or damage.

I like the fact that you use far less Multicore on every joint. Top quality, convenient, economical and now made right here in a modern Australian plant. What more could you want?

HOW TO USE MULTICORE—apply Ersin Multicore Solder simultaneously with the iron or other means of heat to the clean components to be soldered. No additional flux is required. Only apply solder direct to the iron for tinning. Do not carry solder to the joint on the iron.

MULTICORE SOLDERS (AUST.) PTY. LIMITED

43-51 Nelson Street, Annandale, N.S.W. LA 3666

AVAILABLE FROM ALL LEADING ELECTRICAL WHOLESALERS AND HARDWARE AND RADIO SERVICE STORES

B.B.C. try TV on UHF

ON Monday, May 5, the BBC commenced a second series of high-power experimental television transmissions on UHF in Band V (610 Mc/s - 960 Mc/s) from the Crystal Palace. The purpose of these experimental transmissions, as in the first series, is to test the suitability of this band of frequencies for television broadcasting.

The first series of tests, which ran from November 1957 to the end of March 1958, used the normal British 405-line television standards, the same programme being transmitted in Band V as in Band I so as to provide a direct comparison.

The second series of tests, which will continue for three months, will use the Western European standard of 625-lines and the results will be compared with those obtained in the recent 405-line tests. It is hoped that these further tests will throw some light on the problems which would be encountered if it were decided to use the 625-line standard for a television service in Bands IV and V. There is no intention of making any change in the 405-line standard used by the BBC in Band I.

FREQUENCIES

The experimental transmissions will use frequencies of 654.25 Mc/s (vision) and 659.75 Mc/s (sound). As in the first series the transmissions will be in black and white only.

The test transmissions have been planned by the BBC in co-operation with the Television Advisory Committee and the Radio Industry. A number of experimental receivers will be used and the BBC, the Post Office, the D.S.I.R., the I.T.A., and the Radio Industry will make a comprehensive study of the received pictures.

* * *

Britain's new defence

BRITAIN has re-affirmed her intention to rely upon nuclear rockets for defence.

The Government has been strongly criticised for not proceeding with manned aircraft of phenomenal performance.

These include fighters much more advanced than the supersonic P1 fighters of today, and bombers with a performance far exceeding that of the Victoria and Vulcan jets.

Many of these are in a stage of advanced development, but no date has been mentioned by which they will have completely taken over the country's air defence.

To bridge the gap between the present and the rocket equipped future, production of the high rating aircraft now used will be increased.

But eventually they will disappear from the front line.

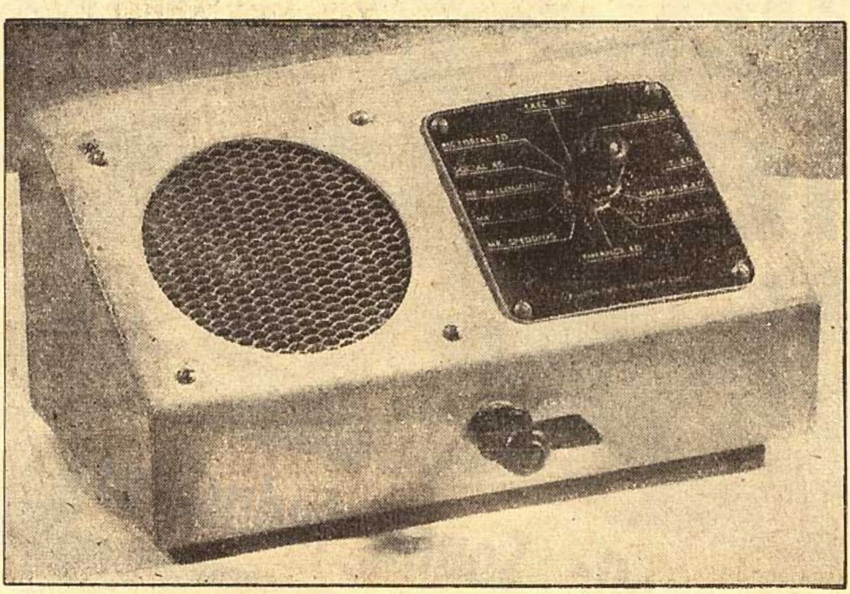
The rockets in which Britain would pin her faith are:

A ballistic rocket launched from underground and more advanced than anything of the same type being developed by the U.S.

A propeller bomb with nuclear warhead that can be fired 100 miles or more from the target.

Long-range ground-to-air missiles to combat Russia's gigantic strategic bomber force.

Anti-rocket rockets.



The neat sloping-panel metal case is in keeping with the new and highly efficient circuit used for the amplifier. Dimensions are: 8½in by 4½in by 4in deep overall.

A Transistorised Intercom. Unit

The greater availability of transistors now allows us to consider quite a few audio devices, and an office intercom. system represents almost an ideal application. We have taken the opportunity to include the results of many experiments with various transistors and transformers available at the present time.

by Maurice Findlay

THERE will be many readers who have joined us since the description of the previous intercom units or who have forgotten the original article and therefore we can profitably take a little space discussing the requirements of a suitable system again.

For example, the system should be capable of accommodating a reasonable number of units. In our case this is limited only by the number of positions available on a switch. A standard switch, readily available, permits 12 stations per system.

NO INTERFERENCE

Two-way conversation between any two stations in the system should be possible. The conversation between these two stations should not interfere with a conversation between any other two stations.

In order to satisfy this requirement a separate amplifier is required for each unit.

Complete secrecy is regarded as essential. No station should be able to listen in on a conversation directed toward another.

A press-to-talk system, together with a simple method of selecting the station to be called, is to be considered essential. In busy offices the very purpose of the intercom may be its advantage over the existing telephone in the matter of speed and convenience. Since you have only up to a dozen stations to choose from at the most the intercom selecting system should allow much quicker contact than a six-digit telephone number or even a four-digit house phone system.

It is considered that battery operation is to be preferred to power mains operation. A mains-operated system must be left with all units always in operation, otherwise a called station may not be able to reply immediately. Neither the battery amplifier previously described nor the transistor amplifier here have an appreciable warm-up time.

The switching system can be arranged so that power is being used only when the system is actually in use. The current drain of the transistor amplifiers is so small that even with greater than normal use the battery will last virtually as long as if it were standing on a shelf unconnected. Because there are no filaments left running the cost of power from the batteries will actually be less than for a mains-operated system.

It would be possible to operate the transistor amplifiers from the mains given a suitable rectifier, but batteries are so cheap compared with the cost of the power supply that it just isn't a proposition.

HOW IT WORKS

Before going on to discuss the design of the amplifier and the cabinet wiring in detail a general picture of how the system works will be of interest. You can regard it as a block diagram in words if you wish.

Each unit contains a speaker, an amplifier and two switching systems. A number of wires run between the units. Actually there is one wire for each unit in the system plus an individual return (or earth) wire. Yet another wire distributes power for the amplifiers to each unit from a central source. This is convenient, since only the one battery is then required to power all units.

If for example there is a total of five units in the system the interconnecting wiring will be required to have a total of six conductors, plus the earth return system, about which we will have more to say later.

The essential point to understand is that each of the lines which circulate throughout the entire system is the receiving line for one of the units. When each unit is in the receive, or normal, position the speaker is connected directly between this line and earth.

However, when a station is used to "talk out," the speaker is switched to behave as a microphone, with its output fed into the input of the amplifier. The output of the amplifier is fed to one of the lines as selected by the switch.

PROCEDURE

For the sake of an example let us say that the general manager on station 2 wishes to contact the sales manager on station 5. For a start the speakers in both intercomm units 2 and 5 will have been connected by a link inside the respective units, across lines 2 and 5 respectively.

The general manager turns his selector switch to position 5. He then presses his "press-to-talk" switch, when three functions occur simultaneously. The speaker is switched to the input of amplifier No. 2, the output of the same amplifier is connected, through the selector switch, across line No. 5 and power is applied to the amplifier. The chain from microphone through the amplifier to the required speaker is then complete and the general manager can have his say.

When the sales manager replies the position is reversed. The speaker in unit No. 5 now behaves as a microphone, the amplifier in the same unit is energised and the speaker in unit No. 2 receives its output through No. 2 line.

The one possible catch here is that the general manager will have to identify himself before speaking out, otherwise No. 5 will not know where to turn his selector switch. The chances are in most circumstances that No. 5 will recognise No. 2 by his voice. ("That old so-and-so again.") Of course the G.M. could be speaking from another office, when it would be necessary to say "Speaking from No. 4," or something else to identify his position.

HANDLING TWO CALLERS

Another possibility with this system is that two stations will call a third station at the one time. In this case the voices of both callers will be heard and the called station will have to switch to one and ask him to wait a moment, depending on which is the more urgent.

As you will have already seen, the essentials of the system are not difficult to grasp. It has been installed in a number of offices with which we have had personal contact and proved to be a great timesaver. The one facility that it lacks which could be of use in some cases is the ability to call a number of stations simultaneously in order to allow conferences. This would require that the output of a particular amplifier be connected across a number of lines at the same time.

You couldn't simply connect all the lines together at the transmitting station by pressing keys or some similar arrangement, otherwise the secrecy feature would disappear. A possible solution would be to install a switching system which connected the lines together at the transmitting station only when the "press-to-talk" button is down. Such a system requires quite complicated and special switches. While it has been used in some commercial systems it adds greatly to the cost and bulk of the units.

If the matter is so important as to require a round-table conference it is usually worth the time for all members to go to the one office.

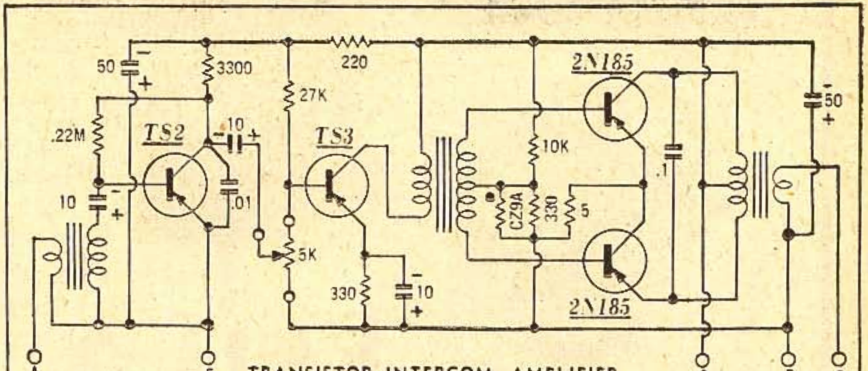
LINE IMPEDANCE

The next important general matter to come up for discussion is the impedance at which the lines should work. For a start it is obvious that it must be a fairly low impedance because the capacitance between adjacent wires in a long and closely packed cable can be appreciable and it is necessary that the capacitive reactance between the wires at the highest frequency involved be high compared with the line impedance, if cross-talk between units is to be avoided.

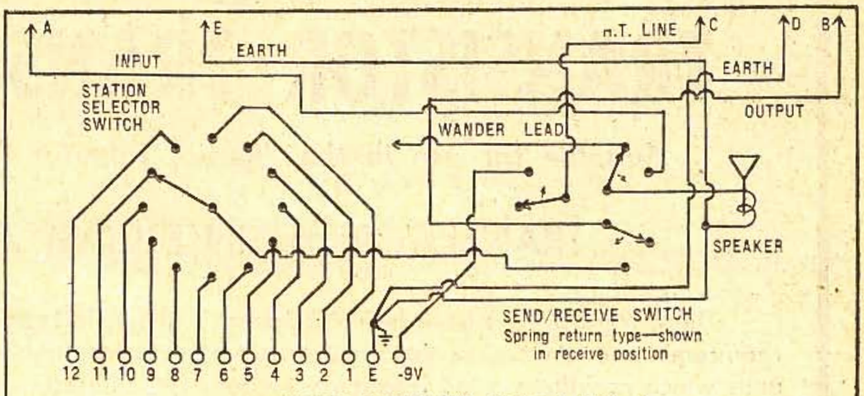
Extensive experiments in our own case have proved that it is quite practical to work at the voice coil impedance of the speakers, which may be 3.5 ohms, two ohms or something of that order. There will be some losses with longer runs, but the power output of the amplifiers and the general efficiency of the system is sufficient to take care of all but extreme situations.

If it is essential for one station to be well away from the others you can

AMPLIFIER & CABINET CIRCUITS



TRANSISTOR INTERCOM. AMPLIFIER



TRANSISTOR INTERCOM. (Cabinet Wiring)

The circuit of the amplifier, which is built on a bakelite strip, appears at the top while the wiring inside the case is shown below. We suggest that you build the two parts separately according to the circuits and connect them together when both are finished.

always use heavier than normal intercom cable, or parallel conductors, choosing the wire gauge so that the total resistance of any pair is not more than twice the nominal voice coil impedance. If, in a large system, a remote station would require to speak to only, say, two other stations in the system it would be possible to economise on wiring by extending only the leads actually required.

In commenting on the system described previously, readers have suggested that it would be a good idea to work at about 600 ohms in the case of long runs. This would certainly reduce the losses to a negligible level in any practical system but could lead to problems of cross-talk between stations due to capacitive coupling.

We have not conducted any experiments to determine just how serious the problem is or even if it actually exists at this impedance, since we are quite satisfied that the results are satisfactory at voice coil impedance.

Next, still talking in general terms, we come to the amplifier itself. In the 10 years since we first described an intercom, transistors have been invented, developed to extremely useful devices and made available on the commercial market. We are assured by the manu-

PARTS LIST

(Parts for interconnection of units not included.)

- 1 special intercom. cabinet
- 2 trailer knobs
- 1 single pole, 12 position switch
- 1 three pole, 2 position, spring-return non-shorting switch
- 1 4 inch speaker
- 1 bakelite strip, 2 3/8in by 8 1/4in
- 2 8-lug tag strips
- 2 2N185 transistors
- 1 TS2 transistor
- 1 TS3 transistor
- 1 CZ9A thermistor
- 2 special transistor output transformers
- 1 special transistor driver transformer see article

CAPACITORS

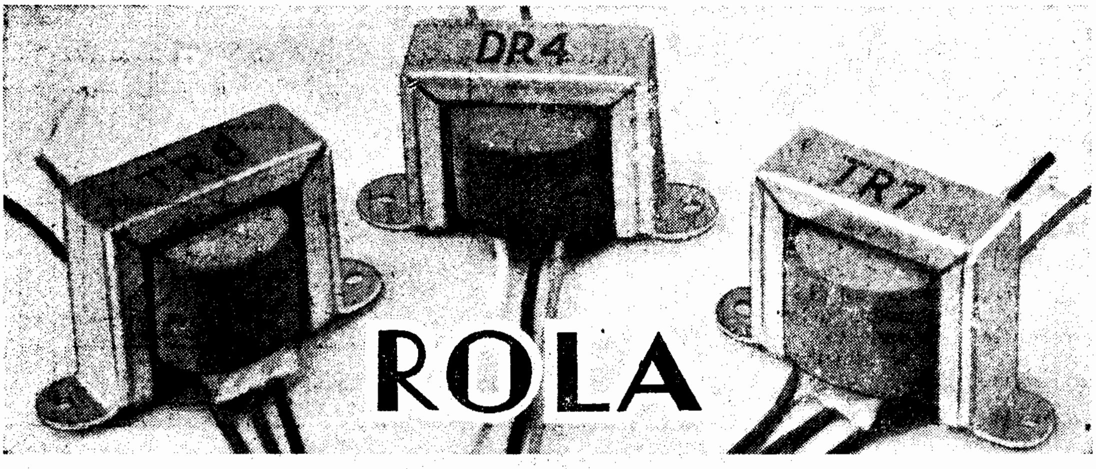
2 50uF 12 volt electrolytic, 3 10 uF 12 volt electrolytic, 1 0.1 uF 100 volt paper, 1 0.01 uF 100 volt paper or ceramic.

RESISTORS all 1/2 watt.

1 0.1 meg, 1 15,000 ohm, 1 10,000 ohm, 1 5,000 ohm potentiometer, 1 4,700 ohm, 2 330 ohms, 1 220 ohms, 1 4.7 or 5 ohms.

SUNDRIES

Hook-up wire, spaghetti tubing, rubber grommet, nuts and bolts eyelets for bakelite panel &c.



TRANSISTOR TRANSFORMERS

Suitable for use in the "Radio, Television and Hobbies"

"TRANSISTORISED INTERCOM AMPLIFIER"

These transformers have been designed in the Rola Laboratories specially to meet the requirements of Australian radio set manufacturers for highly efficient driver and output units which provide a good frequency response when used with standard type low-powered transistors.

They are intended to operate into a standard 3.5 ohm impedance loudspeaker voice coil. General specifications of the output types TR7 and TR8 are similar, but a greater signal input is required to get the increased power for which type TR8 is rated.

ROLA TRANSISTOR TRANSFORMER SPECIFICATIONS

TYPE	DESCRIPTION	IMPEDANCE OHMS	OUTPUT POWER 6 v.	OUTPUT POWER 9 v.
DR4	Driver transformer	3,000 - 1,300 c.t.		
TR7	Output transformer	420 c.t. - 3.5	150 mW	250 mW
TR8	Output transformer	300 c.t. - 3.5	200 mW	375 mW

HIGH EFFICIENCY LOUDSPEAKERS

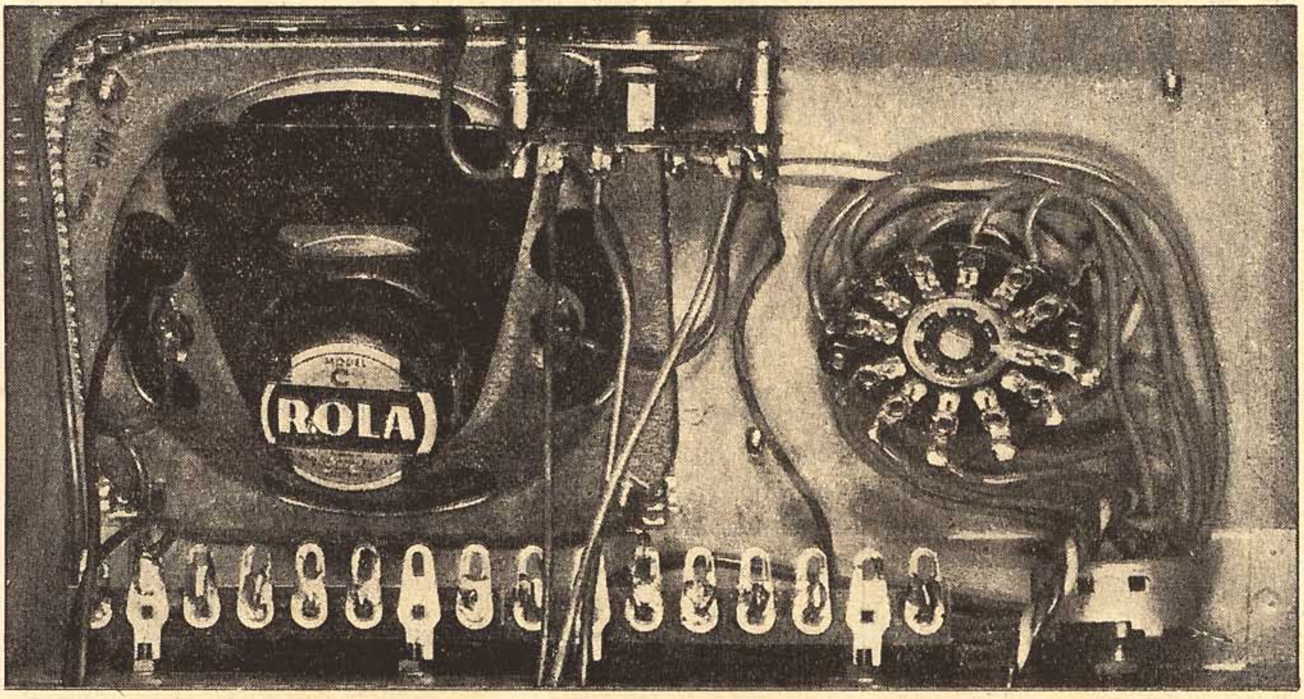
Two small high efficiency Rola loudspeakers intended for transistor or conventional battery-operated receivers have also been developed.

The first of these is the new Model 4C-05A fitted with an F44 diaphragm. This speaker is small in size — it measures only 4⅛" overall by 1¾" deep, light in weight — only 6¾ oz. (without transformer), yet has an efficiency equal to that of the earlier Model 4F. Its low cost, small dimensions and light weight make the 4C-O5A an ideal choice for miniaturised battery or transistor receivers.

Where even higher efficiency is required and space and weight are not critical, it is recommended that the Model 5F be used.

ROLA COMPANY (AUST.) PTY. LTD.

VIEW INSIDE CABINET SHOWS MAJOR COMPONENTS



All components mounted inside the metal cabinet are visible in this photograph. The press-to-talk switch is at the top, the speaker at the left with the station selector switch alongside to the right. Tag strips connecting with outgoing lines are at the lower left with the volume control pot at the bottom right.

facturers of the types specified that supplies are sufficient to meet any likely demand.

Transistors are a "natural" for a project of this nature. They are compact, extremely economical of power and, provided their quite liberal temperature ratings are not exceeded, extremely reliable. In fact, there seems no reason to suppose that a transistor will ever wear out if it is not abused, and it can be soldered into circuit in the same way as a resistor or a capacitor.

The power output of the amplifier described here is greater than that of the previous valve amplifier, while the average power consumed is less than for the filaments alone of the valve amplifier.

NON-MICROPHONIC

Transistors are non-microphonic, permitting very high gains to be achieved without undesirable effects. They do suffer from noise, but phenomenal gain figures can be achieved before this becomes troublesome, provided suitable operating conditions are chosen.

The compact nature of the transistors inspired us to produce an entirely new and smaller cabinet for the units. It is of metal and therefore there is little waste space due to its thickness. A sloping panel brings the station selector switch and the speaker at the best angle for the operator when placed on a desk at arm's length.

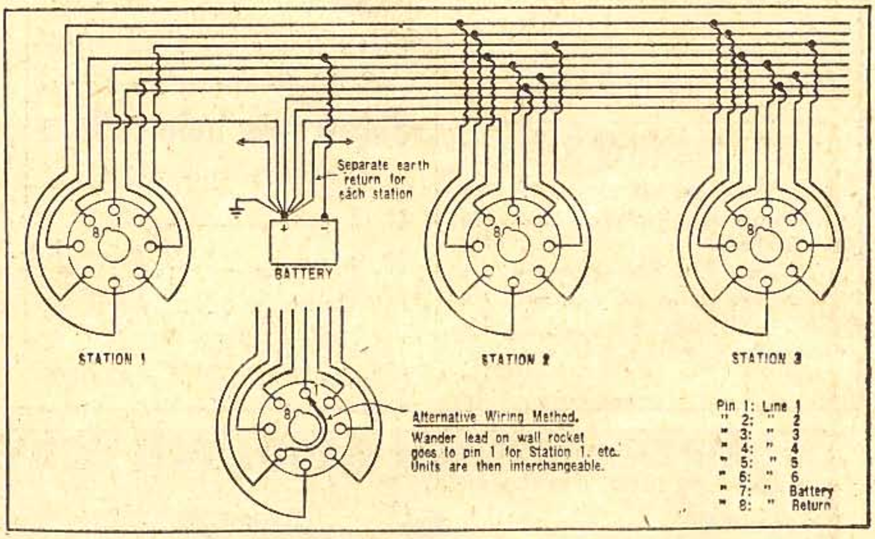
Mechanically, transistors are so arranged that there is little point in the conventional chassis form of construction. We have found that a far more suitable base for the amplifier is a strip of thin bakelite (say about 1-16th inch) with eyelets in suitable places for tag points. Both the eyelets and the punched bakelite are available commercially if required.

The speaker, the switches and terminating strips can conveniently be mounted directly on the metal cabinet, while a suitable place for the amplifier is the baseplate of the cabinet. Input and output impedances are so low that flexible leads between the amplifier and cabinet wiring can be run without any special precautions such as separation or shielding. In fact no shielded wires are required anywhere in the system, since the impedance levels in the amplifier itself are very much lower than in a valve amplifier.

A considerable amount of thought was given to the choice of selector, and especially the press-to-talk switch. While commercial units can use all sorts of elaborate switches (at appropriate cost) we are limited to components which are available through the usual radio supply firms and thence to readers.

The single-pole 12-position switch used for station selection is relatively straightforward and few readers will have cause to complain about the appearance or efficiency of this general idea.

For the press-to-talk switch we felt that a lever looking somewhat like a



A typical interconnection diagram for the intercom. units. The important point is that the earth return wires for each unit return separately to a common point, preferably at the battery. Failure to adopt this procedure will result in cross talk when more than one conversation is in progress at the one time.

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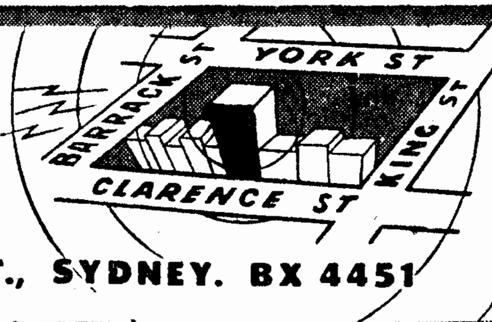

RECORD PLAYING

Collaro 3/554 Record Players. 3-speed studio, "O" Cartridge. £12/15/6

Collaro R.C. 456 Record Changers, 4-speed studio "O" Cartridge, £22/7/6

B.S.R. HF8 Player £13/5/-

B.S.R. UA8 Record Changers, 4 speed £20/10/-

Collaro Transcription Unit with 16in Arm and PX Head £31/2/6

Dual 1004 4-speed Precision Auto Changer £32/8/6

COSSOR

V.T.V.M. KIT

SETS

£29 plus 12½% Sales Tax.

Complete with instruction book, diagrams and printed circuit.

MANUALS

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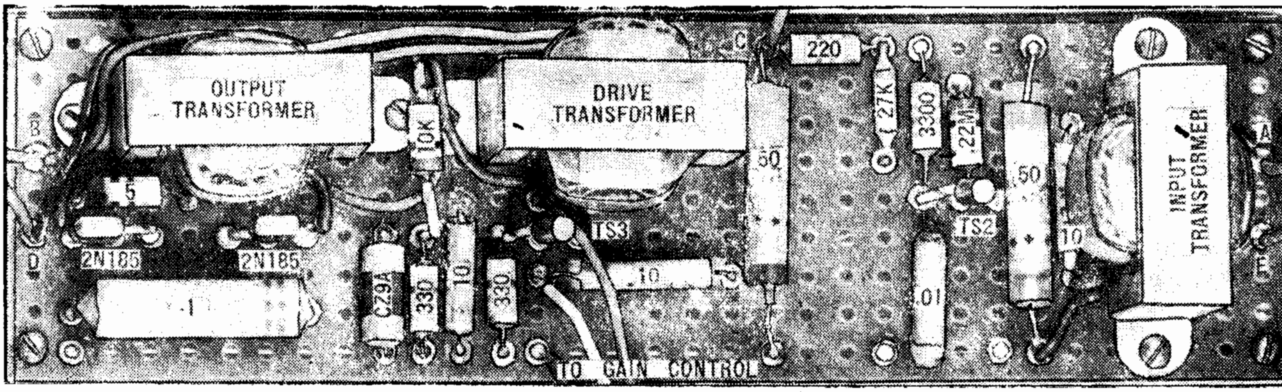

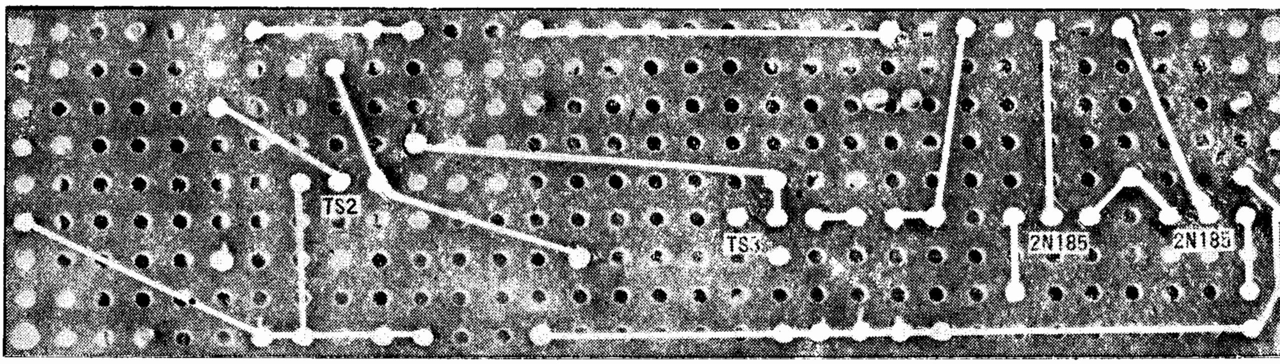

The amplifier is constructed on a bakelite strip 8¾in by 2⅜in. Solder joints are made to eyelets secured in holes in the bakelite. The transistors are soldered directly into circuit along with resistors, capacitors, &c. Transistor leads should be left 1in. long. It is desirable to use long-nosed pliers as a heat sink when soldering.

typewriter space bar attached to the front of the cabinet would fit in well with the appearance and be functional. However, we would then have had to produce a special switch or persuade a manufacturer to do so. The former would have discouraged readers without elaborate workshops and unlimited time, while the latter would have resulted in a very costly item. We therefore decided to compromise and use a spring-return rotary switch together with a trailer knob as in the earlier intercom. Both the switches and the knobs will probably have to be ordered, but apart from a few days wait there should be no difficulty about supplies.

AMPLIFIER DESIGN

Probably the most interesting feature of the new intercom. unit is the transistor amplifier. Very little knowledge of transistors is needed to construct the amplifier and provided you assemble all the specified components according to the circuit and photographs, there is no reason why each of your amplifiers should not work just as well as the original.

On the other hand, most of our readers like to know something of the design of equipment either so that they can substitute near equivalent parts or just for the sake of general interest.

Preliminary experiments indicated that a three-stage amplifier was required to provide enough gain to build up the output of the four-inch speaker, used as a microphone, to the point where it could be applied to another speaker at acceptable level. Actually, the final circuit does have some reserve of gain to allow for variations in speaker efficiency, transistors, voice levels and other factors.

A detailed consideration of the design of the amplifier can best start with the output stage. The collector dissipation rating of the largest of the readily available transistors is relatively low and it is necessary to operate the output stage in class B push-pull in order to obtain a reasonably high power output.

Having settled for class B it almost automatically follows that the driver stage be transformer coupled to the output stage. Circuits not involving a transformer are available but carry with them greater disadvantages than the cost and bulk of the transformer, in this case at least.

A big advantage of class B is that the current drain of the stage is largely proportional to the signal level: with no signal, the current drain is very low while with maximum signal it is maximum. Power is consumed only when the amplifier is actually delivering output. This makes for very high overall efficiency.

In the case of the transistor class B output stage the bias deserves special consideration because the distortion and the ability of the amplifier to operate in a stable manner at high temperatures are intimately connected with the bias circuits chosen.

Normal practice in class B amplifiers is to bias the output device, be it valve or transistor, to the point of "virtual cut-off." This is the point at which the output characteristic would intersect the zero current line if it were perfectly linear.

If the transistor is biased so that the standing current is less than optimum, excessive "crossover distortion" will occur while, if the bias be adjusted so that the standing collector current is greater than optimum, power will be wasted needlessly.

Perhaps even more significant in the case of transistor amplifiers is the increased collector dissipation which accompanies excessive standing current. Heat dissipated at the collector causes its temperature to rise above the ambient temperature. The transistor is sensitive to temperature and the standing collector current increases as the temperature increases.

If conditions are not very carefully controlled it is possible for a "run-away" condition to occur in which the increased collector current causes an increase in temperature which causes a further increase in collector current until finally the transistor destroys itself.

THERMAL INSTABILITY

Transistor circuit design is, in general, more involved than valve circuit design and one of the reasons of this is that some means of rending the operating point of the transistor reasonably stable over a wide range of temperature has to be included.

In most cases this can take the form of a network of normal resistors but there are times when a thermally sensitive resistive element can be included to give even better stability over a given temperature range.

All stages of the new intercomm. amplifier include some form of thermal stabilisation, the circuit details depending on the needs of the particular stage.

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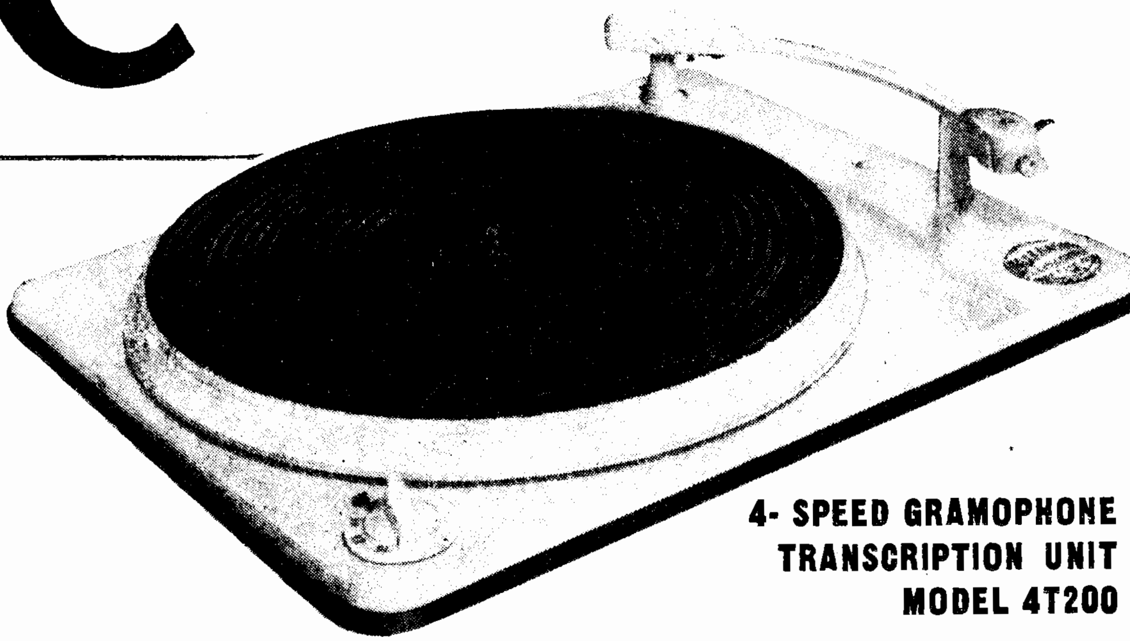

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transistor are roughly equivalent to the grid, plate and cathode respectively of a triode valve. However, there are important differences and the main value of any analogy is as a stepping stone between valves and transistors.

The most important characteristic in the case of a valve is the relation between plate current and grid voltage. The impedance looking into grid circuit is normally linear and very high, even allowing for the grid return resistor which must necessarily be included.

For the transistor the analogous relation is that between the collector current and the base **current.** For a linear output current a linear drive current must be supplied. However, the input resistance of a transistor amplifier looking between the base and emitter is not zero and, furthermore, it is not even linear.

BIAS REQUIREMENTS

Furthermore, the bias which establishes the operating point for the transistors should be essentially a current rather than voltage bias. While the resistors in the normal common emitter arrangement look similar to those in a valve amplifier with cathode bias, closer examination of the values will show that the similarity is very slight.

Another difference between transistors and valves is that valves with zero voltage bias, in most cases, draw a high current. Transistors with zero current bias draw a low collector current. In general, some bias current must be applied in order to bring the transistor to the required operating point.

For class A amplifiers the bias is chosen to bring the transistor somewhere near the centre of its characteristic while for class B amplifiers the bias is usually chosen so that there is a small standing collector current.

In our circuit, the forward bias for the 2N185's in the output stage is determined by a network of four resistors so arranged that the standing current with no signal tends to remain reasonably constant with changes in temperature. The natural stability of the circuit is assisted by the inclusion of a thermally sensitive resistor with a negative coefficient of temperature.

TEMPERATURE COMPENSATION

As the temperature increases the effective resistance between the terminals of the 330 ohm resistor and the CZ9A thermistor in parallel decreases, reducing the forward current bias and hence tending to offset the natural increase in standing collector current with increasing temperature.

The values we have chosen are what we believe to be the best compromise. If you feel that you could tolerate a little more distortion, the 10,000 ohm resistor between the negative high tension line and driver transformer centre tap could be increased in 15,000 ohms with the advantage that the standing collector current of both output transistors will be reduced. In consistently warm climates the 15,000 ohms would probably be the best choice.

The AC load into which the output transistors operate is worthy of some discussion. A number of transformers for transistors with differing primary impedances are available and readers will want to know what is the optimum.

Lower values tend to increase the power output, the transistor dissipation and the drive requirements. While we would like to have as much power output as possible, it is essential that the transistors be operated in a safe condition. We would suggest that the minimum load be 300 ohms collector to collector when the power delivered to the output line will be 300 milliwatts or a little more.

With higher loads, the maximum power output decreases and if it is desired that the output be of the order of 200 mw we would suggest that you choose a transformer reflecting a load no higher than about 450 ohms. A good all round optimum is the 375 ohms collector to collector which has been used by the manufacturers of the transistors in a suggested circuit.

The above assumes that the secondary is feeding into exactly its rated impedance which is usually near enough to being the case when a portable receiver or record player is involved. However, the resistance of the line connecting the output of the intercomm. amplifier to the speaker may easily be comparable with the voice coil impedance. The actual load reflected to the transistors may then be greater than the stated transformer primary impedance.

For example, if the speaker is connected to the amplifier through 100 feet of thin bell wire the additonal resistance introduced into circuit is about 3 ohms. Therefore, over most of the frequency range, the collector to collector impedance presented to the transistors will be almost twice the marked value, assuming a 3.5 ohm voice coil.

OUTPUT TRANSFORMER

Therefore, in cases where none of the lines between units is to be very short you could well choose the lowest of the primary impedance transformers mentioned, that is, 300 ohms.

We have already made the point that the dissipation ratings of the transistors can be exceeded if the load resistance is too low. At very low frequencies the inductive reactance of the transformer primary becomes low and at very high frequencies the reactance of the capacitor across the primary winding becomes low. (The capacitor is included to minimise crossover distortion and give a tone control effect.) Therefore, if the output transistors are driven hard at either very high or very low frequencies they could be damaged.

Trouble is only likely to occur if you attempt to measure the frequency response at near maximum output. Speech fed through the amplifier in the normal way has few sustained very high or very low notes.

Always be careful not to feed the amplifier into a shorted line.

The driver stage uses a single TS3 transistor with a resistive stabilising and bias network generally similar to that of the output stage except that the values are chosen for class A operation. Also, the stage is designed so that it has a reserve of output at any likely temperature without resorting to thermistors.

DRIVER BIAS

The forward bias current is obtained through a resistor which connects with the decoupled negative high-tension line. The connection shown has the advantage that a definite time elapses between the application of the high tension and the flow of collector current in the transistor with a consequent reduction in switching surges.

The transformer used to couple the collector of the driver transistor to the bases of the output transistors is worthy of some comment. The turns ratio of this transformer, together with the operating conditions of the driver transformer, must be chosen so that adequate drive is applied to output transistors. Furthermore, this drive must result in linear output from the output transistors with the driver current drain as small as possible consistent with other requirements.

A number of driver transformers are available with ratios varying from 1 to 1 primary to full secondary to about 2½ to 1 primary to full secondary. All will work satisfactorily, but it is interesting to note the factors limiting the performance at the extremes of the range.

In the case of a transformer with a low primary impedance the current drain of the driver stage must be high in order to develop sufficient power to drive the output stage fully. If taken to the extreme, this can lead to either or both the transistor's current and dissipation ratings being exceeded.

Going to the other extreme, if the primary of the driver transformer has a very high impedance, the collector of the driver transistor will not be able to swing over a sufficiently wide range to drive the output transistors to full output. This is because the peak-to-peak voltage at the primary of the transformer is limited to twice the supply voltage of the driver transistor (or a little less).

(Note that any voltage developed across an emitter resistor in the driver stage must be subtracted from the total supply in calculating the actual supply voltage for the transistor.)

Further, there is the question of distortion. There are a number of factors contributing to the total distortion in the output stage, one of which we have already discussed. Two other factors are the non-linearity of the input characteristic and the reduction in the current gain at high collector currents.

DRIVE REQUIREMENTS

If the current gain characteristic were linear it would be desirable to feed the bases of the output transistors from a high impedance, or constant current, source. However, it often happens that the non-linearities in the input and output characteristic tend to cancel giving less distortion with well-regulated drive.

It is difficult to obtain good driver regulation together with economy. Therefore practical operating conditions are not always chosen for minimum distortion.

A 10 uF electrolytic capacitor is connected across the emitter resistor of the driver transistor to prevent degeneration.

The value is chosen so that there is actually some degeneration of the lower frequencies within the range. This is desirable both to balance the characteristics of the speaker used as a microphone and to prevent too much low frequency drive being fed into the output transistors.

If you find that, with the particular combination of voices and speakers you have, there is a reserve of gain, you could try reducing the value of this capacitor down to about 0.5 uF. This will reduce the tendency to "woofiness" exhibited by the small speakers used as microphones and also make the best use

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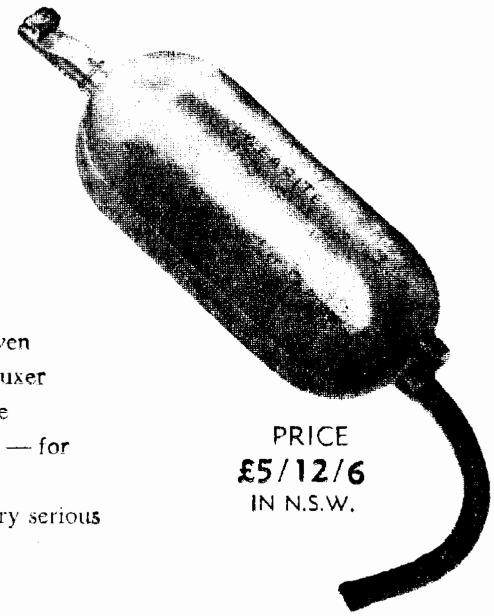

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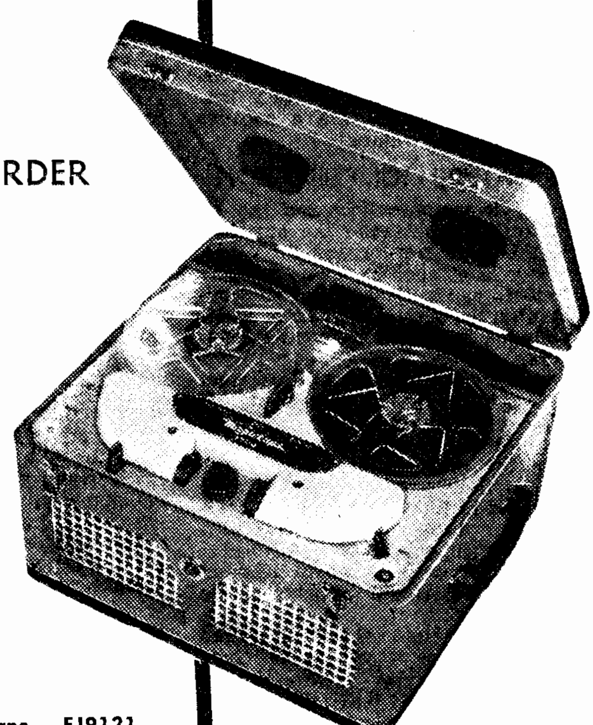

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of the output of the power transistors.

A rather simpler stabilising circuit is used for the first amplifier stage. Forward bias is obtained from the collector of the transistor through a simple dropping resistor. When the collector current increases due to rising temperature, the voltage drops and so does the forward bias current.

THERMAL STABILITY

This circuit does not control the collector current of the stage to within the same limits as the previous network but a greater shift in operating point is permissible since the stage is handling very low signal levels.

As well as the D.C. feedback, a small amount of A.C. negative feedback occurs with this circuit. The amount depends on the internal impedance of the source feeding the base of transistor. In this case it can be neglected since the driver source impedance is low. The negative feedback could be eliminated by means of a network requiring an additional resistor and capacitor but this would not be worthwhile. The reason for using the circuit is to save two resistors and the electrolytic capacitor.

The transistor used in the input stage may be either a TS1 or a TS2 with a preference for the TS2 since it will give higher gain. Types TS1, TS2 or TS3 may be used in the driver stage, but the TS3 is to be preferred again because of its higher gain.

A capacitor between collector and emitter of the input transistor helps to attenuate the extreme high frequencies and also to ensure stability under certain conditions.

WIRING DETAILS

The low impedances of transistors circuitry pose some problems with regard to common impedances in return circuits, particularly in high-gain amplifiers.

In this case it is necessary to run a separate wire from the return circuit of the input transistor back to the speaker voice coil in order to ensure that potentials built up across any lead common to the input and output circuits do not result in feedback and possibly instability. If you carry out the wiring exactly as shown in the circuit diagram there will be no need for worry on this score.

We have suggested in the circuit that a transformer be used between the speaker/microphone and the input of the transistor. This transformer may be of the same type as used to couple the output transistors to the line. The exact impedance ratio is not critical.

It is, in fact, quite in order to use a small speaker transformer with a ratio of, say, 3.5 ohms to 7,000 ohms and there will be very little difference in practical results.

Furthermore, it is possible to feed the speaker voice coil directly into the base circuit of the input transistor completely eliminating the transformer. The gain will drop appreciably but there will be cases when it is important to save on cost, and the gain without the transformer will be sufficient.

TRANSFORMER PLACEMENT

With the layout shown there is no appreciable magnetic coupling between the input and output transformers, but it would be undesirable to have them mounted closer than about three or four inches.

For those who like to experiment, it is possible to apply negative feedback over the last two stages of the amplifier. With negative feedback it will be possible to reduce slightly the standing current of the output transistors.

Place a 10 ohm resistor between the 330 ohm and 10 uF capacitor in the emitter circuit of the TS3 driver and the return line. From the junction of the 330 ohm, 10 ohm and 10 uF components connect a 100 ohm resistor back to the active side of the voice coil winding.

If this connection causes the gain to increase or the amplifier to oscillate it will be necessary to reverse the connections to either the primary or the secondary winding.

With the values mentioned and average transistors, the feedback will be of the order of 6 db but it can be increased or decreased by decreasing or increasing the value, respectively, of the feedback resistor (100 ohms). Extremely low values will not only result in excessive loss of gain but may result in spurious oscillation.

So much for the amplifier.

CABINET WIRING

The wiring inside the cabinet is straightforward except for the point about the earth return for the preamplifier. The point is made clear by the circuit diagram and there is no possibility of error provided you follow it exactly. The object of the extra return wire is to ensure that none of the wiring connecting the speaker (used as a microphone) to the input of the amplifier is common to the output circuit.

Whether the phasing of the transformers happens to be such as to give positive or negative feedback, oscillation will almost certainly occur and could be damaging to the output transistors if permitted to continue.

Because of their relatively low impedances, transistors are particularly prone to feedback troubles due to common impedances. However, in this case the trouble is mainly due to the low impedance of the input and output circuits rather than the transistors themselves. The original valve intercom. amplifier had to be wired in a similar manner for the same reason.

If the low impedance is a disadvantage in one way it is an advantage in another because no shielding is required in the cabinet wiring. Circuits connected with both the input and output of the amplifier can connect to the same switch without the troubles with instability which would occur in the case of high impedance valve circuits. Just to prove the point, we bound the input and output wires leading from the amplifier to the cabinet together in a cable without any instability troubles.

INSTALLATION

The interconnecting wiring which we have already mentioned briefly is deserving of some special mention. Further, we have prepared a special diagram to clarify some of the more important points.

The most important point to note is that each station in the system should have a separate earth return and that this return should be made to the positive terminal of the battery. If desired a connection can be made between the positive terminal of the battery and an external earth such as a water pipe. This will not be strictly necessary.

When we speak of a separate earth return for each station we mean that the earth wires must be insulated from each other right up to the common point. The reason is that all connecting wires in the system will have some audio voltage developed across them due to their resistance. If a length of wire happens to be common to two pairs of stations in the system "cross talk" will occur. Apart from the nuisance of the background noises, the secrecy feature of the system disappears.

PRECAUTIONS

The volume of the cross talk depends on the resistance of the common wire and can be quite low. However, when installing a complete system it is little trouble to include the extra conductors.

From the service point of view, there is an advantage in having all units identical. A spare unit can then be kept and should a unit fail in service, it is simply a matter of substituting the spare. The faulty unit can then be repaired at leisure.

In the normal way, the receiving line is selected by a wander lead inside the unit. However, if the wander lead is extended through the flexible cable to the plug, say via pin 6, the receiving line can be selected inside the wall socket and the units interchanged without the need for changing a lead inside the case.

The disadvantage is that it is then only possible to accommodate five stations with an octal plug. If you must have six stations, connect the wander lead inside the instrument. On the other hand if you must have seven or more stations, you will need an extra, say a seven pin, plug anyway and you may as well make the wander lead connection inside the wall socket.

CONCLUSION

The cabinet design we have used for the original design is capable of variation to suit individual requirements since positions of components are not critical.

In conclusion, a few words about possible alternative amplifiers designs may be helpful.

There is the possibility of applying feedback over the last two stages, using a small value emitter bypass capacitor to shape the frequency response characteristic and omitting the input transformer. The first two make an appreciable improvement to the general quality of the audio while the omission of the input transformer permits the amplifier to be made smaller.

All three modifications result in a loss in effective amplification.

However, at slightly greater cost it would be possible to install an additional transistor amplifier stage which would more than make up the overall loss. Such a stage could be installed between the present preamplifier and driver and may use either a TS2 or a TS3. The emitter bias resistor could be about 1,500 ohms bypassed by a 100 uF, the collector load 4,700 ohms and the coupling capacitor to the next stage 10 uF. The gain control could be a 10,000 ohm pot between the base of the same transistor and ground while the forward bias resistor between the supply line and base should be about .047 meg. Both load and bias resistors should connect to the decoupled supply line. The present 5,000 ohm gain control will no longer be required and may be replaced with a fixed resistor.

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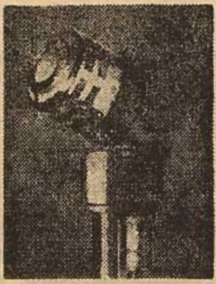

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Fig. 1. Oscillogram of pickup output showing the full orchestra at the left, which is then followed by drums and cymbals.

By **G. A. BRIGGS**

All About Audio and Hi-Fi

SPEAKER POWER AND EFFICIENCY

PART 8

In this article the writer discusses the factors that determine the power handling ability and efficiency of high fidelity loudspeakers.

We have seen that a diffuser can be used to subdue peaks in the upper register and reduce beaming effects. The problem can also be tackled electronically in the speaker circuit by using a filter.

A dividing network in multi-speaker systems is designed to limit the activities of each unit to its most satisfactory audio range and has become almost standard practice in wide-response installations. It is obvious that similar controls can be used on a single speaker or on two or more units working in parallel, although the full effect of a dividing network will not be obtained.

There is, however, the benefit of smoothness from units working in parallel due to cancellation of resonances which rarely occur at identical frequencies in different speakers. The filter now described was made up by Mr R. E. Cooke, and could easily be assembled at home by the average experimenter.

It gives continuously variable attenuation up to 15 db centred around a choice of five frequencies, 2, 3, 4, 5, or 6 kc., selected by a switch. The "off" position of the switch enables rapid A-B comparisons with unmodified response of the speaker (2) to be made without altering the resistor setting.

The filter consists of a parallel-tuned LC resonant circuit shunted by a variable resistor R. The tapped air-cored inductor L is wound by hand; the 1 ufd. capacitor C may be any good paper type obtainable from jobbers. R is a wire-wound, linear taper variable, and S is an ordinary 6-position switch. The full circuit is given in Fig. 2.

The filter is placed in series with the loudspeaker, and the switch gives maximum rejection at various frequencies as follows:—

POSITION	INDUCTANCE	CENTRE OF TROUGH
1	6.2 mhy.	2 kc.
2	2.8 mhy.	3 kc.
3	1.6 mhy.	4 kc.
4	1.0 mhy.	5 kc.
5	0.7 mhy.	6 kc.
6	Filter off	

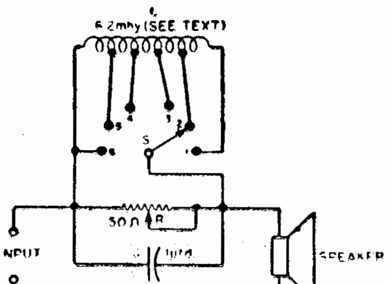
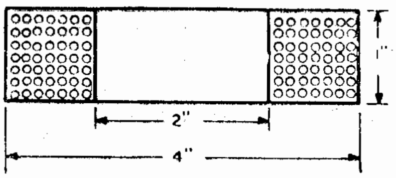


Fig. 2. Filter circuit that can be employed as tone control with speakers of 8-15 ohms impedance. (after E. M. Price.)

Fig. 3. Dimensions of the 6.2 mhy. tapped coil used in the filter circuit 303 turns of No. 18 British SWG (No. 16 AWG) d.c.c. wire is used with taps at 215, 163, 133, and 112 turns for 2.8, 1.6, 1, and .7 mhy.



With R set at its full value of 50 ohms, the maximum dip in response of about 15 db for each switch position is produced. A general picture of results is given in Figs. 4 and 5.

The air-cored inductor L consists of 303 turns of No. 18 SWG (No. 16 AWG) double cotton-covered copper wire. Tappings are brought out as shown in Fig. 2. The total resistance is only 1.2 ohms so the insertion loss is negligible outside the region of resonance.

I have been using one of these filters with an experimental speaker system which has some annoyance value in the upper middle register. It works very well, but it is difficult to decide which is the "correct" setting and I would always prefer a speaker which did not require the treatment.

"PRESENCE" EFFECT

The general effect is similar to the use of a so-called "presence" control on amplifiers, which I find much more baffling than simply relying on the normal bass and treble controls, which usually prove to be adequate.

But there is one possible application of the filter which can be fully recommended, and that is where a wide range speaker is being used on a commercial set not equipped with adequate tone controls and with an over-all response shaped like a salmon, with all the best cuts in the middle.

A large speaker system often sounds woolly on music and resonant on speech with this type of input, and a touch of tone control in the speaker circuit often works wonders.

POWER HANDLING AND EFFICIENCY.

These qualities in a loudspeaker are so interdependent that we might as well deal with them together.

I always think that for domestic use the power handling capacity of a speaker is a very much over-rated virtue; we are concerned with how much comes out of a speaker, not with how much we can put into it.

The main difficulty is the absence of

any recognised system of rating, plus the fact that the method of mounting affects results.

Probably the best assessment is to listen to the speaker on full orchestra—including cymbals—and also on organ and rate it at peaks which are free from roughness, harshness, and undue boominess.

Full orchestra is mentioned here deliberately because, with modern recording techniques, there is far more power in the upper register than there used to be. In fact, the hi-fi craze has often produced too much top, but there are welcome signs of a return to sanity.

Distortion at high frequencies is always much more distressing to the ear than at low frequencies.

COMPARATIVE OUTPUT

The oscillogram of Fig. 1 shows that the peak produced by cymbals is almost equal to the drums. The output from a pickup was photographed on the scope. At the left we have full orchestra for comparison with drums and cymbals that follow. It is interesting to note the steep wavefront produced by these percussion instruments: any overloading of amplifier or speaker at these peaks would obviously mar results.

Rating a loudspeaker at a single frequency is quite useless, because too much depends on the choice of frequency, and the speaker does not have to work at a single frequency—it always receives powerful harmonics.

But this is not to say that **testing** a loudspeaker at a single frequency is useless.

This is, of course, vital to any assessment of performance.

We have already stated that method of mounting affects results. If reflex or horn loading improves the waveform at low frequencies for a given **output** of sound, then frequency doubling and trebling are reduced and so is intermodulation; but the important point is the output. No system can be judged merely by the amount of input it will take.

This is one reason why the open baffle is still better at the bass end than most people imagine, in spite of cut-off due to limitation of size.

The cone is free to move as it likes and the sound waves from back and front enter the room without restriction.

The speaker will handle fewer watts than reflex and enclosed cabinet types, but it needs fewer watts for equivalent acoustic output over most of the audio range.

SPEAKER EFFICIENCY

It is a pity that it is almost impossible to measure total speaker output, but it is very easy to measure and calculate input. (Mr Cooke uses a sliderule, but I can still do it on my fingers.) This is why the habit of rating speakers on input and ignoring output has been so generally adopted.

It cannot be too strongly emphasised that true efficiency in a moving-coil speaker depends on flux density and this is the quality in a magnet that costs the money. And in this connection we refer to total flux, which is the product of gauss and gap dimensions (diameter, width, and depth).

It is impossible to assess the value of a magnet by a statement of gauss alone, as 13,000 lines per square centimetre

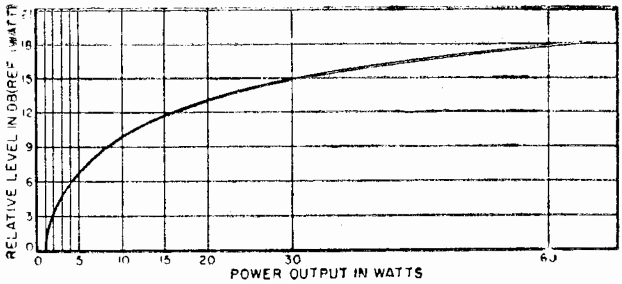


Fig. 4. Relationship between the power input to a loudspeaker and the amount of sound that it produces taking 1 watt as reference.

with a typical 1in centre pole would give 54,000 total flux, where 13,000 lines with a 1¾in centre pole would produce 145,000 lines, at an extra cost of about 100 per cent.

Magnet weight gives a rough idea of value, but as the prices of magnetic alloys vary, the weight is not a complete guide. Actually, it makes no difference to the user which type of magnet is employed; whether it is alni, alnico, alcomax, ticonal, ceramic, or hygienic does not matter. The only thing that counts in value is the total flux. All modern magnets merit the description **permanent.**

EFFICIENCY AND WATTS

It is always difficult to grasp the relationship between the power we put into a speaker and the amount of sound which comes out, because a twofold increase in power produces only 3 db increase in sound pressure, which is just easily perceptible. (To the ear, the increase sounds more like 33 per cent than 100 per cent.) Fig. 3 shows the relationship, taking 1 watt as a reference.

Acoustically, the increase in level caused by an increase in power from 30 to 60 watts is the same as from 1 to 2 watts, but electrically it is quite a different story. As Fig. 3 shows, it pays to use a high-efficiency (i.e., high flux density) loudspeaker and work on the steep portion of the curve below 15 watts, because the next 3 db are at a high premium in terms of amplifier watts, which cost money and involve bulky equipment.

DOUBLING THE POWER

We have ourselves often been astonished at the small increase in sound level in a concert hall which results from doubling the power. Using four 15-watt amplifiers, each 15 ohms output, in parallel, gives 60 watts when four 15-ohm speakers are switched on, also in parallel. With one speaker in circuit the available power is only 15 watts due to mismatch.

Under these conditions, two speakers are better than one and four are better than two, but the total difference never **sounds** like 45 watts. The same argument applies in reverse under domestic conditions, where we can drop from 30 watts to 15 watts in amplifier output with little apparent sacrifice in sound.

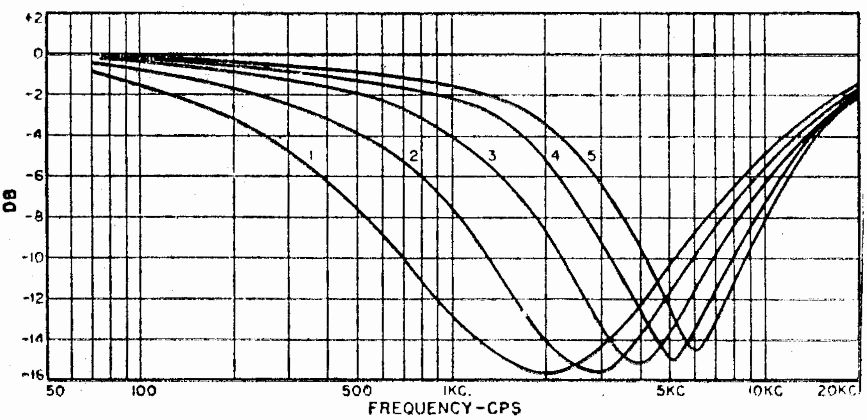


Fig. 5. Audio output response curves of the filter circuit described previously. Note that as more inductance is switched in the dip moves downward from 6 to 2 kc.

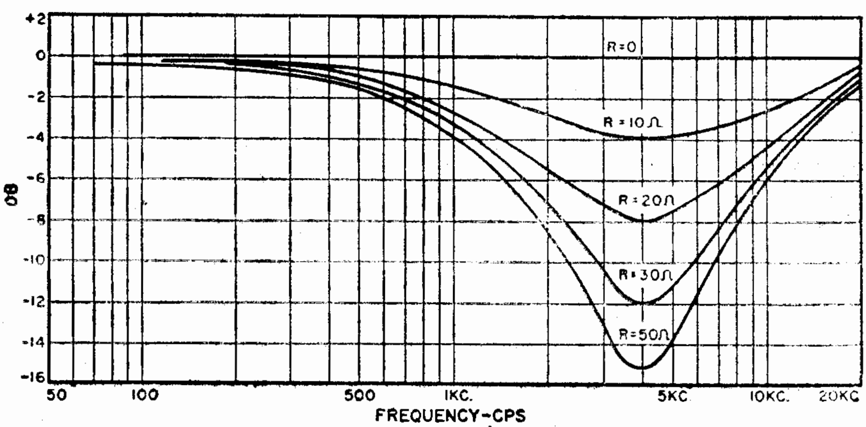


Fig. 6. These response curves show what happens to the attenuation as the resistor is varied and the coil tap remains on 3rd position. Maximum dip here is 15 db.

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(The reader will notice I am careful to say "we can drop . . ." rather than you, because this viewpoint is more popular here than in the States.)

I admit that the margin of safety on the peaks shown in Fig. 1 is greater with a 30-watt amplifier than with a 15 watter, but I am assuming that the domestic levels of 3-5 watts on full orchestra—previously stated as adequate —will not touch 15 watts on transient peaks with drums and cymbals.

This is even more difficult than rating power handling capacity. When I see it stated that the efficiency of horn-loaded speakers is 40 per cent compared with 8 per cent for reflex enclosures, and even as low as 2 per cent for small infinite baffles, I can only conclude that the conditions of test do not even approximate the conditions of use, so the findings are of doubtful value to the average listener.

MEASUREMENT OF EFFICIENCY

The question of where a test is made is of vital importance. For instance, if you work under free-field conditions and measure the output at the mouth of a horn you will obtain maximum reading, but if an open baffle is used the reading in front of the cone represents only half the output which would be available in a live room. The reverberation time of the listening room also affects results—the longer it is, the greater the build up of sound, but this would not necessarily affect all speakers to the same extent.

The strongly directional properties of horn loading are too well known to need further emphasis, but if efficiency tests are made on-axis they do not apply if you listen 30 deg. off-axis. In other words, directional properties have a lot to do with the question, and an omni-directional speaker system rated officially as 8 per cent efficient might give an average sound level in a normal listening room almost equal to horn-loaded types rated much higher.

Part 9 of this series will deal with speaker mounting and response curves will show that these differences are not as great as one might expect, although it is clear that the totally enclosed cabinet filled with sound absorbents mops up half the sound produced by the cone, and reflex enclosures absorb much of the middle and upper registers.

AMPLIFIER OUTPUT

The relationship between speaker efficiency and amplifier watts is well summed up by N. H. Crowhurst as follows:—

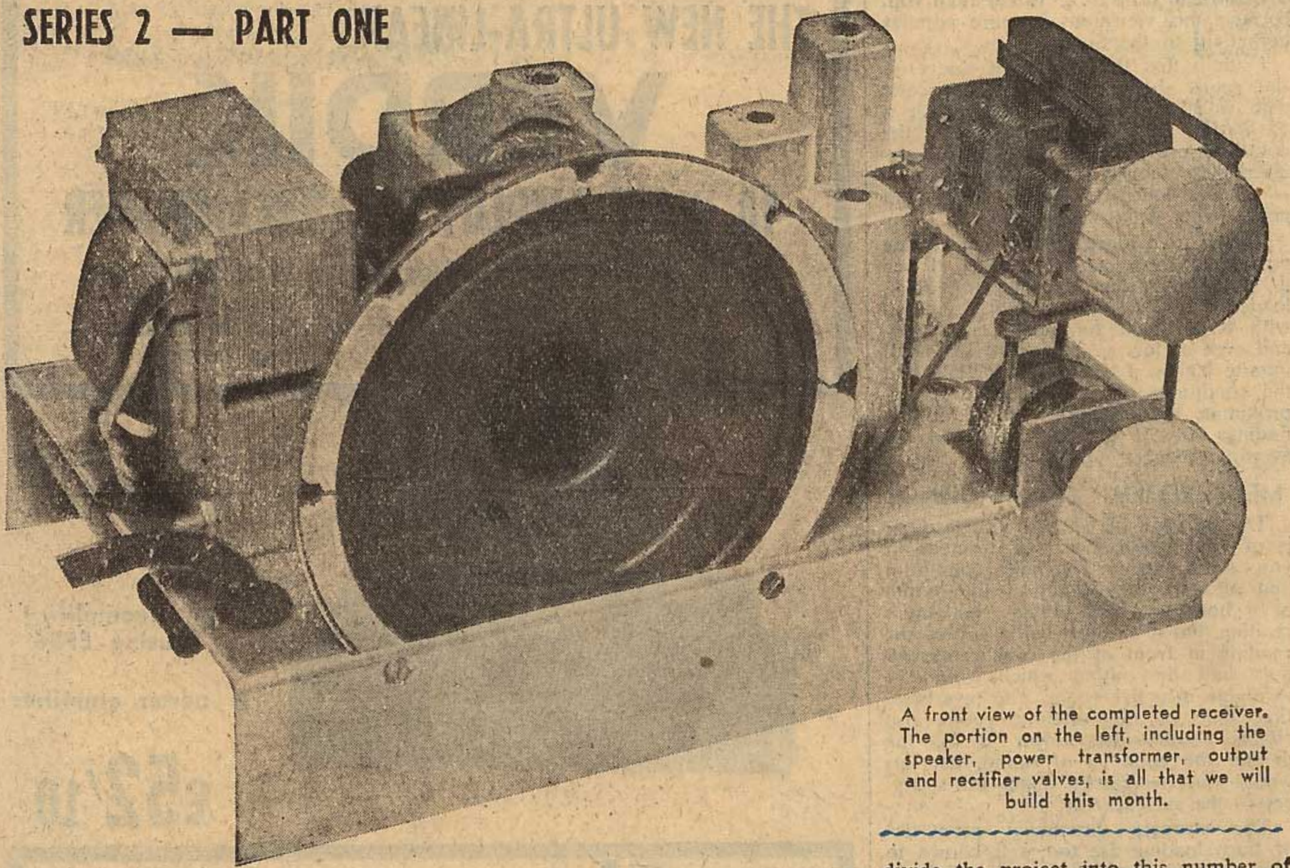
"Take a 2 per cent efficiency speaker in comparison with a 10 per cent efficient speaker. Obviously, a 10-watt amplifier with a 10 per cent efficient speaker will produce the same acoustic output into the room as will a 50-watt amplifier with a 2 per cent efficient speaker. Both will give a maximum of just 1 watt into the room."

Mr Crowhurst also said that the actual sound energy you need in the living room is only a matter of hundreds of milliwatts at the peak. I agree.

It is, I think, necessary here to repeat the warning that we only get 10 watts out of a 10-watt amplifier when it is correctly loaded. Amplifier makers belong to the more fortunate members of the audio industry; they provide a

(Continued on Page 127)

SERIES 2 — PART ONE



A front view of the completed receiver. The portion on the left, including the speaker, power transformer, output and rectifier valves, is all that we will build this month.

Learn While You Build A Receiver

Here is the first of a series of articles aimed directly at our beginners. If you have never built anything more than a crystal set—or even if you have never built anything—there is still no reason why you should not start right now to build yourself a "real" set. As well as producing something useful, you'll learn a lot and have a lot of fun into the bargain.

by Philip Watson

Beginner's projects must be the most consistent demand we encounter in our reader's mail. With young (and not so young) enthusiasts continually joining our ranks, it is not surprising that there is an almost continual demand for projects of this kind; projects which are simple, reasonably economical, and satisfying—as well as providing a groundwork of knowledge from which more ambitious things may be tackled.

NOT FORGOTTEN

Our recent excursions into the realm of TV have brought some accusations that we are neglecting or have abandoned this section of our readers. They may rest assured that this is not so. We have no intention of losing sight of their needs, even though these must, of necessity, be shared with the needs of all our other readers.

There are many ways in which we can attempt to satisfy these demands. Crystal sets, one and two valve sets, simple record players and similar projects have been described in the recent past and, together with the recent "Course in Radio" series, are all excellent material for the beginner.

Another approach is to describe something rather more ambitious, such as a conventional receiver, but to spread the description over several issues, and divide the project into this number of small sections.

In this way the beginner is not asked to tackle anything larger or more complex at any one time than would be presented by, say, a simple two valve set, yet he is progressing steadily toward something far more rewarding—a "real" radio set which is in no sense a toy or a novelty.

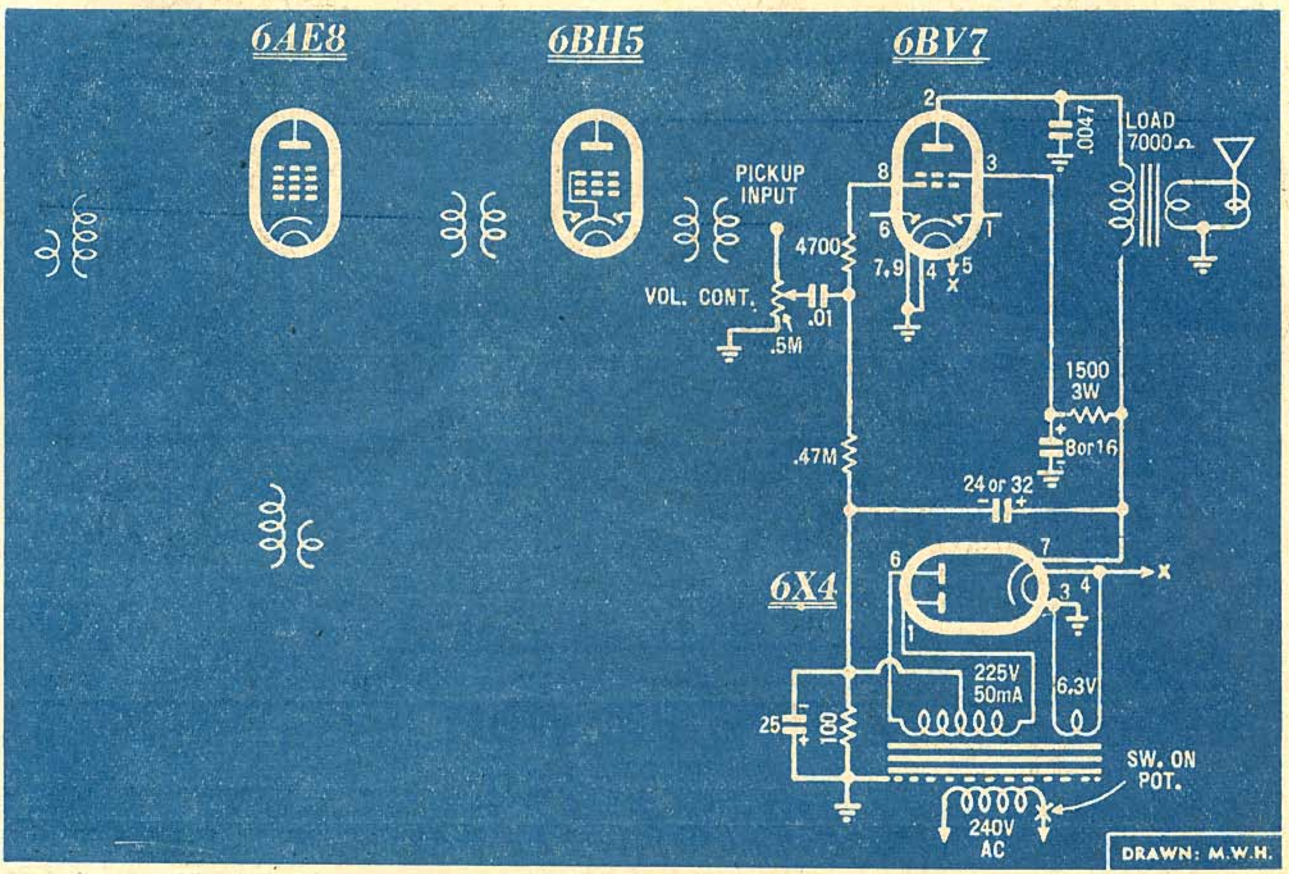
Although some previous experience is always a help, and this project may appeal particularly to those who have tried their hands at some of the smaller sets, we aim to present the description in a manner which will allow even the beginner to follow it without difficulty. Thus, there is no reason why you should not tackle a project of this size as your first set, even though such a procedure may seem a little unconventional.

A further advantage of doing the job on the instalment plan is the purely financial one. Doing it this way, you will not have to lay out the full cost of the parts before you get started, but only for those required for each stage as it is commenced.

TYPE OF SET

In more specific terms, the set you are about to build is a typical four valve mantel set, employing the superheterodyne circuit, using the latest components, and quite comparable in performance with similar size commercial sets. You can also make your own cabinet—we will tell you how to do that, too—and

FIRST SECTION — POWER SUPPLY & OU TPUT STAGE



Here is the portion of the circuit we will be using this month. It includes the power supply and power output stage, and is really a simple audio amplifier. If circuits are strange to you, try working out this small section—it's not really hard.

the finished set will be something you will be proud to own, not only for its performance, but because you can say, "I made it myself."

The usual valve "line up" for sets of this kind is a frequency converter, an IF amplifier, a power output valve, and a rectifier, and this is the arrangement employed in our set. In spite of the fact that these sets employ only three signal valves (i.e., excluding the rectifier) they still have adequate sensitivity for all local listening requirements, and represent an excellent compromise between performance and cost. They are probably one of the most popular types of set in Australia today.

The first section we propose to build is the power supply and power output stage. This will be followed in subsequent issues by the IF stage, detector and AVC section; and finally, the aerial, oscillator, and converter stages.

MAKING A START

By starting with the power supply and power output stage we greatly simplify the job of checking our first section when it is complete. The power supply will have a nearly normal load into which to work, and so will deliver approximately correct voltages. If it doesn't we will know there is something wrong and the trouble can be traced and corrected before the set becomes too complex.

Similarly the power output stage can be made to work, and even deliver signals to the speaker if we can provide a suitable signal source, such as a pickup, allowing us to be quite sure that this is working properly before we commence the second stage.

Since we hope to give you some idea of the "why" as well as the "how" we will endeavour to explain something of what goes on in each section before we tell you how to build it. That way you will not be working completely "blind."

If you intend to follow radio seriously as a hobby one of the first things is to learn to follow a circuit diagram. While this method of presentation may seem strange and difficult at first, it is really used because it is the easiest and most satisfactory.

As a help to get you started we are printing drawings of the most popularly used circuit symbols, as well as a normal circuit of the section we are to tackle this month. We suggest you study this circuit, and the symbols, during the discussion which is to follow.

The power supply is the first thing to consider. This is designed to take the power from the supply mains and convert it into the various values and type of power we require to operate the set. Let us see just how it does this.

The major component is the power transformer. It is to be found right at the bottom of the circuit and it is not hard to imagine that it consists of three windings on an iron core. One winding (the primary) is shown connected to the 240 V AC mains, while the two secon-

PARTS LIST

- 1 Chassis 9in. x 5½in. x 1¾in.
- 1 Power transformer type PF201.
- 1 5in. loudspeaker type 5C.
- 1 Speaker transformer 7000 ohm, type EBG96.
- 1 6BV7 valve.
- 1 6X4 valve.
- 1 Miniature 9 pin socket.
- 1 Miniature 7 pin socket.
- 1 7 tag terminal strip.
- 1 5 tag terminal strip.
- 1 4 tag terminal strip.
- 1 3 tag terminal strip.
- 3 ⅜in. grommets.
- 2 ¼in. grommets.

Hook-up wire, 18 gauge tinned copper wire, 3 core power flex, 3 pin plug, nuts and bolts (2 countersunk for speaker mounting) solder lugs, solder &c.

RESISTORS
- 1 .5M potentiometer with single circuit switch.
- 1 .47M ½W.
- 1 4700 ohm ½W.
- 1 1500 ohm 3W.
- 1 100 ohm ½W.

CAPACITORS
- 1 32 mfd electro. 350PV.
- 1 25 mfd electro. 40PV.
- 1 16 mfd electro. 350PV.
- 1 .01 mfd paper 400V.
- 1 .0047 mfd paper 400V.

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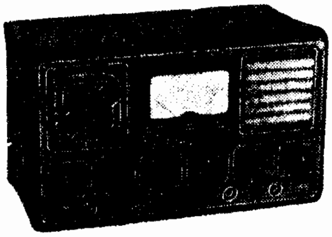

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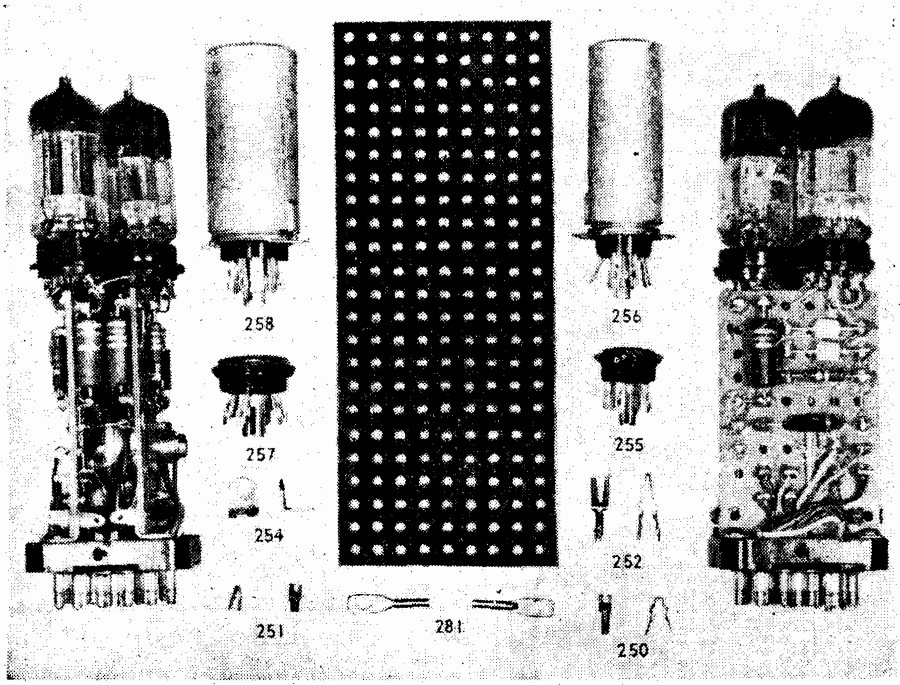

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dary windings supply high and low voltages to operate the set.

The simplest requirement is to energise the valve heaters. These operate at 6.3 volts, draw between .3 and .8 amp, according to type, and are quite happy with an alternating supply. So we provide a winding on the transformer delivering 6.3 volts at up to 2 amps. This is the small winding on the right.

The next requirement is the HT supply. This is not quite so simple, since it needs to be a direct supply rather than alternating. We start by providing a HT secondary winding, centre tapped and having a voltage on each side approximately equal to the direct voltage we require. This is the larger winding marked "225V 50 mA."

SECONDARY WINDING

The secondary winding is connected to the rectifier valve (the 6X4 pins 1 and 6) and this performs the function of converting the alternating voltage to direct voltage (rectifying). The valve is really two rectifiers in one, the two being employed to provide "full wave" rectification, or the utilisation of both halves of the alternating supply. The rectified voltage appears at the 6X4 cathode (pin 7).

But the rectifier cannot complete the job. It can make the supply direct, in the sense that it is flowing in the one direction, but it cannot make it a perfectly smooth supply. As it comes from the rectifier it contains a very high ripple content, a characteristic which would give rise to severe hum in the receiver.

This is eliminated by means of a filter network. The components used for this are very high value capacitors (electrolytics) and chokes or resistors. Chokes are most efficient, but are more expensive and bulky. In small sets, such as this one, it is often possible to provide perfectly adequate filtering by means of the cheaper and smaller resistor. In this circuit the capacitors marked "8 or 16," "24 or 32," and "25" are the filter units, together with the "1500 ohm 3W" resistor.

FEED FOR 6BV7

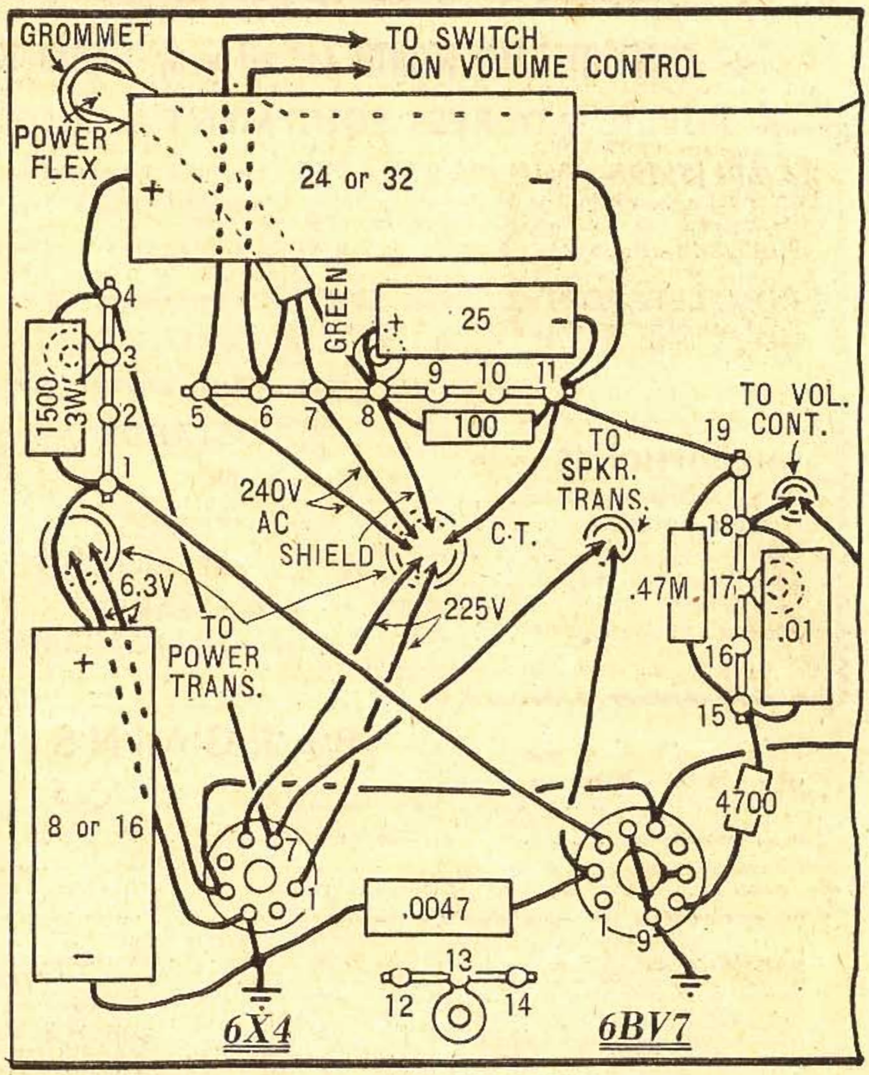
Due to somewhat different requirements it is possible to feed different parts of the circuit from different parts of the filter network. In this case the 6BV7 plate is supplied from the first filter capacitor (where the voltage is higher), while the remainder of the set takes its power from the second capacitor, and where the filtering is better.

The one remaining section of the power supply is the 100 ohm resistor from the HT winding centre tap to chassis (earth). This is to provide "bias," a small negative voltage required for the grids of the various valves to provide correct operation. This system is known as "back bias."

Now let us consider the 6BV7. This is called a power valve, since its function is to deliver power (as distinct from voltage or current alone) to the loudspeaker. The more power it can deliver the more noise you can make before the signal commences to distort.

It is also an amplifier valve, since the signals it delivers to the loudspeaker are many times stronger than those it receives from the previous stage. As a final qualification we call it an "audio"

ASSEMBLY & WIRING DETAILS



This diagram shows the location of the parts under the chassis as well as the wiring. Compare it with the photograph on the next page, and check it against the circuit on page 49.

amplifier, because the signal it handles is audible.

By audible signals we mean signals that require only to be fed to a loudspeaker or a pair of headphones in order to be heard. Typical examples of audio signals are those produced by microphones, pickups, and (as in this case) the detector of a receiver. In the normal way all we ever need to do with these signals is amplify them until they are strong enough to operate a loudspeaker, headphones, or similar device.

TYPES OF SIGNAL

The reason we find it necessary to classify the type of signal is because, in other parts of the circuit, we have valves amplifying quite different types of signals. These are called "RF" (radio frequency) or "IF" (intermediate frequency) signals, and we will have more to say about these later on.

In addition to the heater (pins 4 and 5) this valve has a cathode (7, 9), two diode plates (1 and 6), a control grid (8), a screen grid (3), and a plate (2). All these connections are brought out to a miniature 9-pin base.

Signals we wish to amplify are applied between the control grid and the cathode. In this case the audio signals first appear across the volume control (.5M, extreme left of the diagram) and are coupled through the .01 capacitor to appear across the .47M grid resistor.

SIGNAL PATH

Tracing out from each end of this resistor we find that the upper end connects to the grid (we can ignore the 4700 ohm resistor for the moment) and the lower end to the cathode via the bias network and chassis. Thus the signal is applied between grid and cathode.

The amplified signal now appears between the plate and the cathode. Since we require this signal in the speaker (extreme right of the circuit) we connect the speaker between plate and cathode. You should have no difficulty in tracing the connection from the plate to the top of the speaker transformer, but tracing the other end of the trans-

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MODEL TK-90. Size 6in x 4in x 2¾in. Model TK-90 is a handy size **rotary switch type circuit tester with a** black bakelite **panel and** cabinet, **having a high sensitivity** 45 uA **meter 20,000 ohms per volts on D.C. and** 8,000 ohms **per volts on A.C. D.C. Volts: 10/50/250/500/1,000V (20,000 ohms/V). A.C. Volts: 10/50/250/500/** 1,000V (8,000 **ohm/V**). D.C. Current :50 uA/2.5/25/250 **mA. Resistance: 5/50/500 K. omh/5Mg ohm (By 3V** internal battery). Decibels: — 20 to + 5db. (0db — **.0775V — 600 ohm) + 5 to + 22db. £15/15/-. Post Vic. 1/10; Int. 3/-.**

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former back to the 6BV7 cathode is not so easy.

For the present you will have to more or less take our word for it, but this circuit is via the electrolytic capacitors in the power supply and which eventually connect to chassis and so to the cathode. The two diode plates are not required at this stage.

Thus this single valve, plus the power supply, constitutes a complete, if simple, audio amplifier. It will deliver as much power to the speaker as the latter will comfortably handle, and it can be fully driven by a comparatively small signal voltage on the grid.

DRIVE VOLTAGE

The maximum voltage required is in the vicinity of 4.5 while signals as low as 1 volt would still produce a useful volume. Since many crystal pickups are capable of delivering signals of the order of several volts, particularly from peak passages, it is easy to imagine that one of these might be fed straight into the volume control and deliver a worthwhile signal from the speaker.

This is quite practical, and we have described several simple record players in the past based on this principle. The first part of your set, therefore, may be employed in this role if you have a pickup available, and it is an excellent way to test it.

So much, then, for the theory of our set. Now let us consider how we are to start actually constructing it. Elsewhere in the article you will find a list of the parts you will require for this section, and the first thing to do is to take this to a radio dealer and ask him to supply the parts listed.

We have made this list as detailed as possible in order that you will be supplied with parts as nearly as possible identical with those we used. In most cases there are many components available having identical electrical characteristics, but which differ widely in their physical dimensions. Where this is likely to be important we have specified the type number of the preferred version.

PARTS LIST

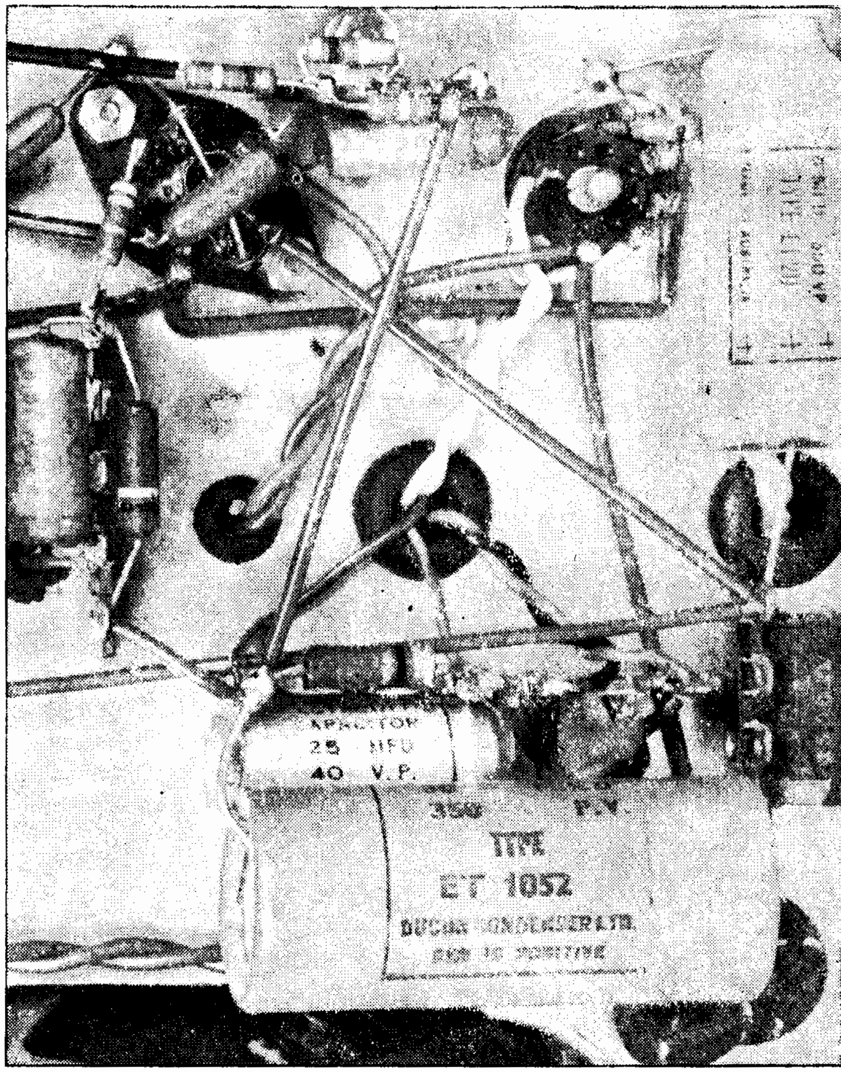
Your kit of parts will consist of a ready-punched chassis, a power transformer, speaker, speaker transformer (either separate or mounted on the speaker), the two valves, and a collection of resistors and capacitors. Also make sure you have hook-up wire, solder, solder lugs, nuts and bolts and some 18 gauge tinned copper wire.

(If you wish to make your own chassis, a blueprint will be available in the usual way. However, the use of a ready-made chassis is a considerable help to the beginner, and costs very little more than a home-made one. All things considered, we suggest it is the better proposition.)

The first step is the assembly. This is mainly a "nut and bolt" operation, or the mounting of the major components in their correct position on the chassis, and should be completed before any attempt is made to tackle the wiring.

To assist you in this we have prepared a detailed layout and wiring diagram showing the position of components underneath the chassis as well as the wiring. However, for the present we are concerned only with placing and orientation of components, particularly the valve sockets, power transformer, and terminal strips.

WIRING & ASSEMBLY PICTURE



A photograph of the relevant portion of the chassis underside. Compare it with the wiring diagram on the previous page, remembering that there are some components in this picture which are not yet required. These will be discussed next month.

Before mounting the transformer, fit the three 3/8in grommets and the two ¼in grommets in the chassis holes indicated. These are necessary to prevent the edge of the chassis from cutting vital leads where they pass through it. These may appear too large for their respective holes at first sight, but a little patience will allow them to be fitted.

The speaker is mounted above the chassis in the cut-out provided and secured to the front of the chassis by two mounting bolts. If the speaker transformer has been supplied separately it should be bolted to the bracket on the speaker frame in the general position shown in the photographs.

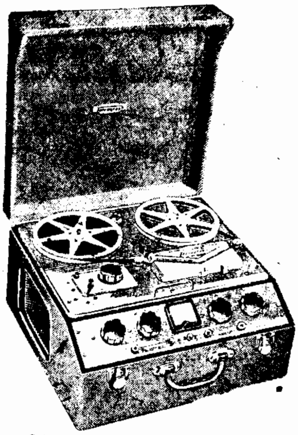
This transformer is fitted with four leads. Two are of plastic hook-up wire and connect to the primary, and two are single strands in spaghetti tubing and connect to the secondary. The two secondary leads should be connected to the two eyelet type terminals on the speaker frame. The primary leads may be in two different colours, but this is of no significance in this circuit.

With all the major components mounted, we can commence the actual wiring. An experienced person would be able to do this by reference to the circuit diagram alone, and this is a standard of ability at which you should aim. However, we have also provided the wiring diagram, plus a detailed description of the wiring, and you should have no difficulty in following these latter. At the same time, try following the circuit as you go; it will provide excellent practice.

EARTH CONNECTIONS

Our first job concerns "earth" or chassis connections. You will see a number of these earth signs in both the circuit and wiring diagram, and they simply mean that the wire concerned must be securely connected to the chassis.

In practice, this presents some minor problems. Ideally the connections should be soldered, but both steel and aluminium chassis present difficulties. Soldering to aluminium is virtually "out" as far as ordinary techniques are concerned, but a satisfactory connection



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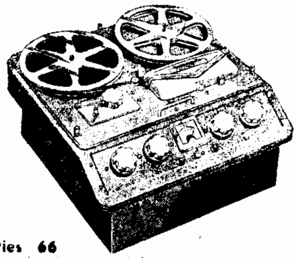

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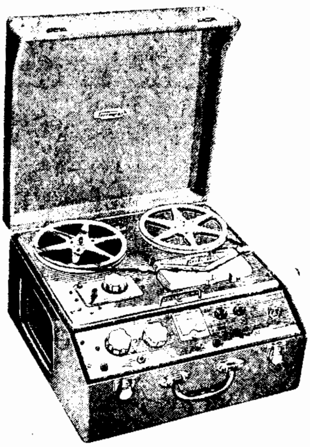

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can be made by anchoring a solder lug under a convenient mounting bolt.

A steel chassis can be soldered, but requires a larger than average iron and a certain amount of care. For this reason it is seldom attempted by the amateur. The solder lug technique as for the aluminium chassis is also less satisfactory due to the possibility of rust forming on the steel surface and upsetting the performance of the set at a later date.

The best way to overcome this is to mount all the solder lugs required (see wiring diagram) and then connect them all together with bare tinned copper wire. 18 gauge is a handy size and it should be straightened by stretching gently before being used. Note that among these "earth" connections is one from one (either) side of the speaker transformer secondary.

TRANSFORMER LEADS

Next, identify the power transformer leads from the code supplied with it (make sure of this when you purchase your parts) and select the primary (240 AC) leads. Note that in some cases these will be coloured black and red, while another lead, the secondary centre tap, may also be black. Confusion can be avoided by noting the grouping of the leads where they enter the side of the winding.

There is, in fact, no particular significance in the red and black primary leads in this case and they may be connected either way round. They are connected to two tags on the seven terminal strip and, to make it easier for you to follow our instructions, we are numbering the terminal tags on the wiring diagram and will refer to these "tag numbers" in our description.

Tags 5 and 7 are the two used in this case, while the incoming power lead terminates on tag 8 (green-earth), tag 7 (black-neutral), and tag 6 (red-active). A twisted pair made from hook-up wire runs from tags 5 and 6 to the volume control switch.

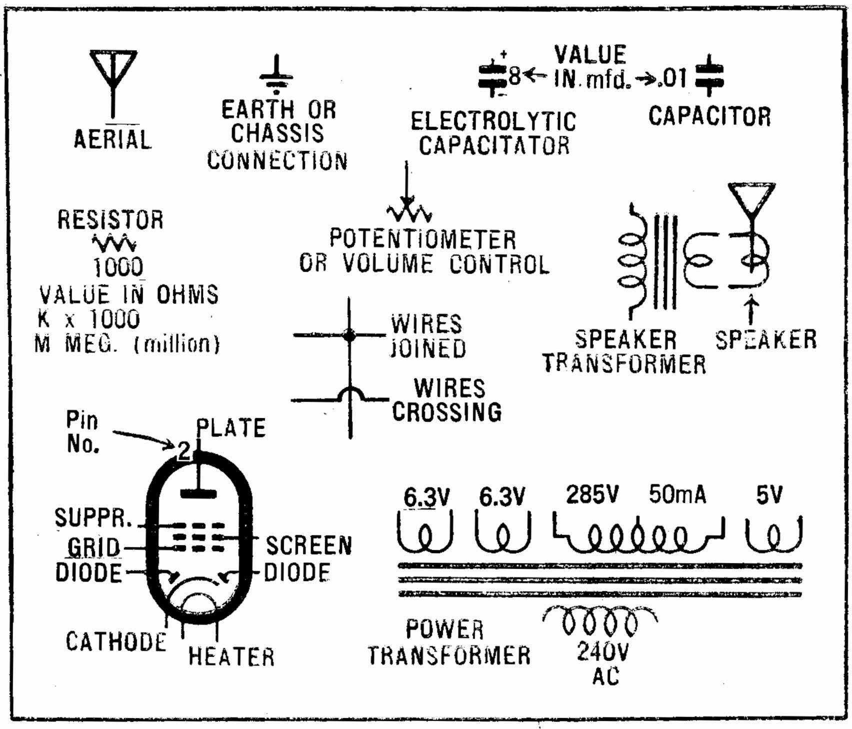
If there are only two terminals on the switch there will be no confusion, but some units may have four. In such cases only two will be required, and it will be necessary to find a "pair." This may be done by setting the switch to the "ON" position and checking for continuity with an ohm meter or other simple continuity tester, such as a battery and lamp.

POWER CORD

The incoming power cord must have a strain knot between the terminal strip and the chassis, in the interest of safety. A three pin plug is fitted to the opposite end and extreme care must be taken to see that the wire connecting to the receiver chassis (normally green) is connected to the earth pin on the plug. Make this connection first to avoid confusion.

There may be a thin cotton covered lead from the transformer and this is to terminate an "electro-static shield" between primary and secondary. Its purpose is to minimise signal being fed to the set from the mains, and is simply connected to the nearest available chassis connection. (Tag 8).

The two heavy leads in tubing are the filament leads. These should be twisted together and trimmed to a convenient length for connection to the 6X4 socket. Before attempting to solder these



Here are a selection of symbols such as used in the circuit on page 49. Acquaint yourself with each of these, then try following the circuit. If necessary refer to the wiring diagram also. Additional symbols will be given next month to cover the new section.

to the socket pins the enamel must be removed and the wire tinned.

In addition, one pin (No. 3 is easiest) requires to be earthed to the chassis. A short length of tinned copper wire should be passed through the socket lug and soldered to the lug previously mounted under the mounting bolt. However, don't solder the wire to the socket lug until the transformer filament lead has been slipped into place with it.

Pin four is treated similarly, except that the second wire is a length of hook-up wire which will ultimately run to the next socket.

Three leads remain, being the centre tap and two ends of the HT secondary winding. The two ends (probably yellow) are twisted and trimmed for connection to pins 1 and 6 of the 6X4. The centre tap goes to lug 11.

This completes the wiring of the power transformer. It is a good idea to check this much of your work carefully before going any further.

If this much appears to be OK, we can mount some of the smaller components. The 100 ohm back-bias resistor connects between tags 11 and 8, as does the 25 mfd electrolytic. The latter must have the positive (red) end to tag 8. The 32 mfd connects between tags 4 and 11, with the positive end to tag 4.

SOCKET CONNECTIONS

The 1500 ohm 3 watt resistor connects between tags 1 and 4, the positive end of the 16 mfd also connecting to tag 1. The negative end goes to chassis via the lug under the 6X4 socket. Tag 4 is connected to 6X4 pin 7.

Next we attack the 6BV7 socket. The short length of hook-up wire previously connected to 6X4 pin 4 is now trimmed and fitted to 6BV7 pin 5, while another short length is also fitted before soldering the connection. This latter is for ultimate connection to the next valve. In the meantime make sure the free end cannot short to the chassis.

Now a short length of tinned copper wire must be run from pin 4, through the central shield to pin 9, and then to the chassis lug. Pin 7 is soldered direct to the central shield. Note that the central shield can usually be rotated with a pair of pliers until the small hole is in a suitable position.

Twist together the two speaker transformer primary leads, pass them through the chassis hole near the power transformer, and connect one to 6BV7 pin 2 (plate) and the other to 6X4 pin 7 (cathode). A lead from 6BV7 pin 3 (screen) connects to terminal strip tag 1. A .0047 mfd capacitor connects between pin 2 and the chassis lug under the 6X4 socket.

LAST STAGES

The 4700 ohm resistor connects between pin 8 (grid) and tag 15, and a .47M between tag 15 and tag 19. A short length of hook-up wire bridges tag 19 to tag 11. From tag 15 a .01 mfd capacitor connects to tag 18 and from this point a length of hook-up wire (one of a twisted pair) runs to the moving arm (centre terminal) of the volume control.

Looking at the front of the volume control, select the most clockwise terminal and connect it to chassis. The metal housing of the volume control will serve in most cases, provided the control is securely mounted with the lockwasher provided. The remaining terminal is the "active" into which the audio signal to be amplified is fed. For the moment it connects to the other wire of the twisted pair, the opposite end of which is left free and about three inches long on the underside of the chassis.

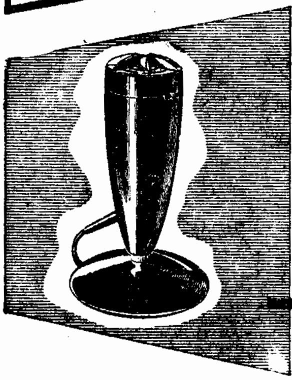
This completes the wiring and, if all has been carried out correctly (and we

(Continued on Page 127)

A COMPLETE RANGE

CRYSTAL MICROPHONES
MICROPHONE INSERTS

FOR EVERY PURPOSE



DESK or HAND MICROPHONE, MIC36

This Microphone is ideal for home recording and public address, etc. Response unexcelled for its size and price. The performance is not affected by vibration, shock or low frequency wind noise. Omni-directional frequency response substantially flat from 30 to 7,000 c.p.s. Recommended load resistance not less than 1 megohm, dependent on low frequency response. Can be supplied complete with switch and floor stand adaptor, as required, at a small extra cost **PRICE, £6/18/6**

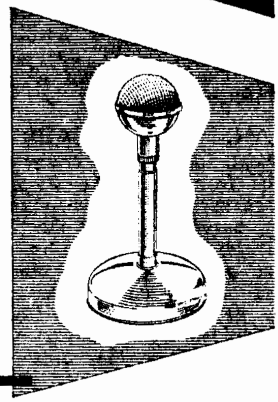
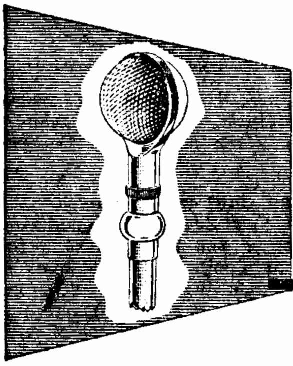


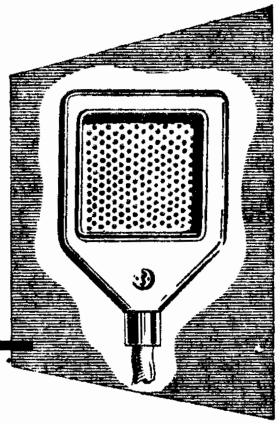
TABLE or STAND MICROPHONE, MIC22

This omni-directional Microphone is robust in construction, with a pleasing appearance. Vibration, shock or low frequency wind noise will not affect the performance. The low frequency cut-off is dependent on the load resistance. The cut-off is given by the equation, F = 80 divided by R, where F = c.p.s., R = megohms. An adaptor (floor mounting) is available at low extra cost. **PRICE, £9/18/6.**



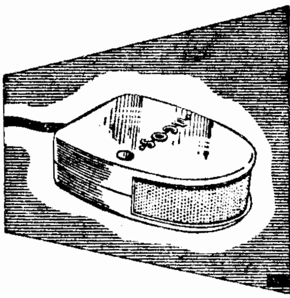
HIGH-QUALITY MICROPHONE, MIC16

This Microphone incorporates the world-famous floating crystal sound cell construction. Its fine performance is not affected by vibration or shock. The fidelity is not impaired by low frequency noise **PRICE, £24/19/6.**



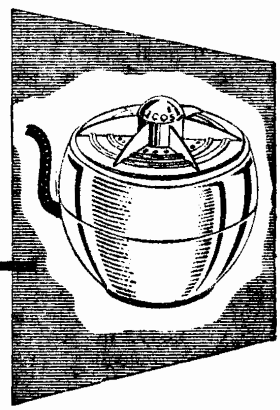
LAPEL MICROPHONE, MIC28

Designed to give freedom of movement, this Microphone is small and non-directional. Housed in a soft, moulded-rubber case, which gives protection against shock, it is provided with a pin at the rear of the case for pinning to the lapel. **PRICE, £5/19/6.**



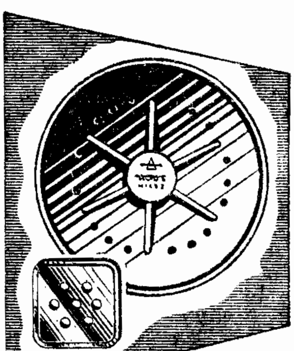
GENERAL PURPOSE, MIC35

The MIC35, is ideal for amateur transmitters, public address, etc. Housed in an attractive die-cast case, it features a high sensitivity and substantially flat characteristics. Provided with a built-in shunt resistance of 2 megohms, it will, when connected to the grid of the input valve, give a substantially flat response from 50 to 5,000 c.p.s **PRICE, £2/15/-.**



HAND or DESK MICROPHONE, MIC33

This Microphone has been designed for the high quality public address and home recording field. High sensitivity and flat characteristics are obtained by a specially designed acoustic filter. Housed in an attractive plastic case with an unexcelled response for its size and price. Unaffected by vibration, shock or low frequency wind noise. Omni-directional frequency response substantially flat from 30 to 7,000 c.p.s **PRICE, £6/18/6.**



(MIC32 illustrated)
(MIC23 illustrated).

CRYSTAL MICROPHONE INSERTS

These inserts are available in varying sizes, ranging from as small as $\frac{13}{16}$ in. square to 1-$\frac{13}{16}$ in. round, with various thicknesses from $\frac{3}{32}$ in. to $\frac{3}{16}$ in. Suitable for every purpose, such as hearing aids, public address, tape recording, amateur transmitters, etc., they have responses from 2,250 c.p.s. to 3,500 c.p.s. at -5 db to -30 db. Insert can be supplied with or without 10 meg. resistor as required.

MIC19/4 and MIC32, **£2/15/6**; all others, **£1/19/6.**

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FROM THE SERVICEMAN WHO TELLS

Have you ever noticed how one sometimes encounters a "run" of sets having similar faults? I've had three this month; all variations on the one theme — leaky coupling capacitors. What's more, they occurred in three widely differing pieces of equipment.

The first case concerned one of the popular portable receivers designed to operate from either batteries or a built-in power supply. The owner complained that the set distorted very badly after running for a short time, recovering temporarily if switched off for an equivalent period, then building up to a distorted condition again.

I immediately wanted to know whether the effect occurred on both battery and mains operation, but the owner was a bit vague on this point.

"To tell you the truth," he said, "we don't use it much on batteries. It's some months since we took it out of doors, it mainly sits on the kitchen shelf and churns out the wife's serials. In fact," he added, "I suppose we use it for most of our listening really."

(I often wonder why set designers bother to provide upwards of four watts of clean audio when a couple of hundred milliwatts — distorted — seems to be perfectly adequate for so many listeners. However, that's another story.)

GOOD ON BATTERIES

Since the owner was unable to help I simply switched the set over to its own batteries and let it run for half an hour or so. Reproduction seemed quite clean—for a portable—and remained so for the whole of the test period.

Having established that much I switched it over to its power supply and checked again. The reproduction was still clean, and I put it aside again to see what would happen.

I didn't have long to wait. Even after a few minutes I imagined I could detect some distortion, and at the end of 10 minutes the announcer was talking with a mouthful of plums and a symphony orchestra sounded like a skiffle group

On opening the cabinet the first thing that struck me was the position of the power supply, and in particular the heat-producing transformer and rectifier, which were directly under the power output stage. It seemed inevitable that there would be a tie-up between the two in some way.

My first guess was that the output valve was mildly gassy and that the extra heat was enough to aggravate this condition to the point where it became noticeable. Since this valve was easily accessible and I had another handy, it was a natural thing to simply swap them over.

NOT THE VALVE

My theory was quickly shattered when the new valve behaved—immediately—exactly as the other had done. If it was the output stage, it certainly wasn't the valve.

Adopting a more scientific approach, and still having the impression that it was the output stage, I traced out the plate circuit and connected a milliamp meter in series with it, allowing the set time to cool while I was setting things up.

When I switched on again the set played normally and the plate current read 7.5 mA—a figure which I regarded as fairly normal. However, the current started to creep almost immediately and, at the end of 10 minutes when the distortion was once again rife, it was up to nearly 12 mA., at which point it seemed to stabilise.

Switching off for a moment, I quickly disconnected the coupling capacitor from the previous stage and switched on again. The current was back to 7.5 mA and remained perfectly steady while I watched it closely for several minutes.

There seemed little doubt now that the coupling capacitor was the culprit and, while there is nothing unique about a leaky coupling capacitor, the fact that it only failed when overheated did make it rather unusual.

I removed the faulty capacitor, fitted a new one, and gave the set another test. When it seemed to be functioning correctly after about 10 minutes, I turned my attention to the faulty capacitor. Purely for my own satisfaction I switched on the R/C bridge and connected the capacitor across the leakage indicator terminals.

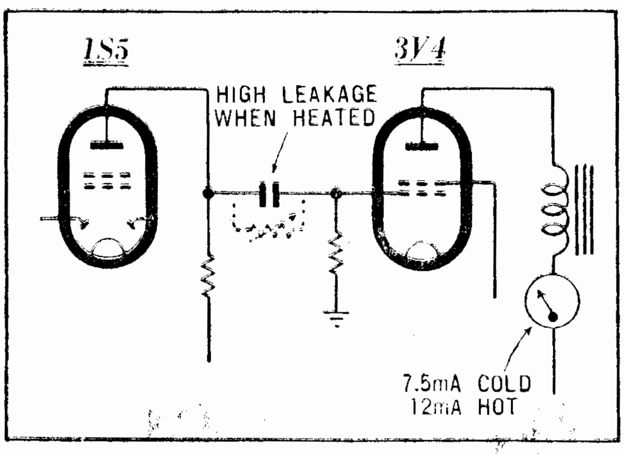
It was back to room temperature now and the leakage showed as a series of flashes at about one second intervals; rather more than I would like to see in a coupling capacitor, but not a really serious leakage.

Then I picked up the soldering iron and held the barrel directly under the capacitor. Almost immediately the rate of flashing commenced to increase, and went right on increasing until the speed was so great that the flashes merged into a continuous glow. With the iron removed the rate dropped quickly to its original "one a second."

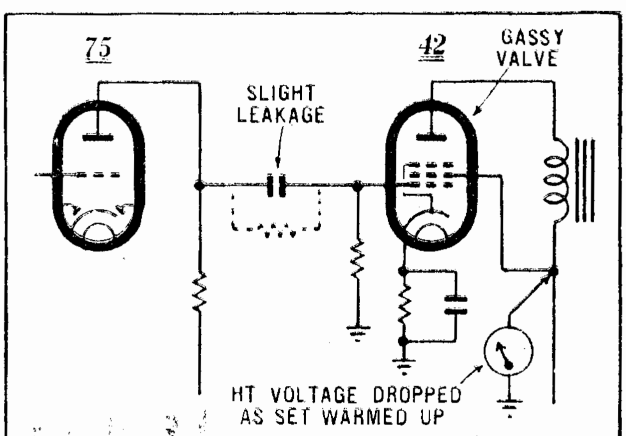
HEAT TEST

Had I needed any further proof that this was the culprit, then this test would most certainly have provided it. As it happened, I didn't, but I can easily imagine plenty of cases where substitution or other tests may not be so conclusive, and a check of this kind may be very valuable.

My next set was a rather unique old-timer. If my memory serves me correctly it would be about 1936 or '37 vintage. This was a period in which the term "miniaturisation" was virtually unheard of, and sets always strove to be bigger



My first leaky coupling capacitor turned out to be a heat sensitive version—just to make it harder! It was only when the set's AC power supply was used that trouble occurred, the output stage being directly above the rectifier and power transformer.



The second case also had its own little peculiarity. In this case the leakage was not sufficient in itself to cause noticeable distortion, but it did show up a gassy output valve and was probably responsible for making it that way.

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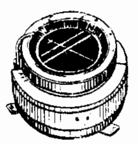

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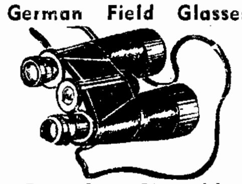

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These can be rewound.
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and more elaborate than their competitors.

This one was no exception. In addition to being big physically, it boasted a most elaborate tuning mechanism. In the centre of the regular dial—large and impressive enough in its own right—there was a selector fashioned along the lines of a telephone dial. This could be used to "dial" any one of the eight local stations, normal variable tuning, short-wave, or "Gram."

Unfortunately, its impressiveness finished with its appearance. When switched on, the set was weak, had a nasty hum level and a bad rattle in the speaker. Also, the "telephone" dial seemed to lack positive indexing, so that it was theoretically possible for a careless operator to set it between two stations, rather than the one required. Altogether a rather formidable list of troubles.

The owner was an elderly lady of rather limited means, and I realised that the job could be a costly one; perhaps more costly than she could afford. I decided that some compromise might have to be struck between what was desirable and what was economical.

SWITCH TROUBLE

A glance under the chassis was sufficient to reveal the dial trouble. As I had expected the telephone dial simply operated an eleven-position switch (one of the older types no longer in production) and the two indexing arms on the clicker plate had succumbed to old age.

In fact, it was a classic case of metal fatigue, the two arms having fractured where they joined the main shaft. One had broken away completely, while the other was hanging by a mere scrap of metal and quite incapable of performing any useful function. It seemed safe to assume that the set had been operated almost exclusively on the telephone dial.

However, I was less interested in this at the moment than in the electrical problems. A check on the HT voltage was most revealing, being only a little over 100 volts. This led in turn to the rectifier, a poor decrepit 80 trying valiantly to keep going in spite of its age.

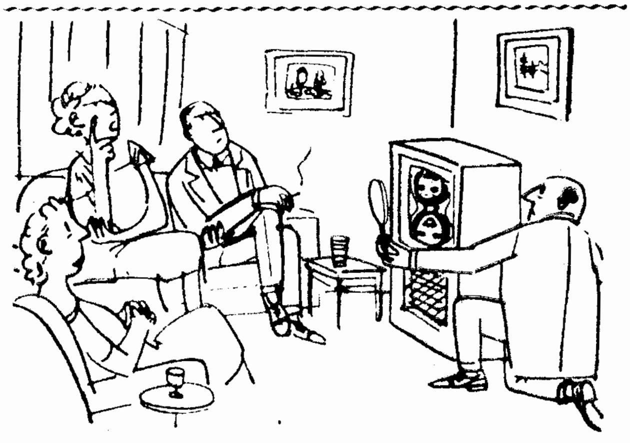
A new one helped matters considerably, but the HT was still on the low side. Remembering the hum I turned my attention to the electrolytics, both of which appeared to be fairly old. The first one was the most obvious culprit, and a new one restored the remainder of the missing HT volts and removed most of the hum. The second one was less obviously faulty, but I changed it anyway on principle.

The set was sounding better already. The hum had vanished, while the correct HT voltage seemed to have restored normal sensitivity. Only the speaker rattle remained to mar the performance.

This presented something of a problem. The speaker was certainly too old to return to the makers for repair, while, being an electro-dynamic type, replacement might be difficult. The only alternative seemed to be the fitting of a new permag type, plus a filter choke and dropping resistor.

While a perfectly satisfactory approach, the cost of the new speaker, plus additional parts, plus labour charges, would all add up to a fair sum. With other charges already incurred, or in sight, it could easily prove an embarrassment to the owner.

I took another look at the speaker. It was not the type which lent itself to repairs on the service bench, even supposing that the time could be justified, which was doubtful. On the other hand the degree of rattle was not severe, and I considered it might be worth trying a few simple "wangles."



☆

"Couldn't we just have it as bad as it was before?"

☆

One trick is simply to vary the pressure of the mounting screws, thus slightly distorting the frame and, if you're lucky, correcting the centring. However, the one which proved most satisfactory on this occasion was one of the simplest of all. I simply turned the speaker the other way up.

Apparently the suspension systems in some of these old speakers were prone to sag ever so slightly after many years' use, thus allowing the voice coil's own weight to drag it off centre. Turning it over simply reverses the procedure, the weight now pulling toward the centre. Of course, in another 20 years . . . but I doubt if I'll be worrying about that.

In this case the cure was not complete, but the improvement was considerable. At normal levels the rattle was virtually absent, though it would show up on some of the louder passages. Since I felt it unlikely that it would ever be driven at all hard in its own home, it seemed that my "cure" was adequate, particularly as there seemed to be a chance that it might get better rather than worse as time went on.

With the speaker functioning better the set sounded quite reasonable, and I considered the various electrical problems solved. The next point to consider was the broken switch, and I left the set running while I pondered the best solution to the problem.

It was while I was thus meditating, and after the set had been running for about 15 minutes, that I realised that all was not well. The reproduction was no longer clean, but had a definite "edge" on it.

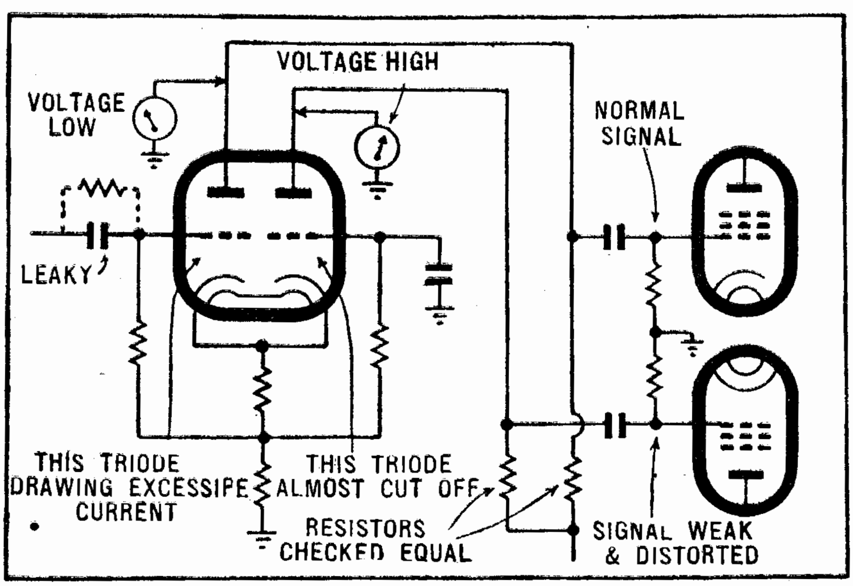
I let it run for a few more minutes, and the distortion increased noticeably during this time. It seemed that I hadn't finished with the electrical problems after all.

DROP IN VOLTAGE

A check on the HT voltage showed that it had dropped noticeably. This fact suggested that the output valve was drawing excessive current and, in turn, that positive voltage was building up on the grid.

Disconnecting the coupling capacitor from the grid restored most of the HT voltage, though it still seemed short of its previous best. Next I checked for any sign of positive voltage on the grid side of the disconnected coupling capacitor. Sure enough, there was a small but perceptible deflection of the needle; a clear indication of a leaky coupling capacitor.

Next I touched the meter prod on the grid of the output valve and was rather surprised to discover a positive indication here also, in spite of the dis-



Number three was different again. Being part of phase changer stage it caused one side to produce very weak and distorted signals, completely ruining the performance of a high power amplifier. Because the symptoms were rather unusual, it required some careful checking to track it down.

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3 x 3 x 1	11/7
3 x 3 x 2	17/10
3 x 3 x 3	24/10
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connected capacitor. This is an almost equally certain indication of a gassy valve, so it seemed there were two faults in this part of the circuit, both contributing to the same trouble.

In fact, it seems most likely that the leaky coupling capacitor occurred first, the resultant over-running of the output valve causing it to become gassy. Much as I regretted it, there seemed no alternative but to replace the valve, as well as fitting a new coupling capacitor.

And that was leaky coupling capacitor number two; one that I very nearly missed by reason of the time needed for it to show up. Presumably, the order of leakage was not enough in itself to cause obvious disturbance to the output stage, but it was enough to start a slow cycle of grid emission, increased cathode current, higher temperature, more grid emission, etc., building up over a period of about 20 minutes from a dead cold start.

THE SWITCH AGAIN

Now I returned to the problem of the broken switch. As with the speaker, this was mainly an economic one, and I had to decide just how much expense could be justified.

The switch was almost completely built-in by the broadcast and short wave coils and the array of trimmers associated with each channel. To replace the switch, or even the clicker plate and shaft, would mean that the entire coil and trimmer assembly would have to be ripped out and subsequently replaced.

While quite feasible technically, such a job was going to take a lot of time and the cost might be hard to justify. As far as I had been able to see the fault was not causing any inconvenience, the owner apparently having adapted herself to it, if, in fact, she even noticed it.

I finally decided that this was a case where I could benefit the customer most by leaving a fault in the set, rather than trying to correct it.

This left only a routine alignment to complete the job, assuming nothing serious showed up in the process. The thing that struck me most about this aspect of the set was the remarkable stability of the fixed tuned circuits associated with each of the eight switched channels. I knew enough about the history of the set to know that these had not been touched for many years, yet they were virtually "spot on" for each channel.

A HARD ONE

I don't know whether this was the result of good engineering, good luck, or a little of both. In general, however, switched tuned sets have never been regarded as much of a proposition, if only because of this very problem. Except in a few expensive designs employing AFC (Automatic Frequency Control) the problem of ensuring that the set will be accurately tuned to the station selected is a very serious one. And unless it does tune accurately it is worse than useless.

It is not easy to make physical versions of "L" and "C" which will remain absolutely constant regardless of temperature and other atmospheric varitions, plus normal vibration and handling. In fact, it is near enough to impossible, and certainly not in any sense an economic proposition.

Of course, they don't have to be "absolutely constant," but the amount of drift which can be tolerated is very small, even allowing for some unconscious tolerance on the part of the average user.

As a result, the few sets designed along these lines have never been regarded as overwhelmingly successful, and it is significant that the idea has been almost completely abandoned in recent years.

All the more reason, therefore, for my interest in this set and its high order of stability, even though I can offer no explanation why this was so. Neither have I encountered enough of this model to be able to say whether it is a natural characteristic or merely a fluke.

Quite naturally, the alignment was a bigger job than usual. The IF channel was perfectly normal, but the broadcast trimmers took a little working out. The eight switched channels had been achieved by connecting various values of capacitance across the main broadcast aerial and oscillator coils.

Also, because of the dual-wave facility, the regular broadcast trimmers could not be connected across the gang, and had to be mounted permanently across the coils. Thus, any disturbance of these two trimmers would upset the entire switched channel system, meaning that it was essential that they be adjusted and sealed before any attempt was made to adjust the switched trimmers.

Simple enough when you work it out; but a nasty trap for the unwary.

And so I was able to return the set to the customer in satisfactory working order without involving her in more expense than was absolutely necessary. She was extremely grateful that the charge was so reasonable and any lingering doubts I had about the measures I had adopted were quickly dispelled.

A PA SYSTEM

Story number three concerned a moderately high powered public address amplifier which had been built by an enthusiastic amateur for use by a local charitable organisation. He apparently had had no difficulty in getting it working but, even without making any measurements, it was quickly apparent that the power output was a long way short of the 30 watts or so the circuit was designed to give.

Lacking the facilities to check the performance in detail, and having tried the obvious things, he sought my aid to give the unit a complete check. It turned out to be a fairly conventional circuit using a couple of EL34s driven by a twin triode functioning as a cathode-coupled phase changer, preceded by a 6AU6 as a voltage amplifier.

Since power output was the factor in question, I commenced by setting up some gear to measure this with reasonable accuracy. Leaving the output transformer secondary completely open, I connected a heavy duty resistive load of correct value across the primary.

An AC voltmeter and a CRO also connected across the primary completed this section of the set-up, the other portion being the audio generator delivering 1000 cps into the input terminals. By driving the output up to overload point, the power being developed can be calculated from the AC voltage and load resistance.

This set-up quickly confirmed what the owner had said. The maximum power available at the overload level was a fraction over six watts, while it was apparent that the overload was occurring in anything but a symmetrical pattern. Quite obviously, something was very wrong.

The next thing I did was to disconnect the feedback loop. There is nothing more futile than trying to track down a source of distortion within a feedback loop. Regardless of where the distortion originates, it will be fed back to the input circuit and appear in all stages, making it impossible to detect the offending one. Naturally the input from the generator had to be reduced to compensate for the increased gain.

With the aid of the CRO I then checked the signal level at the grid of each output valve. I was gratified to discover that the signal at one was only a fraction of what it was at the other, and very distorted into the bargain. Well at least I was on the track.

UNBALANCED DRIVE

Tracing through the circuit I established that the valve receiving the weak drive was the "lower" one in a conventional circuit, and the one being driven from the cathode coupled section of the twin triode. It looked as though this was the faulty stage but, to make quite sure, I isolated it from the output valves by disconnecting both coupling capacitors. The signal from the two plates remained unbalanced as before.

At this point I suspected the twin triode and substituted a known good one. It made precisely no difference, thus killing that line of thought.

Next I measured the DC voltage at each plate and discovered that this was very much higher on the cathode coupled section than on the driven section. Since both sections should have been working under identical conditions, with equal plate loads, I immediately suspected a faulty plate load resistor.

Once again I drew a blank, the two resistors measuring as nearly equal as made no difference, leaving me a trifle bewildered for a few minutes. I studied the circuit again and could see little else around the twin triode that could cause trouble. Very little, that is, except the coupling capacitor to the 6AU6.

COUPLING CAPACITOR

Mainly because it was a little easier, I simply disconnected the 6AU6 plate load resistor from the HT supply, rather than unhook the capacitor itself. Then I checked the two plate voltages again, and was gratified to discover that they were now near enough to equal. There seemed little doubt that I had found the culprit.

Strangely enough, two capacitors lying on the bench—used, but not by any means old and battered—proved to be nearly as bad as the original, making three capacitors in a row which were not good enough for this application.

I was rather relieved, therefore, when a new one from stock proved to be OK, but I was inspired to wonder how often a lesser degree of leakage resulted in at least partially upsetting the balance of a phase changer.

Having found the culprit it was comparatively easy to work out the exact effect it had caused. By placing positive voltage on the grid of the first section it had increased the cathode current of this section and thus increased the bias developed across the cathode resistor. Since this resistor was common to both sections the increased bias appeared between grid and cathode of the second

(Continued on Page 127)

Here's your answer, Tom!

This month's queries come from two sources. One is a Tom who, having looked through a recent issue of our journal, put pen to paper in an effort to satisfy his curiosity and, to quote him, "to provide an interest to other beginners." The other is an experimenter with problems on the use of alternative components and valves.

Having looked through a current issue of your magazine, I have found a number of terms which I would like explained. What are IF strips, unmodulated signals, HF circuits, potentiometers, EHT voltages and tag terminal strips?

Simple as these terms may appear to some, Tom, to the uninitiated they must be puzzling. The term "IF strip," for example, refers to the sub-assemblies consisting of valves and associate components of an Intermediate Frequency channel.

It is common practice in the design and construction of television receivers to build the video and sound IF channels on a sub-chassis which attaches to the main chassis. Using this method of construction, the IF channels may be prealigned, serviced or interchanged without disturbing the complete assembly.

To explain the term "unmodulated signals" it would be easier to give a brief explanation of modulation.

Modulation is the process of superimposing an intelligence on a signal of a certain frequency, which is being broadcast by a transmitter. The steady carrier wave is made to vary, either in frequency or amplitude depending on the system of modulation used, in sympathy with the modulation source.

The absence of modulation would obviously produce only a steady carrier of some fixed frequency, which is therefore referred to as an unmodulated signal.

The words "high frequency circuits" are not so much a recognised term as a phrase which appears fairly frequently in radio literature. Its meaning is likely to vary with context.

HF CIRCUITS

The most common usage is in relation to receivers where "high frequency circuits" would refer to those carrying radio frequency or intermediate frequency signals, as distinct from the audio and power supply system.

Very rarely, with the discussion centring on tuning systems, etc., "high frequency circuits" might be used to describe short-wave coils, circuits and switches, as distinct from the broadcast band units.

In an article on audio amplifiers, speaker systems, and so on, "high frequency circuits" might describe units handling the treble end of the spectrum as distinct from those handling the middle and bass register.

The term "potentiometer" usually refers to a potential divider performing the function of a volume or gain control. It consists of a resistor which is effectively subdivided by a sliding contact. Placed across a source of potential difference, it allows smaller potentials to be picked off between one end and the sliding contact.

The letters EHT, Tom, are an abbreviation for "extra high tension." They refer to the very high voltage (usually between 1,000 and 20,000) applied to the high voltage electrodes in a cathode-ray tube.

Use of the term EHT avoids confusion with the normal HT (high tension) or B-plus voltage present in oscilloscopes, television receivers and other such items.

"Tag terminal strips" are strips of bakelite equipped with terminating lugs. They are used to support minor components and wiring when a number of these are to meet at a single junction point. The use of mounting strips results in shorter leads and neater wiring layouts.

* * *

Two other points which have aroused my curiosity were a mention of a "grid bias circuit" and "feedback." Would you explain these?

The term grid bias refers to the negative D.C. potential which is applied to the grid in order to make this electrode negative with respect to the cathode.

The incoming signal adds to or subtracts from the fixed bias and causes variations in the electron flow from the cathode to the anode. These variations of electron flow or plate current appear across the plate load as larger signals, thus achieving amplification.

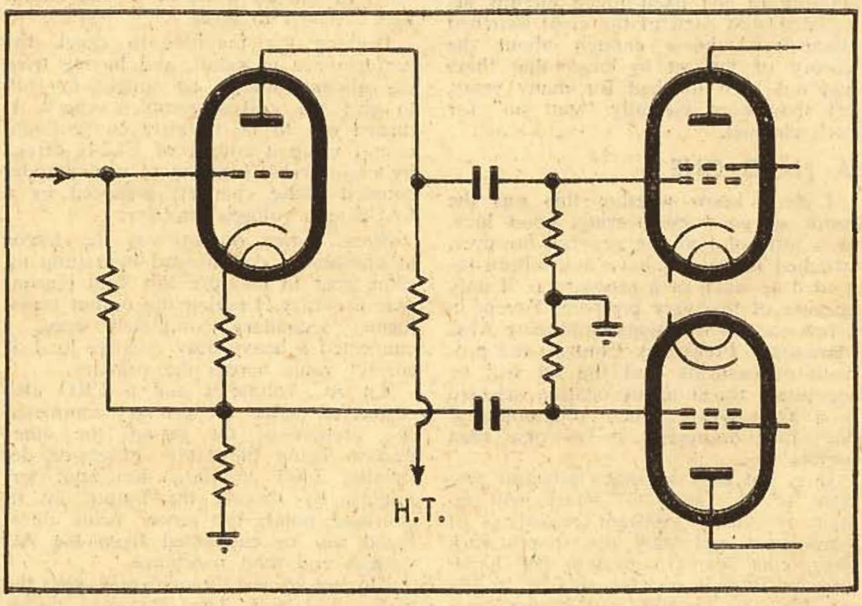
There are several ways in which a steady potential may be applied to the grid of a valve. A bias battery may be inserted between the grid leak and earth, the positive side of the battery being earthed. The cathode is then returned to earth and the potential difference between the grid and the cathode will be that of the battery voltage.

BIAS BATTERIES

Bias batteries are bulky and inconvenient to use and the standard practice is to use a cathode bias circuit. In this arrangement use is made of the cathode current, which is a combination of the screen and plate currents. A resistor is placed in the cathode return to earth so that the current flowing through it causes a voltage drop across it. This places the cathode effectively above earth by the voltage developed across the resistor.

If the grid is returned to earth, then the cathode will be that many volts above or positive with respect to the grid, which is at earth potential.

Making the cathode positive with respect to the grid is equivalent to placing



Circuit of a standard "plate-cathode" phase changer discussed in answer to Tom this month.

a negative potential on the grid, hence the grid may be considered negative with respect to the cathode.

Another well-known arrangement is to make use of the total current drain of a receiver or amplifier by connecting a resistor in the negative return of the power supply, that is, between the centre tap of the power transformer and earth.

The resultant voltage drop across this resistor makes the centre tap negative with respect to earth and, if the grid is returned to the centre tap while the cathode is returned to earth, the grid is effectively biased by that voltage drop.

In a few special cases, notably oscillators and the amplifying circuits in transmitters, the grid may have such a large signal applied to it that it becomes positive and draws current during part of the signal input cycle.

By placing a resistor and bypass in the grid return circuit the voltage developed by the grid current bursts, charges the capacitor to an average figure and this becomes, in effect, a self-generated grid bias.

FEEDBACK

"Feedback" is the condition which arises when energy is fed back from the output to the input of an amplifier. The feedback may be positive or negative, depending on whether it adds to or subtracts from the normal input signal.

When positive feedback exceeds a certain value oscillation takes place, and this is the principle applied in the design of most oscillators.

Negative feedback on the other hand is useful in reducing most forms of distortion, and, when used discreetly, it helps to stabilise amplifiers.

* * *

What is a phase-splitter circuit?

The phase splitter is generally a stage comprising of a valve and its associate components, designed to produce two balanced out-of-phase voltages from a single signal voltage applied to its grid.

The circuit of a standard phase splitter and its relationship to a push-pull output stage is reproduced. Referring to this, the action is not difficult to follow. The normal resistance load for the valve is divided into two separate load resistors, one in the plate circuit, the other in the cathode circuit.

The plate current of the valve passes through both resistors and sets up voltage differences across them. The cathode will be at a considerable positive voltage above earth, and the plate at a still higher one.

Any change in plate current caused by an increase or decrease of an incoming signal will increase or decrease the voltage drop across each of the resistors.

An increase in the voltage drops will cause the cathode to become more positive, while the plate becomes less positive. This will constitute a negative-going and positive-going signal at the plate and cathode respectively.

A decrease in the voltage drops will cause the cathode to become less positive while the plate becomes more positive and the signals appearing at the plate and cathode will reverse their directions.

Because of this tendency for the plate and cathode signal voltages to move in the opposite directions with variations of the input signal, a balanced out-of-phase output is available to drive a push-pull stage.

I was wondering if you could suggest a publication on valves, explaining their function, type and comparing them electrically, thus providing a list of alternative valves which will do the same job. For example, I replaced (by means of an adaptor socket) an old 22A in an old battery superhet with a 1L5-G and the same results were obtained as using the old valve. A publication listing such alternatives would be invaluable.

Most of the valve companies could help you with the type of information you need. Many of their publications are available either free or at very low cost. Valve data books often contain a list of equivalent types in addition to the characteristics of different valves which would save you turning over the pages in order to find the equivalent to a particular type.

There have been valve books published which attempt to list all the valve types ever manufactured. Even with only very brief data and no curves a very thick volume is needed. Most local valve books list only types which are, or have been, popular in this country and, therefore, a much more modest volume will suffice.

Many valve types are similar except for one characteristic such as the base, the filament voltage or the shape of the envelope. A well-known example is the 2A5, 42, 6F6, 6F6-G family. The 2A5 is an output pentode with a 2.5 volt filament. The 42 has the same electrode structure but the filament is rated at 6.3 volts. The 6F6-G has the same electrode structure, bulb and filament voltage as the 42 but is fitted with an octal rather than the older style 6-pin base. The 6F6 has the same features as the 6F6-G except for a small metal instead of a glass envelope.

* * *

With regard to your printed circuits, what significance does an arrow with a cross at the end of it have? Also by what means may I use say a 5,000 ohm speaker in a circuit designed for a 7,000 ohm speaker? Would it be possible to reverse this and use a 7,000 ohm speaker in a circuit designed for a 5,000 ohm speaker. Also could a 0.5 meg. potentiometer be wired to do the job of a 1 meg. pot?

You certainly have a thirst for knowledge, Tom, but perhaps we can answer the last of your questions without too much trouble.

The arrow with the cross probably refers to our filament circuits where we usually do not draw the full wiring from the power transformer to the filament of each valve as it is usually sufficiently clear what is required and the extra lines would only confuse the drawing.

Some pieces of equipment have a number of filaments connected to one transformer winding and a number to another winding. We may use an "X" to show one correspondence and a "Y" to show another.

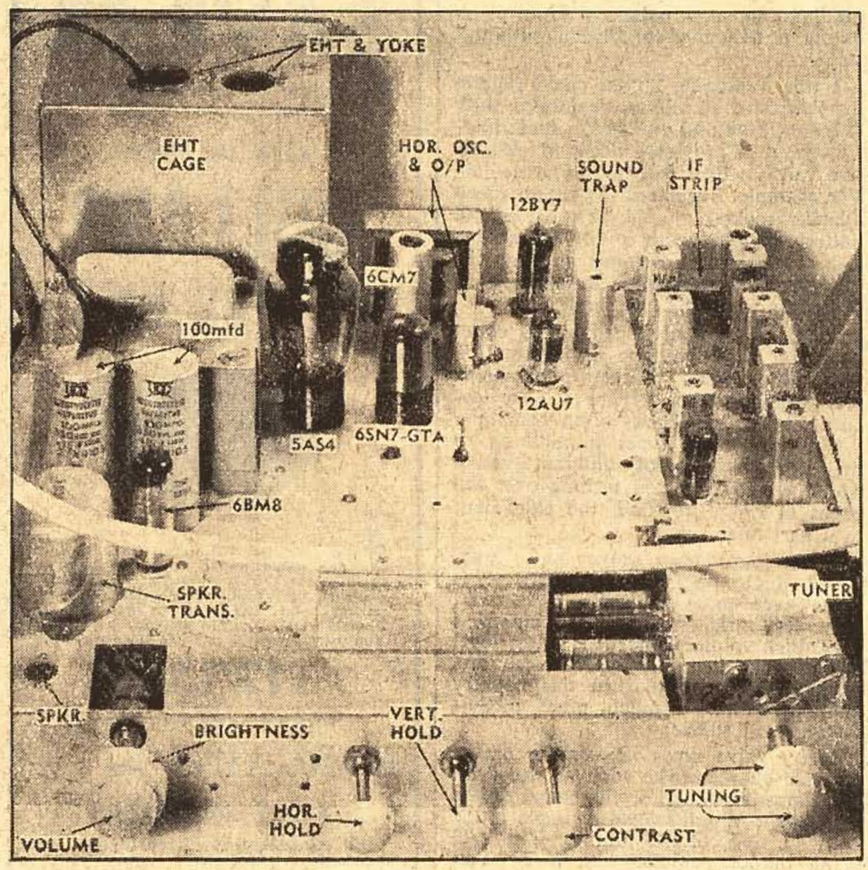
The question about the significance of speaker impedances has been discussed before but, with this small impedance change, you could swap the values back-

(Continued on Page 127)

Our TV Set For 1958-Part Two

With the help of this second article, you should be able to complete your 1958 Television Receiver. In particular, the article details the wiring of the video amplifier, synch. separator and oscillator stages, the EHT cage and physical mounting of the picture tube.

by Neville Williams



This top view of the chassis, seen through the picture tube supporting clamp, clearly shows the position of the major components. Note the position of the tuner and the cutout which clears the two valves.

If you followed the suggested constructional procedure to the point reached in our last issue, you should already have tuned in the three active channels and listened to the sound side of their programs. You will be in the happy position of knowing that this much, at least, of your receiver is in operation.

On the other hand, if you have struck trouble and fail to hear the sound, deal with the problem now. The addition of picture circuits won't correct an existing fault and will represent just that much more circuitry to worry about and to complicate the job of trouble-shooting. However, let's hope that this word of advice is not necessary.

Just before proceeding, a couple of matters relevant to the main circuit warrant special mention.

As explained last month, the circuit is equally suitable for use with 17 or 21-inch tubes, provided they are of the 90-degree deflection type and use electrostatic focus. Four currently available types were listed as possibilities and you can take your pick, having regard to size, brand, price and availability.

Since our last issue went to press, two new types have been announced for local manufacture and distribution. These are the 17BJP4 and the 21CBP4.

Special feature of these tubes is that they have a straight electron gun, as distinct from the conventional bent gun, and, therefore, do not require an ion trap magnet to align the electron beam.

The change allows the use of a somewhat shorter neck than in earlier types, eliminating or reducing the bulge at the rear of the conventional TV cabinet. Manufacturers claim that the use of an aluminised screen, together with other unspecified refinements, has virtually eliminated the risk of ion burn.

Though we have not had opportunity to try either of the new types, the manufacturers state that they will operate in the same circuit and with the same base connections as the other tvpes listed.

Another point concerns the A.G.C. circuit, which was discussed last month. The idea appears to have found a good deal of acceptance and there is a chance that at least some of the I.F. strips will be sold with the additional components already fitted.

The exact value of the A.G.C. diode load and feed resistor is not critical in the circuit as shown. We used 0.33M resistors but higher values, such as 0.47M or 0.68M would work equally well, if already fitted.

VIDEO AMPLIFIER

Continuing now with the construction of the receiver, the next obvious step is to wire the video amplifier stage, which is just alongside the rear end of the I.F. strip. The socket should be mounted with the blank space toward the I.F. strip or the rear corner of the chassis, depending on whether it happens to be a moulded or a wafer type.

Note that the 12BY7 has a centre-tapped heater. Pins 4 and 5 join together and go to one side of the circuit, while pin 6 goes to the other side. We have heard of one or two cases where a mistake here causes the 12BY7 to operate at half heater power, resulting in slow heating, with possible reaction also on the picture quality and synch. pulse amplitude.

The 12BY7 cathode connects to one side of a sound trap coil, tuned to 5.5Mc and intended to minimise interference in the picture from the 5.5Mc intercarrier beat frequency.

SOUND TRAP

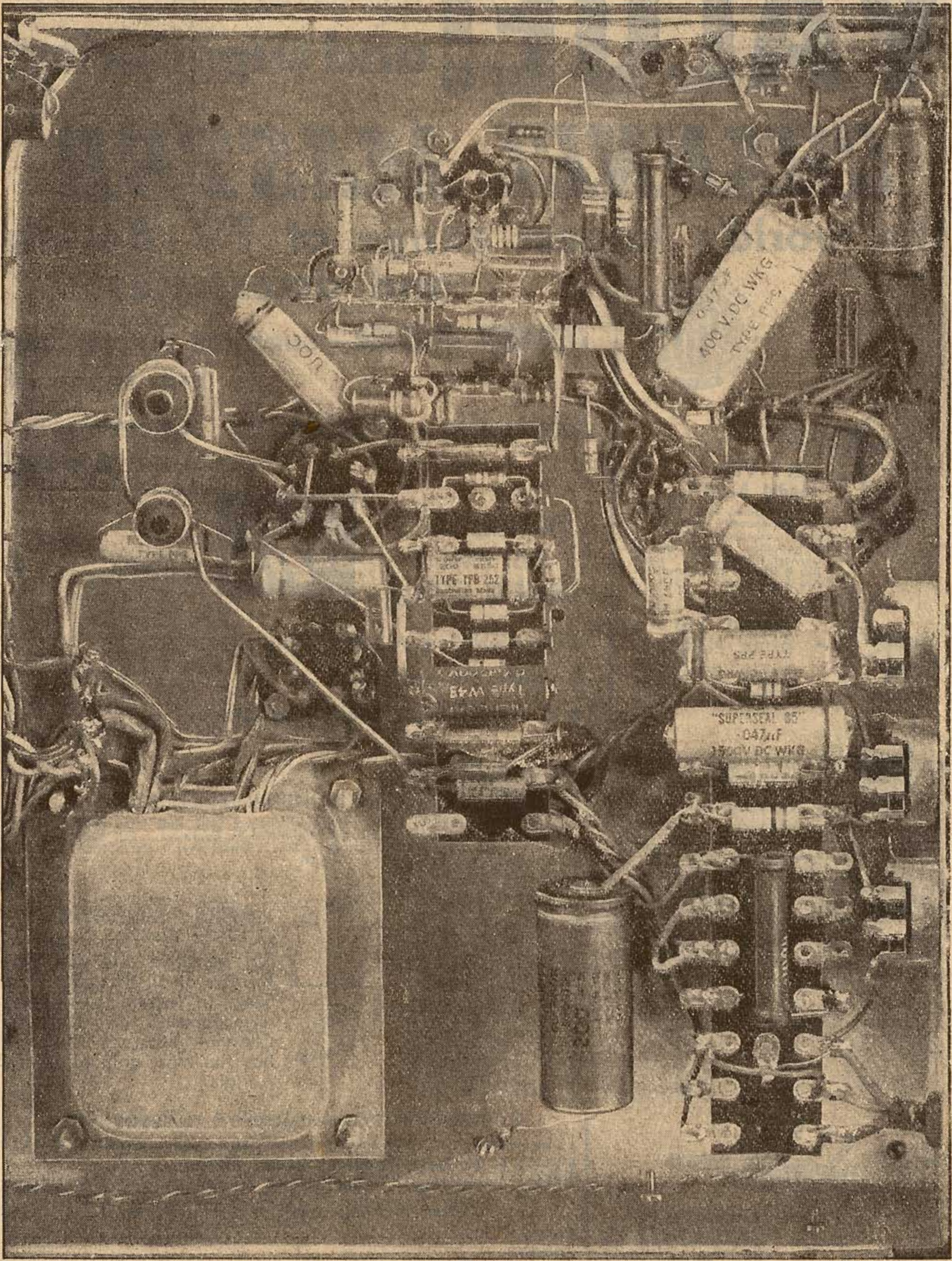
The trap coil can be hand-wound quite readily, using a miniature coil can and former with variable iron slug. The winding consists of 6¼ turns of 22 B and S gauge enamel close wound about ⅜-inch from the bottom of the former.

The capacitor can be a paper, mica or ceramic type, preferably close tolerance and most definitely NOT one marked "High K." It can be mounted inside the can, just clear of the winding, if it is small enough.

Commercial trap coils using many more turns of wire and a smaller tuning capacitor are not recommended for this particular position.

This simple cathode trap, as suggested

DETAILED VIEW OF THE PICTURE CIRCUIT WIRING



This section of the chassis, shown here in greater detail, contains most of the picture circuit wiring. The video amplifier is at top right, with the synch. separator alongside. In the centre is the line oscillator and its associated panel, while most of the frame circuitry is centred on the panel at the lower right.

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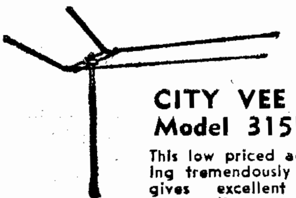

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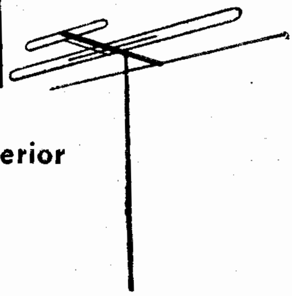

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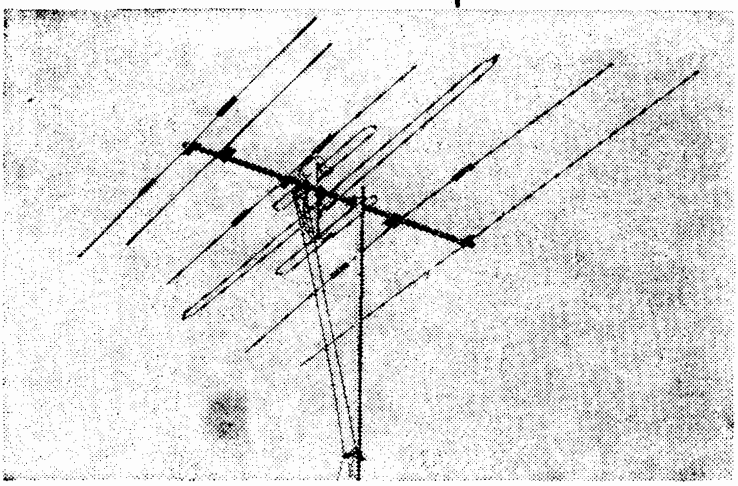

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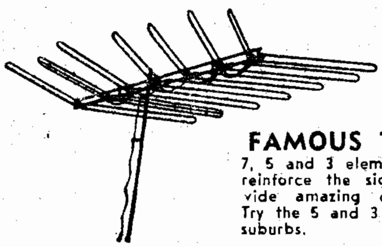

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in application data for the 12BY7, has proved fairly adequate in practice. Its effect can be augmented in special cases with a further trap in the plate circuit and we may have more to say about this at a later date.

The cathode circuit to earth is completed through the 500 ohm Contrast Control potentiometer which is now mounted, for convenience, on the front face of the chassis.

Here a word about the cathode wiring. Since the circuit is "hot" and carries frequencies up to at least 5.5 Mc, precautions must be taken against possible radiation, earth loop effects and possible instability. Also, cathode-earth capacitance will give some useful high frequency video boost with resistance in circuit but only if the capacitance is of the right order.

CATHODE LEAD

With these things in mind, the lead from the trap coil to the potentiometer should be run in small diameter coaxial type cable. Earth the braiding near the 12BY7 socket and use it as the sole earth return for the potentiometer.

This last is shown in our photographs as a tandem type and is, in fact, a double 1,000 ohm type with the elements wired in parallel to give an effective 500 ohms with ample current carrying capacity.

As an alternative to this type, a wire-wound pot can be used, as far as we can discover without any ill effects.

Single element carbon types, particularly small types are not recommended for this position. While current through the element is quite low in normal use, it can rise to damaging proportions when the control is advanced towards minimum resistance with very weak signal input.

As mentioned last month, the grid connects to the last lug on the adjacent tagstrip, and thence to the video output lug within the IF strip. The lead should be kept clear of the chassis, to minimise capacitance, and the pigtails on the resistor, which picks up AGC on the tagstrip just mentioned, should be kept short for the same reason.

SCREEN BYPASS

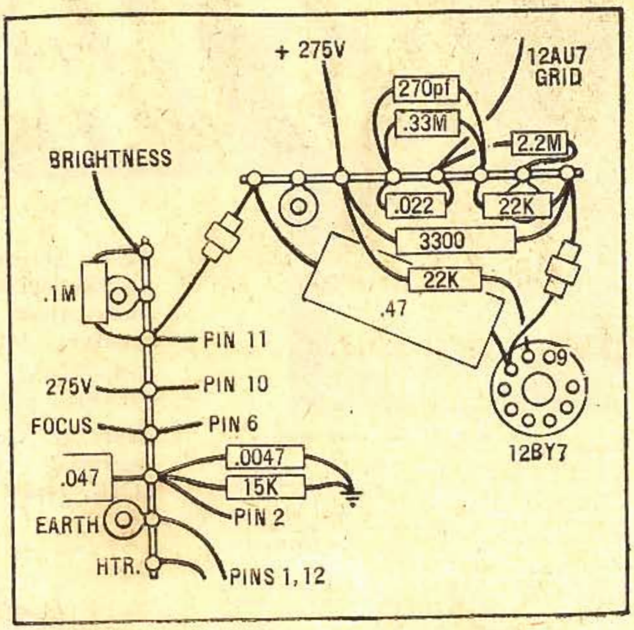
Note that the screen bypass is now shown returned to the cathode circuit rather than to earth, as a precaution against instability in the video amplifier.

Instability may show up as a random transverse pattern on the screen or, if it happens to occur at a much higher frequency, its most evident effect is to reverse the action of the Contrast Control. The picture contrast is seen to increase in the normal way as the control is turned towards minimum resistance but the action then reverses, the contrast diminishing to a low order at zero resistance.

In the unlikely event of this trouble still being evident, when the receiver is tested, the screen bypass can be wired directly back to cathode instead of to the bottom of the trap coil.

In the original set the screen bypass was held in place against the rear corner of the chassis by a loop of wire, the capacitor leads running away to the appropriate points.

Components and wiring which feed the output of the video amplifier to the picture tube and to the synch separator terminate on two eight-tag strips, which are mounted adjacent to the 12BY7 socket, as shown in the accompanying sketch.



☆ Components to do with the video output circuit can be grouped logically as shown on two 8-tag strips. The strip at the top segregates the signal for the synch. separator, while the strip on the left provides a termination for the cabled leads running to the picture tube socket. Note that the picture tube cathode lead must be kept separate from the others ☆

There is plenty of point in following this layout, because it is logical and orderly to begin with and, furthermore, the peaking components assume orders of capacitance which the layout gives. A further and no less important point is that it keeps high level video voltages away from points in the synch separator circuit, other than the input grid itself.

In actual fact, of course, components can be kept even closer to the tagstrip than can be depicted in a simple plan sketch.

Note also that the 0.47 mfd coupling capacitor is deliberately swung clear of the chassis and not tucked down against it and among other components. Stray capacitance to earth is thus once again kept to a minimum.

As indicated, all leads to do with the picture tube terminate on one tagstrip and then pass up through a grommetted hole to the picture tube socket. The external lead to the socket will need to be a trifle more than 12 inches long. All wires can be plaited for neatness except the cathode wire, which passes through a separate hole and is kept clear of the others to minimise capacitance loss.

WIRING DIAGRAM

Interconnection of the tagstrips and relevant components to the remainder of the wiring should be clear enough from the main circuit diagram.

Mounting holes for the tagstrips are already drilled in the chassis, though, in the one we used they had to be extended a little with a file to straighten the strips and make them fit as intended.

If you have a CRO on hand, operation of the video amplifier can be observed at this stage by setting the CRO time base to about 16, 25 or 50 cps and clipping the vertical amplifier input lead to the cathode end of the 0.47 mfd. coupling capacitor.

By suitably manipulating the CRO controls and the receiver tuning it should be possible to see the video content in one or more frames, changing with movement in the picture and with the frame synch area fairly sharply defined.

Amplitude of the pattern should vary with the setting of the contrast control.

From the video amplifier, portion of the signal is diverted to the 12AU7 synch separator stage and this can logically be wired next.

As already mentioned, the components to do with the separator input circuit are mounted on the tagstrip adjacent to the 12BY7, leaving only a simple lead to run to pin 2 of the 12AU7. Keep this lead reasonably clear of the other components and also away from pin 1, so that video energy shall not be coupled directly into the second stage instead of via the first triode.

WATCH LAYOUT

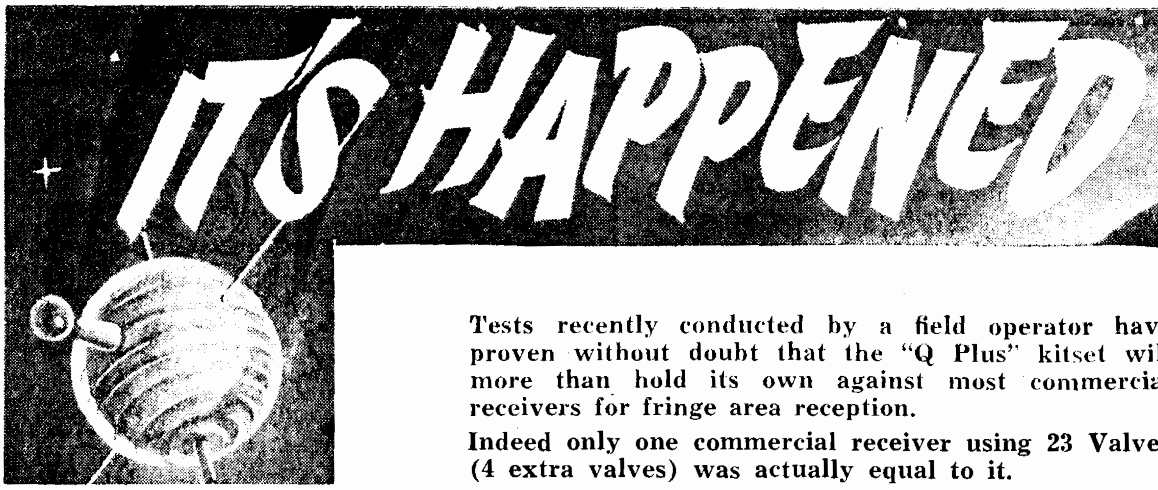
The remainder of the components have to be disposed between the synch separator and the two oscillators which the synch pulses are intended to control.

While there may be many possible ways to arrange the components the layout is important to the extent that unwise placement may change the intended proportion of line/frame/video signals or, by grossly increasing the bulk of the circuitry, make it liable to pick up line energy from the deflection output circuit.

With this in mind, we suggest that you follow the method shown in the accompanying diagram. It involves mounting an 8-tag and a 7-tag strip in the space between the separator socket and the two oscillators. The chassis you buy may have the necessary mounting holes already punched, but drilling an extra small hole is no great chore.

The 8-tag strip supports most of the synch. separator components, while the 7-tag strip carries mainly the synch. input and timing components for the frame oscillator.

For neatness, it is almost essential to use small resistors and capacitors, but, once again, do not use "high-K" capacitors. These are intended primarily for



Tests recently conducted by a field operator have proven without doubt that the "Q Plus" kitset will more than hold its own against most commercial receivers for fringe area reception.

Indeed only one commercial receiver using 23 Valves (4 extra valves) was actually equal to it.

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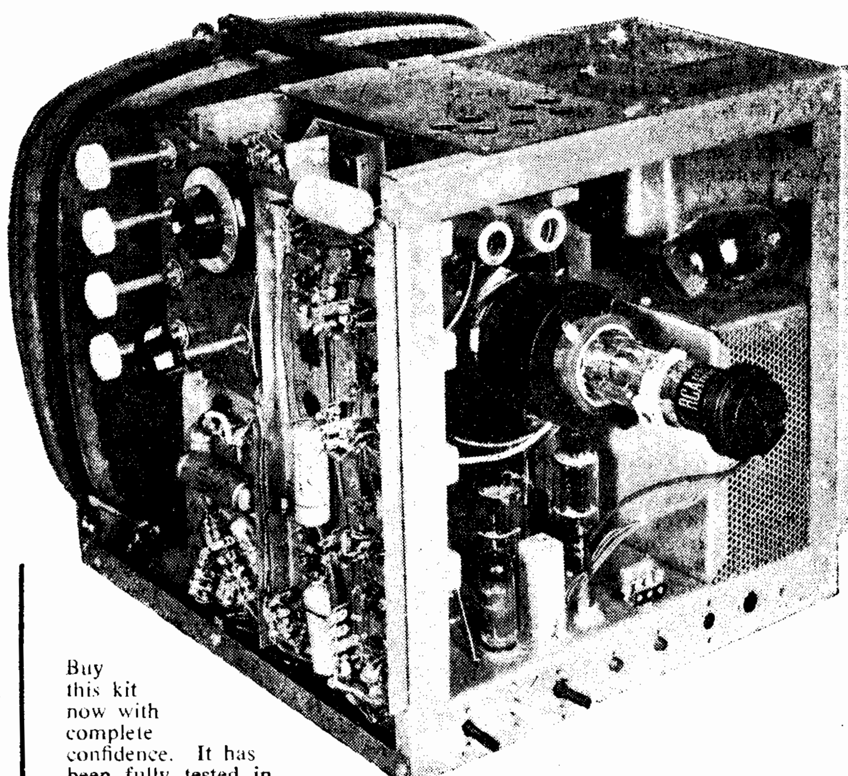

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Power Supply (5AS4)
Primary taps for 200, 220 and 230 v. operation, desired tap selected by special plug and socket, mounted on power supply chassis, full wave rectification with capacitative input filter, giving low ripple content. A 300 mA fuse is incorporated. Mains transformer has copper shield for minimum external field.

Tuner (6BQ7A, 6U8)
Q Plus type VTT/1 10 channel turret tuner featuring low noise "Cascode." R.F. amplifier and high-mu mixer oscillator. Low impedance output to I.F. channel. Special moulded coil formers threaded throughout their entire length prevent cores from coming loose. Special "alkyd" low loss high stability plastic used on all coil biscuits and mouldings. Oscillator is compensated for frequency drift due to variations in temperatures. This unit comes fully tested and pre-aligned.

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Audio Amplifier and Output (6AV6, 6AQ5)
A triode voltage amplifier with beam tetrode power output. Negative feedback is applied to the 6AQ5. The required F.M. de-emphasis is obtained by a simple R/C network at the input to the volume control. Frequency response 90 C/s—5Kc/s at—6db.

Video Amplifier (12BY7)
A high gain pentode using a combination of series and shunt peaking. Video detector is directly coupled to video amplifier grid. Output is capacitatively coupled to picture tube cathode. The gain (contrast) is controlled by a cathode potentiometer. Frequency response up to 4 Mc/s at -6db., and greater than -40 db., at 5.5 Mc/s.

Sync Separator, Sync Phase Inverter (12AU7)
Sync pulses are obtained from the output of the video amplifier and applied to the sync clipper which removes most of the video content, and provides a substantial degree of noise immunity. The sync phase inverter further separates the sync pulses from the video, and also reverses the phase suitable for triggering the line and frame oscillators.

Frame Oscillator and Frame Output (6CM7)
A frame blocking oscillator is used. The frame output stage drives the deflection using an auto-transformer to match the output to the yoke impedance.

Line A.F. Line Blocking Oscillator or 6SN7GTA
The line A.F.C. is a D.C. control valve to correct the line blocking oscillator which used a "sine wave" stabilising coil. Small changes in sync control are obtainable by a pot. control on the D.C. control valve. Once aligned correctly, this circuit will remain in sync. over long periods, with varying signal strength and mains variation.

Line Output, E.H.T. Supply (6DQ6A, 1B-3GT, 6AX4-GT)
The line output/E.H.T. transformer (Q Plus VHOPT/1) (auto-transformer type) and the E.H.T. rectifier are shielded in a metal case and cover, supplies 15 KV picture tube ultor on load. Provision is made to alter this section for higher ultor voltage and drive suitable for a 90 deg 21in picture tube. Picture tube (17AVP4A) 90 deg magnetic deflection, electrostatic focus.

A.G.C.
"Simple" type A.G.C. voltage is developed by separate rectifier has an A.G.C. clamp.

Chassis
The main chassis comes pre-assembled, ready to take the power supply, line output/E.H.T. cage, tuner, video and sound I.F. channel, frame oscillator and output sub-chassis. The picture tube mounting, strap etc. are screwed to the main chassis, making it one complete unit.

Controls
Channel selector and fine tuning are a dual concentric knob, volume off-on, brightness, contrast, frame hold, line hold, controls are grouped together and fitted with smaller knobs. Frame height, frame linearity, line drive, line oscillator, line sine wave, controls are mounted on the rear of the main chassis. All these controls can be adjusted without removing the back of the cabinet.

General
The speaker (5in) is mounted on the left hand side of the cabinet and mounted onto the cabinet. 9ft of 3-core P.V.C. sheathed power flex extends from the rear of the cabinet.

bypass functions and, because their capacitance can be much higher than the marked value, they can cause malfunctioning in separation and timing circuits, where time constants are significant.

Having completed the wiring of the synch. separator stage, the waveforms can be checked against those shown on the circuit diagram.

The clarity and amplitude of the observed waveforms will be affected somewhat by the loading and characteristics of the C.R.O., and, in the output circuit, by the fact that the oscillators are not in operation. However, they should be sufficiently close to the published diagrams to indicate that the stage is indeed separating out the synchronising pulses.

Next step is to wire the 6CM7 frame oscillator and output stage, but before proceeding to detail this, some explanation is necessary in regard to certain key components in both the frame and line deflection circuits.

FRAME OSCILLATOR

The frame oscillator is of the blocking type and depends for its correct operation on a blocking oscillator transformer having just the right characteristics. Similarly, the frame output valve must operate into a suitably designed output transformer, with a secondary winding to match the coils in the deflection yoke.

The line oscillator is also of the blocking type, and the whole circuit assumes the use of an oscillator coil and a sine wave coil having just the right characteristics.

The line output valve must also be coupled to the deflection yoke by a line output transformer having the correct ratio, with a secondary and an extended winding such that the EHT output and the EHT rectifier filament voltage are just right, when the beam is being properly deflected. Two other minor components, the line Width and Linearity coils, must also have the intended effect.

Last, but not least, as a by-product of its operation, the line output system must supply an adequate voltage and current from its B-plus boost circuit to supply the frame oscillator and output.

Unless all these components "mate together," the circuit will not work correctly, if at all.

In this receiver, as in the previous models, we have adopted the very simple course of using A.W.A. oscillator and deflection components, distributed by Manufacturers' Special Products and marketed by most radio trade houses.

POSSIBLE SUBSTITUTES

During the past few months, however, we have seen electrical duplicates of most of these components, manufactured by other reputable firms. While, we have not been able to check them all, they should be equally suitable for the present receiver.

The vital point to watch is that you are supplied with components which are expressly designed for use in the R. TV and H. circuit and intended for 90-degree deflection. Do not try to make do with others, just because they happen to be called by the same name. They may be excellent in other circuits but quite unsuitable for this one.

Coming now to the 6CM7 frame oscillator and output stage, you will need for the valve a good quality moulded socket, fitted with a valve shield. This is a precautionary measure against possible penetration of line deflection energy into the frame oscillator, with disturbing effects on the interlace.

The socket should be mounted with pins 1 and 9 towards the IF strip and care taken, when wiring, to see that it is not contaminated with excess flux. As indicated on the circuit, the output plate operates with something like 500 applied volts and a pulse amplitude of about 1,000 volts peak to peak.

The frame blocking transformer and the frame output transformer mount above the chassis in the positions shown in last month's general photograph. the leads passing down through grommetted holes in the chassis.

FRAME WIRING

In wiring the frame circuitry, the only component in our layout which attaches to the 6CM7 socket is a 3.3M resistor, which bridges from pin 6 to the end lug on the 7-tag strip mentioned earlier. It is shown clearly in the synch. separator wiring diagram.

All other components to do with the frame oscillator and output stage are mounted on the panel near the rear edge of the receiver and set away from the chassis, on pillars or long bolts, by not less than 1 1-8 inch.

This board is often supplied in lengths containing 24 lugs per side. A 15-lug section can be cut for the frame panel leaving a 9-lug section to be used later for the line oscillator components.

Actually, if last month's instructions were followed, this panel will already be in place, with the end lugs used to terminate the mains input circuitry.

Wiring to the remaining lugs is shown in the accompanying layout sketch and, for the most part, follows our earlier 21-inch receiver. However, lugs serving the EHT cage are wired somewhat differently.

One of these lugs is connected to earth, one to the 6.3 volt heater wiring, one to the B-plus line, while the other receives the boosted HT voltage from the cage for subsequent filtering. Four leads passing down through the chassis from the cage can be attached very simply to these lugs, the only other sub-chassis cage lead being the one carrying sawtooth drive voltage to it from the line oscillator.

The "safety link" wiring, hitherto accommodated on the resistor panel, is now in the cage itself, so that three lugs are now unused. Note the position for the 6,000-ohm boost filter resistor and the 16mfd capacitor, the latter being tucked between the panel board and the chassis.

The suggested spacing of the board should allow the capacitor to be fitted in comfortably but make sure that it is not placed in a position where a heated solder lug could puncture its outer sleeving. The negative end of the capacitor now returns to pin 9 of the 6CM7, not to earth as formerly.

Interconnection of the remaining lugs and components to the rest of the wiring should be readily discernible by comparison with the main schematic circuit.

The frame oscillator and output stage cannot be tested under actual working conditions at this stage, because both sections are intended to operate from about 500 volts, supplied from the not-yet-completed E.H.T. cage. In any case, it is unwise to operate either the frame or the line output stage without proper connection to the deflection yoke, which provides their output load.

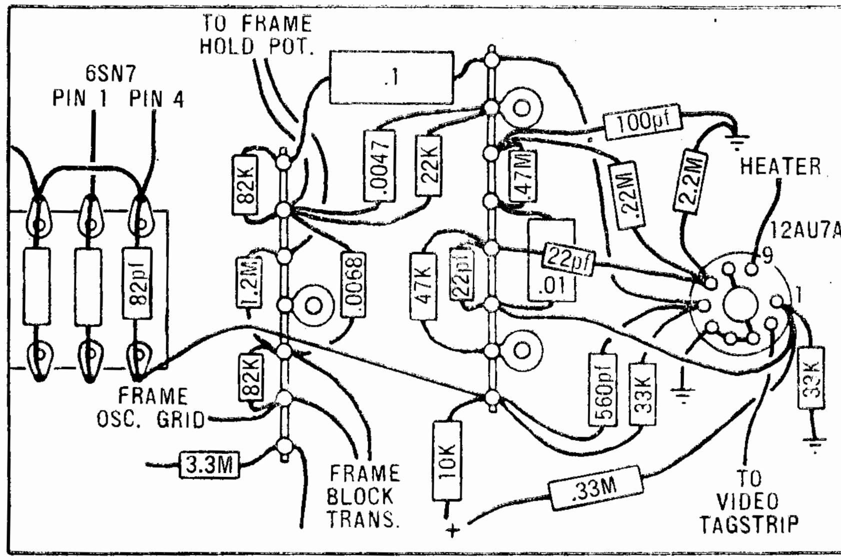
PRELIMINARY TEST

However, neglecting actual amplitude, the frame oscillator can normally be made to work, if supplied temporarily from plus 275 volts, and the waveform and locking observed on any ordinary oscilloscope.

The frame output transformer, incidentally, is mounted above the chassis and the red (or brown) and yellow leads terminate on adjacent lugs, as indicated, at one end of the panel.

From these same lugs a twisted pair of leads run to a socket and plug, mak-

WIRING OF THE SYNCH SEPARATOR



Components around the synch. separator can easily become a confused mass unless mounted and wired systematically. We suggest you arrange them this way, those on the 7-tag strip leading logically into the frame oscillator. Note also the line pulse feed to the nearest lug on the line oscillator panel.

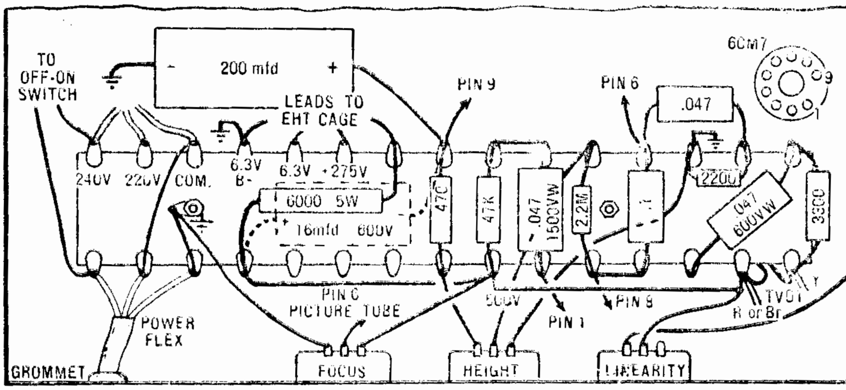
ing connection with the vertical scan coils in the yoke.

In our earlier receivers, these frame leads passed out through a separate grommetted hole near the frame transformer, attaching to a socket which more or less floated in mid-air between the chassis and the yoke.

In this receiver, the frame leads run underneath the chassis and up through the cage to a socket which is attached to the underside of the cage cover. The horizontal deflection leads also terminate at this socket, as also do two leads from within the cage, providing the B-plus "safety link."

There appears to be no electrical objection to this scheme and it does eliminate loose wires on top of the chassis. The yoke lead simply plugs into a mating socket in the top of the EHT cage.

The final major section to be installed and wired in the main chassis is the line oscillator and control circuit, using a 6SN7-GTA (or "B").



This diagram shows the arrangement of components on the panel serving the frame oscillator and output stage. Leads run to the yoke from the two lugs at the bottom right. They can be twisted for neatness but must be color coded so that they connect to the correct pins on the yoke plug.

OSCILLATOR COIL

With the elimination of the angle bracket from the centre of the chassis, the line oscillator blocking coil is now mounted alongside the sine wave coil and about 1 3-8 inches away from it. If your chassis does not have a suitable hole already punched, one will have to be drilled to the exact size of the existing hole for the sine wave coil.

The holes must be accurate, to suit the patent push-fit clips used for both coils. Mount the sine-wave coil nearer the power transformer and the blocking oscillator coil in the remaining hole. In the finished receiver, the cores of both are readily accessible from above the chassis for final adjustment.

The 6SN7 socket should be mounted with the keyway pointing in the general direction of the audio amplifier, so as to bring pins 1 and 2 adjacent to the oscillator coil.

Three or four components to do with the line oscillator are soldered to the socket and coils but the rest mount on a terminal panel having nine lugs per side, as mentioned earlier. Provision should be made to mount this in the position shown, about 1 1-8 inch from the chassis but it can well be wired up before actually being secured in position.

WIRING DETAILS

Referring to the circuit, the 68K resistor attaches directly to the Line Hold pot, an .01 capacitor bridges across the sine wave coil, a 68K resistor across half of the line oscillator coil and a 270pF capacitor swings between the oscillator coil and pin 1 of the 6SN7 socket.

The sine wave coil has two connections only and polarity is not important. However, there are three connections for the oscillator coil and manufacturers' data show the "start" or inside of the winding connected to plate, "finish" to the grid capacitor, with a tapping marked by a yellow spot. Make sure you get it the right way round.

In the absence of a drawing of the panel carrying the line oscillator components, it will be necessary to describe the wiring of it in so many words. It is quite tricky and it may be helpful to sketch it out roughly for yourself to minimise the risk of error.

For the sake of identification, we shall refer to the two lugs nearest the 6SN7 socket as number 1 pair, progressing through 2, 3, 4 and so on to the other end.

The capacitor between the number 1 pair of lugs is the 82pF mica or ceramic, which feeds the line pulse from the synch. separator to pin 4 of the 6SN7 grid. The connections to it are obvious from the main circuit.

The 0.15M line oscillator grid resistor mounts between the number 2 pair, the lug nearer the 6SN7 socket being connected directly across to pin 1.

Between the number 3 lugs is the 0.33M input grid resistor, the lug nearer the socket being connected under the panel to the appropriate lug 1 and thence to pin 4 on the 6SN7 socket as already mentioned. The other end connects to the 0.1 mfd. capacitor, running across to the number 4 lug, nearer the socket, and thence to the valve cathode pin 6.

From this same point, an 82K resistor bridges to lug 4 furthest from the 6SN7 socket, an 0.82M resistor running from here to the adjacent lug 3 to complete this portion of the circuit.

Another 0.33M resistor mounts between the number 5 pair of lugs, the one nearer the socket being earthed. The .02 mfd cathode bypass can thus bridge directly between this earthed lug and the adjacent lug 4. The circuit to the other end of the 0.33M resistor is completed by linking it to the adjacent lug 4 and also to lug 2 on the same side of the panel.

An 0.47 or 0.5mfd capacitor is supported across the number 6 pair of lugs, a 3900 ohm resistor running from the one farthest from the socket back to the earthed number 5 lug just mentioned. The other end of the capacitor must be linked to lug 4 and thence to the 6SN7 cathode, pin 6.

The number 7 lugs and the number 8 lugs carry respectively an 82pF capacitor and a 68K resistor. One end of the resistor bridges across to the sine wave coil, the other end being connected to the B-plus line.

The 0.15M resistor and 15pF capacitor in the feedback line bridge between the end of the 68K connecting to the sine wave coil and the remote end of the 82pF capacitor just mentioned. The remaining end of this capacitor must be connected to the appropriate lug 1 on the panel and thence to the grid pin 4.

Purpose of the line oscillator is to supply a sawtooth drive voltage, locked with the transmitter line frequency, to the line output stage. The active signal lead runs from the junction of the 68K resistor and sine wave coil, through the nearby grommetted hole, into the EHT cage above.

The drive voltage is developed principally across a .001 mfd. capacitor running to the cathode of the line output valve. This serves both as a timing capacitor and an RF bypass and the line oscillator circuit will not work reliably without it.

TESTING LINE OSC.

The capacitor in question is mounted in the EHT cage and, to test the line oscillator without the cage in position, it is essential to bypass to earth temporarily the junction of the 68K resistor and the sine wave coil, using a .001 capacitor.

As indicated in the circuit and photographs all components to do with the line output stage and the EHT supply are housed in a metal cage above the chassis, a method which serves very well to confine the energy associated with the line deflection system.

The EHT cage can be built as an entirely separate unit, connecting into circuit by a few simple leads passing down beneath the main chassis. The terminal points for these leads have been indicated earlier.

All components in the EHT cage are assembled on to a base plate measuring approximately 5 x 5 inches, with a half-inch flange upturned to support the top cover. This latter should be a tight push-fit but is intended to be held in place by three or four self-tapping screws.

The box you buy may be specially designed for the 90-degree components or it may have been drilled according to an earlier blueprint, intended for the original 70-degree components. In this latter case, one or two new small holes

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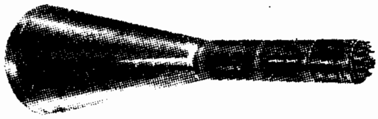

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.01	5000	Block	4/9
.01 + .01	2000	Block	3/
.01 = .001 + .005	600	Block	1/6
.02	1000	Mica	2/
.025	2000	Mica	3/
.1	500	Block	1/3
.1	1500	Block	2/6
.25	3000	Block	3/3
.5	750	Block	2/
1	400	Block	2/3
2	400	Block	3/3
4	750	Block	6/6
5	400	Block	4/
3 + 5	400	Block	7/9

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might need to be drilled or existing holes elongated with a small file, to make everything fit in properly.

Considerable care is necessary in positioning the line output transformer. It needs to be pushed along as far as possible in one direction to clear the Linearity and Width coils but, at the same time, the circumference of the EHT winding must be kept well away from the cover, so as to minimise the risk of corona discharge.

Things will fit into position much better if the mounting foot of the line output transformer is reduced to ½-inch wide, on the side opposite the terminal lugs. Be very careful in doing this, because any crack or chip in the insulation of the EHT coil will encourage corona effects.

RECTIFIER SOCKET

Before finalising the position of the transformer, however, the skirted socket for the EHT rectifier should be considered. It needs to be mounted on pillars, 5/8-inch above the baseplate and holes should be elongated, if not already correct, to bring the socket right over against the side of the cage.

The line output transformer should now be slipped in alongside it, with the EHT coil fitting into the existing cutout in the bakelite flange. This cutout can be enlarged somewhat with a round file, or even extended slightly into the vertical portion, to allow the EHT coil to come close against the socket and as far as possible from the side of the cage.

Having thus determined a position for the line output transformer, leaving as much clearance as possible for the Linearity and Width coils, drill the necessary holes so it can be mounted temporarily in position.

As indicated in the photographs, the Linearity coil pushes into the top hole in the vertical bracket, the Width coil being below it and set to one side to clear the filament loop supplying the EHT rectifier. The position of these coils should be checked, without actually locking them in place.

The position for the horizontal drive capacitor can likewise be checked and, if the bracket does not clear the line ouput transformer, a couple of new holes can be drilled, setting the capacitor a little further back but still in line with the screwdriver hole in the rear bracket.

The drive capacitor can most easily be soldered to the supporting bracket but, before it is finally mounted in position, make sure that it will spring readily to the fully open position, when the screw is turned anti-clockwise.

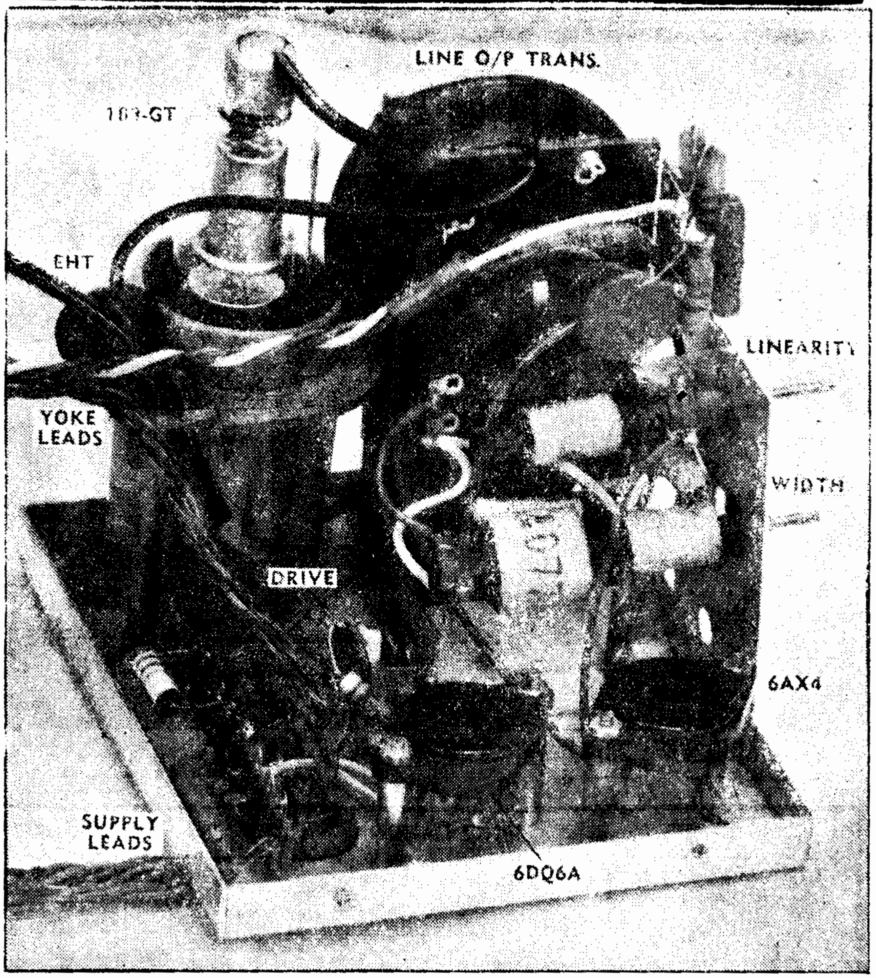
OTHER VALVES

For the line output and damper diode valves, ordinary moulded bakelite sockets will suffice, though they must not be contaminated with flux. You will need to provide pillars or long bolts, so that they can be mounted about 1 inch above the base plate.

One other point needs to be specially checked at this stage. As mentioned earlier, the new design provides for the yoke socket to attach to the inside top of the cage cover. All wires come to it from within the cage, except for two frame output leads, which merely run up through the cage from beneath the chassis.

If not already provided, we suggest

COMPONENT LAYOUT — EHT CAGE



A detail view of the EHT cage, with the 6DQ6A and 6AX4 valves removed. Most of the components relevant to the 6DQ6A are on the tagstrip in the foreground, those to do with the Width and Linearity circuits on the tagstrip on the line output transformer panel.

that you punch or file two octal-sized valve holes in the top of the cover. One is merely a clearance hole to allow the EHT lead and its shrouded connector to pass through. A scrap of split plastic tubing can usefully be cemented around the edge to prevent chafing and possible arcing.

The second should have small holes drilled to suit the mounting centres in a standard moulded socket.

Two simple methods suggest themselves for securing the socket. If it has a metal flange, two nuts can be soldered to the underside, allowing screws to be tightened from the top. With an all-bakelite socket, screws can be passed through the holes in the socket, pointing upwards, and each locked with a nut. After passing through the cage cover, a second nut on each will secure the socket in place.

> **12BY7 SCREEN RESISTOR**
>
> Due to a mechanical fault, the value for the 12BY7 screen resistor did not print in the main circuit diagram. It should read 22K, 1W.

The intention is that wires should connect to the socket from within the cage, no longer than strictly necessary, so that they will not lie against hot valves etc. If need be, the receiver can be operated with the EHT components exposed. Alternatively, it is a simple matter to slip the cover over the base plate, manipulate the socket into position and secure everything in place, without undoing any soldered joints.

Having thus made sure that all the major items can be installed without further complication, the smaller items can be fitted and wired.

8-TAG STRIP

Most of the components serving the 6DQ6 line output valve are carried on an 8-tag strip near the front of the cage. This can be seen in the photograph and the arrangement of components is illustrated by the accompanying sketch.

A trailing lead, passing through the base plate, terminates on the lug marked "Drive." This ultimately connects, underneath the main chassis, to the active end of the 68K resistor, mentioned earlier, supplying the line oscillator plate circuit.

Another trailing lead, picking up 275 volts from beneath the main chassis, terminates on an otherwise blank lug, all B-plus leads from within the cage returning to the adjacent lug as shown. The circuit between the two is completed via a short twisted pair, con-

necting to the yoke socket on top of the cage and the "safety" link in the yoke plug.

At this stage, the drive capacitor can be mounted permanently in position, also the sockets for the 6DQ6A and 6AX4, and the relevant wiring completed.

Two heater wires from the sockets can be twisted together with the B-plus lead and another for the B-plus boost circuit, for ultimate connection beneath the main chassis. By using separate colours for the heater wires and grounding one to the cage baseplate, it can serve both as a heater lead and as an earth return for the HT circuits.

2-WATT RESISTORS

Note that the 68 and 8200 ohm resistors are specified as 2 watt and, if not immediately available, can be made up from pairs of 1-watt resistors in parallel, each approximately double the specified value.

The components to do with the B-plus boost circuit are mounted on an 8-tag strip, with one lug trimmed off so that it will fit between the feet of the line output transformer. This strip can be seen in the second of the cage photographs and the suggested connections are shown in the accompanying small diagram.

The third tagstrip illustrated is a four lug type and carries the remaining components, associated with the damping and line output circuits. By drilling a hole carefully in the bakelite terminal panel of the line output transformer, the components, so mounted, are readily accessible and the outgoing yoke leads run straight up to the socket.

While the tagstrip can well be bolted into place, there is not much point in wiring until the line output transformer has been mounted permanently in position.

Installing the line output transformer and EHT socket calls for some careful work, because the ends of the rather stiff, wire loop supplying the rectifier filament have to pass up under the socket to the pins, without straining or cracking the insulation or coming too close to the metalwork.

INSIDE SOCKET

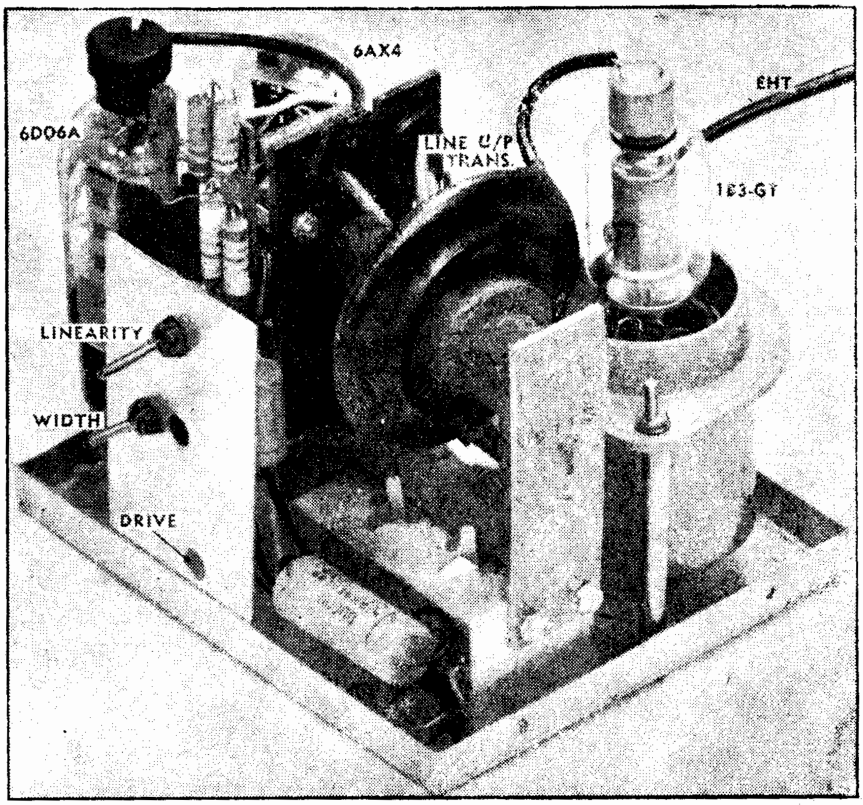
Two small resistors also have to be tucked up inside the skirted socket, again to be as remote as possible from the baseplate. Miniature resistors should be used so that they can bridge between vacant pins and be pushed in close alongside them. The 1.5 ohm resistor can connect between pins 6 and 7, while the 2200 ohm resistor can run between 7 and 4, this last becoming the take-off point for the EHT lead.

Having placed the resistors, our suggestion is to drill three small holes in the skirted base, about ½-inch from the bottom, on the side facing the transformer and in a position such that the two filament leads can run conveniently through the holes to the appropriate pins, the EHT lead passing out through the third hole.

Check the position of everything by holding the transformer and socket in place on the baseplate and noting the relative positions. They can then be turned upside down in the same relative position, the filament leads trimmed, passed through the holes and soldered.

EHT leads are available nowadays with a shrouded connector ready to clip

ANOTHER VIEW OF EHT CAGE



This second view of the EHT cage, taken from the opposite corner, shows the line output transformer in the foreground with the tagstrip carrying the B-plus boost components below it. With care, every component in the cage is accessible for service.

into the Ultor of the picture tube. Slip a small grommet over the lead to help hold it in position later, inside the cage, pass it through the hole in the socket and solder to the appropriate base pin.

If, for any reason, you cannot obtain a proper EHT lead, ordinary plastic hook-up passed through a length of plastic tubing will suffice. Alternatively, the braiding can be stripped off a length of small diameter coax cable and the outer sheath replaced, to give a doubly insulated inner conductor.

A spring clip for the Ultor connection can be manufactured from a safety pin but exposed connectors are always prone to some ionisation or leakage, particularly when dust begins to collect on the glass.

Some shrouded Ultor clips have been available with only very short lengths of lead attached.

WHERE TO JOIN

Do not attempt to join an EHT lead in the centre, because a discharge can occur through any insulation with which you are likely to bind the joint. Make a continuous lead as just described and join it to the Ultor clip just outside the shroud—a point which is normally remote from other metalwork.

With the leads duly attached, the EHT rectifier and line output transformer can be turned right way up and mounted permanently on the baseplate, taking care not to fracture the joints just made, nor to strain the loop and relevant insulation.

A scrap of tinned copper passed round the grommet mentioned earlier and held under one of the rectifier socket screws will support the EHT lead on its way up through the top of the cage cover.

With the transformer and rectifier socket in position, the rest of the wiring can be proceeded with, including the third tagstrip, which, as explained, attaches to the line transformer panel.

Once again, it may be necessary to use resistors in parallel to achieve the necessary 2 watt ratings, while we had to approximate the 22pF. capacitor with two 12pF. units in parallel.

COMPONENT POSITION

All components bridge directly between lugs except for a 1,000pF., which runs direct to terminal 3 on the line output transformer, and a .0022 which runs down to the end lug of the strip carrying the B-plus boost components.

The Linearity and Width coils can also be pushed into position and wired up. The Linearity coil, with only two active connections, can presumably be wired either way into circuit, although manufacturers' data implies that the start of the winding goes to B-plus and the finish to the damper diode, through the 1.5uH choke.

This last item, by the way, can conveniently be mounted between the appropriate active lug and a third spare lug on the former.

Polarity of the width coil is very important and connections should be checked against the main circuit and the subsidiary diagram.

You will find that wiring the cage is quite a tricky business and each lead

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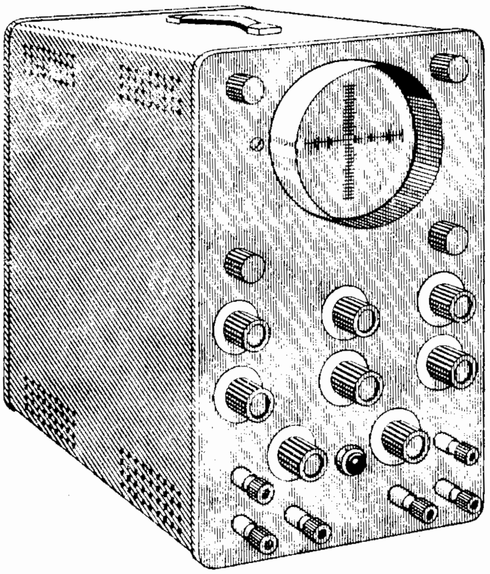

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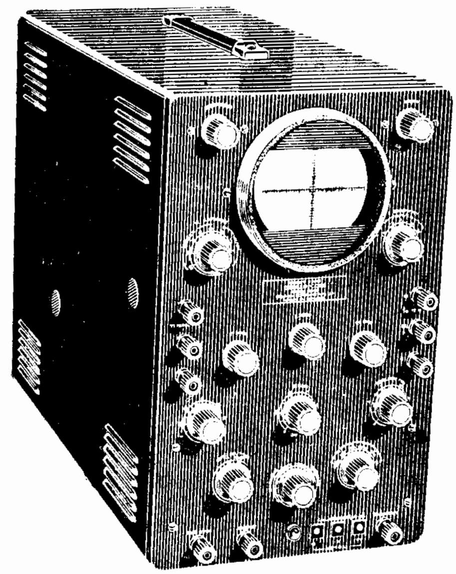

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and each component will need to be double and triple checked to make sure that it does really go where the circuit dictates.

With the wiring completed, the cage can be bolted into position and the few connections made beneath the main chassis. The receiver could now conceivably be tested with the picture tube propped up on the bench alongside, but this is a rather dangerous practice. The wise constructor will proceed immediately to mount the tube in position.

The exact height of the tube, and its fore-and-aft position on the chassis will depend, to a large extent, on your choice of mask and cabinet styling. You can take your pick whether to mount the tube initially and modify its position later, or do some advanced planning.

The accompanying diagram shows typical mounting arrangements for a 21-inch tube, which could be scaled down readily enough for the 17-inch variety.

TUBE CLAMP

According to manufacturers' instructions, the clamp around the face of the tube should not be wider than three-quarters of an inch and a visit to a hardware store brought to light a standard aluminium beading of this width and the section indicated on the accompanying diagram.

One end was bent over as indicated, leaving clearance to receive a 3-16th inch Whitworth nut. Then, with another pair of hands (and arms) cradling the tube, the beading was bent carefully around the face. This involved all but a few inches of the 6ft length, by the time a little slack was allowed for the packing rubber and the end bent over to form a socket for the clamping bolt.

A clearance hole in one socket will allow the bolt to pass through and also give access for a screwdriver to engage the slot in the screw head.

Having formed the clamp, lock it on to the tube face with the rubber in position, check it for accurate shape and note how much of the clamping bolt has passed through the nut. The rubber, by the way, is 1 x 1-8th inch sponge strip.

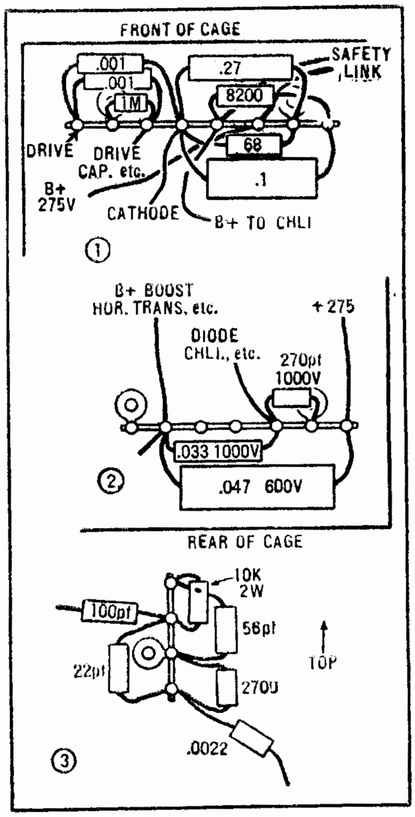
At this stage the clamp can be removed from the tube, the tube put away and the clamp screw tightened again to the same setting as with the tube in position. If handled carefully, the clamp should retain quite accurately the shape of the tube face.

SUPPORT BRACKET

Next make up a U bracket from steel or 16-gauge aluminium, to the dimensions indicated ,and attach to the chassis. It will not be exactly central, having to clear the cutout mentioned last month for the commercial tuner. The distance from the front of the chassis is typical but may need to be modified according to your ideas on cabinet design, mask position and so on.

Having positioned the U bracket, attach the tube clamp beading to it, centring the beading over the chassis. Use countersunk screws and packing washers where necessary, to adapt the curvature of the clamp in the U bracket.

The clamp is locked to the chassis with the aid of another length of aluminium beading, preferably a rather wider and stronger type. The section of the beading used in the original is illustrated, being about 1 1-8th inch



These small diagrams show the suggested wiring to the three tagstrips in the EHT cage. (1) is near the front of the cage, (2) between the feet of the transformer and (3) on the panel of the transformer.

wide. Its position relative to the chassis is obvious from the drawing.

The finished bracket work is very strong and the chassis can readily be rolled on to its side with the tube in position.

The tube is supported purely by the face clamp and, in fact, the manufacturers specify that the base socket be not supported other than by the tube.

To earth the outer conductive coating, we drilled a couple of holes in the sloping support brackets and angled so that a wire stretched between them would pass across the coating clear of the Ultor connection. The "wire" is a length of copper braiding held taut at one end by a light spring.

When the tube is ultimately put into operation a substantial charge is built up on and between the inner and outer coatings. This cannot be dispelled by merely flicking a wire between the Ultor terminal and "earth." Because of the nature of the coating, the charge builds up again after discharge, or even after several discharges.

One can, therefore, easily get a shock when handling the tube. In itself, it is not dangerous, but reaction to it may cause one to mishandle the tube, with dire consequences.

With the tube in position, the yoke and centring magnet assembly can be passed over the neck, with the input leads coming in at the bottom.

In the original deflection kit, the yoke and centring magnets were separate and the yoke had to be held against the flare by a disc of wood or bakelite, slipped over the neck and held forward by a couple of springs attaching to the support brackets.

Current practice is to attach both yoke and centring magnets to a common bakelite shell, which is locked to the neck of the tube by a clamp, so that additional locking is unnecessary.

ION TRAP MAGNET

If the picture tube is of the bent-gun type, it will also require an ion trap magnet just near the base to re-direct the electron beam. The ion trap magnet must be fitted in the correct approximate position for the particular type of tube, for any raster whatever to appear on the screen. Immediately after switching on the ion trap has to be adjusted for maximum picture brightness, but more of this anon.

The ion trap is normally supplied with the picture tube but, if not, care should be taken to see that it is a suitable type. Ion traps vary in strength and are not necessarily interchangeable from tube type to tube type.

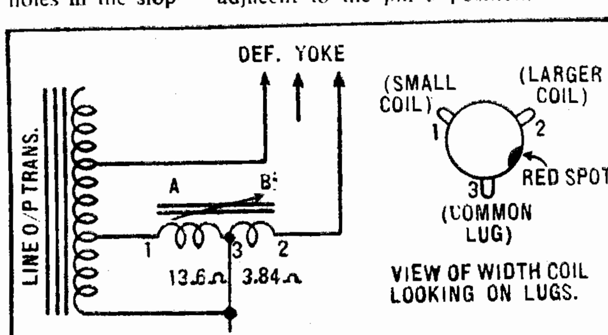
For the 17AVP4-A and the 21ALP4-A, the ion trap should be positioned initially so that the magnet block is about in line with pin 12 on the base and with the red spot downwards and adjacent to pins 9 and 10. It should be about ¼ to 3/8th inch from the bakelite base.

In the case of the AW53-80 and the AW43-80, the standard magnet supplied should be slipped on to the neck of the tube with the arrow facing away from the screen. It should be on the side diametrically opposite the line marked on the tube neck, which line is normally adjacent to the pin 3 position.

☆

Here are the essential data for connecting the width coil. Reversing the connections would probably make it impossible to obtain full horizontal scan.

☆



Two other types of picture tube, mentioned at the start of this article, do not require ion trap magnets.

With the tube, yoke and ion trap in position, the receiver should be ready for an initial test of the picture circuits.

Quite a few checks and adjustments may need to be made before best results are obtained and, all being well, these will be the subject of separate discussion in our next issue. However, for those who may want to get the receiver into operation before the issue appears

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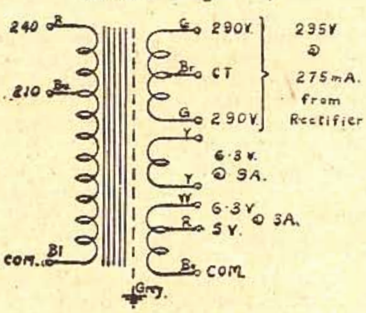

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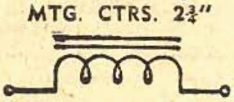

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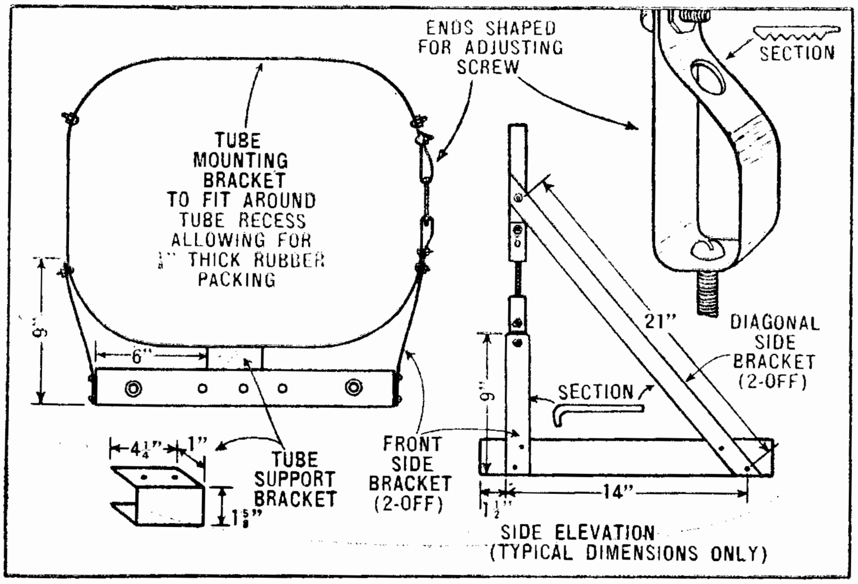


This diagram illustrates a simple method of supporting the picture tube, using materials available to the home constructor. The same method is applicable to 17-inch tubes.

a couple of points warrant preliminary mention.

When first switching on, no raster may appear on the screen of a bent gun tube until the iron trap magnet is in its approximate correct position. Switch the set on with the Brightness control in its minimum brightness position (cathode to B-plus end) wait for a few moments after the sound is heard, then advance the Brightness control by about one third of its travel.

If no pattern appears on the screen, try moving the ion trap slightly about its suggested position, backward and forward and around the neck of the tube. If there is still no pattern, advance the Brightness control a little further and try again.

When a pattern appears, set the ion trap tentatively for the brightest trace. If no illumination is evident with the Brightness control well advanced, the chances are that there is a fault in the EHT circuit.

This can be verified by switching off, removing the EHT lead from the Ultor socket, and switching on again with the EHT lead supported in the fingers well clear of any joint in the insulation. By bringing the connector near the metalwork of the chassis, a discharge should occur over a distance of about 3/8 inch, rather like an auto ignition spark, only continuous.

FRAME, LINE HOLD

Adjustments may be necessary both to the frame and line hold circuits to make the picture stand still, not forgetting that the Fine Tune control may also have to be manipulated to get a steady picture. Almost any setting will allow sound to get through but tuning for picture information is more critical.

If the picture is holding in neither direction, patterns on the screen are completely erratic but rotation of the Frame Hold potentiometer should be sufficient to halt most of the vertical movement, indicating that frame lock has been achieved.

Adjusting the line hold circuits is a good deal more complicated because an automatic frequency control system is involved.

Lacking a CRO, an initial setting up procedure is as follows:

Set the Line Hold potentiometer at half resistance, preferably with the aid of a multimeter, and short out the Sine Wave coil.

Adjust the core of the Horizontal Oscillator coil till the picture locks, then observe the total number of turns through which the core can be rotated, while still keeping the picture intact. Set the core in the middle of its locking range.

Now remove the short from the sine wave coil, leaving the potentiometer and oscillator coil strictly alone. If the picture has now torn, adjust the core in the Sine Wave coil till it locks once again.

SINE WAVE COIL

Having regained the picture, you will probably find that the picture will tear away at the top if the core is screwed too far out of the winding, and disintegrate completely if screwed too far in.

Best waveform appears to be present with the core screwed toward the latter extreme, rather than the former, though it should not be taken so close that locking is erratic when switched from channel to channel.

Having thus selected a position for the core in the Sine Wave coil, turn attention again to the Line Hold potentiometer. Swing it through its full travel and note whether the picture breaks only on one extreme. If so, make a slight adjustment to the Horizontal oscillator core so that the behaviour of the potentiometer control is more nearly balanced, holding in the centre of its adjustment and causing picture breakup at either extreme.

To be Continued.

SMALL HIGH-VOLTAGE SUPPLIES

High-voltage, low-current power supplies are frequently required in radiation detectors and counters, photoflash units, insulation testers, photomultiplier circuitry, cathode ray equipment, photoluminescent sources, and X-ray devices. This article, reproduced by courtesy of the Aerovox Corporation, summarises current trends in design, and although some components are not available in this country, they are mentioned for their reference value.

SINCE most power supplies in the low-current category are small in size and light in weight, they are well suited to use in portable equipment, especially in battery-operated equipment. In recent years, there has been an increasing demand for small-sized high-voltage, battery-operated supplies.

The purpose of this article is to describe the types of circuits which are being employed, giving practical examples and comparing their characteristics. It is expected that this survey will be a guide in the selection of the proper supply unit for a given application.

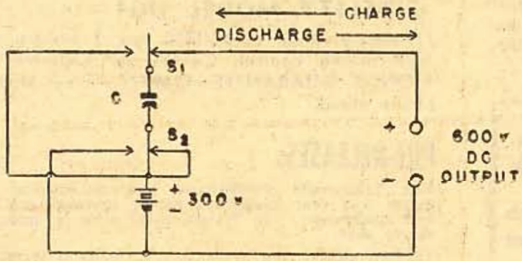
Many arrangements are not included in this resume, since they are highly experimental in nature or are of a make-shift character. Practical units which have proven themselves in the field generally fall under the headings: (a) batteries, (b) charged-capacitor type, (c) vibrator-transformer type, (d) vacuum-tube flyback type, and (e) transistor oscillator type.

BATTERIES ARE SIMPLEST

The simplest DC voltage supply is a battery. Miniature dry batteries are available in 90- and 300-volt sizes. These batteries may be series-connected for higher voltages than their rated values and are sometimes used to build up a high-potential supply.

In some applications, especially those in which circuitry must be kept simple and at a minimum, only batteries can be used. The complication and added space requirements attendant to the use of tubes, transformers, filter chokes and capacitors, and voltage regulators thus are avoided.

Despite its simplicity, high-voltage battery operation is the most expensive way to obtain kilovolt potentials. A high-voltage supply using batteries only has the highest initial and replacement costs.



SIMPLIFIED CHARGED-CAPACITOR DOUBLER

FIGURE 2

The milliampere-hours per unit cost rating likewise is poorer than that of other types of high-voltage supplies.

Several types of such batteries are available overseas, but it is safe to say that they are definitely low-current units, the useful lifetime of which is abbreviated sharply by all operation at high levels, as well as by long, continuous operation at low current drain.

Because of the expense of miniature high-voltage batteries, a current-limiting resistor should be connected in series with them, whenever circuit peculiarities permit, to prevent their rapid destruction in case of a short circuit.

The operator should take care to switch the batteries off at all times when they are not actually in use. A cool, dry environment is the most satisfactory condition under which such batteries should be operated. When not in use for long periods of time batteries should be stored at temperatures between 40-60 deg. centigrade.

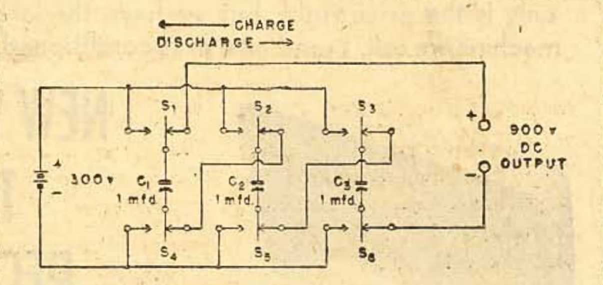
In circuits in which current drain is quite low (i.e., under 1 milliampere), and operating time can be reduced to a series of short intervals, charged capacitors may be operated in series to supply high DC voltages. This permits a reduction of battery expense, since only one battery is needed to charge a number of capacitors in parallel, which then may be switched in series to deliver as many times the battery voltage.

The time interval during which the voltage obtained in this way may be held to a useful level depends upon the total capacitance of the series capacitor combination and upon the output current drain. At any current level, the higher the capacitance the longer the interval.

In practical circuits in which this type of supply is used, a switch (usually a pushbutton) is provided for momentarily re-connecting the capacitors in parallel for charging.

Figure 1 shows a charged-capacitor type of supply operated from a miniature 300-volt battery and delivering 900 volts DC.

When the 6-pole, 2-position switch is temporarily at its left-hand CHARGE position, capacitors C1, C2, and C3 are connected in parallel with the battery and become charged. When the switch then is thrown to its right-hand DISCHARGE position, the capacitors are connected in series, and 900 volts are available at the output terminals of the circuit. The total capacitance in the discharge condition is 0.333 mfd.



CHARGED-CAPACITOR SUPPLY

FIGURE 1

It is convenient to have the switch rest normally in the DISCHARGE position to provide a normal connection of the series combination to the output terminals. If the switch has a spring return, the capacitors are charged each time the switch is depressed or thrown, after which the switch returns automatically to the DISCHARGE position to deliver high-voltage output.

METHOD LIMITS

It might be expected that this scheme could be extended indefinitely, the voltage multiplication being proportional to the number of capacitors. It is limited, however, by the number of poles and contacts which may be included in a practical switch without the latter reaching ungainly size.

Also, in order to obtain a sufficiently high total capacitance with a large number of capacitors in series, the required individual capacitance values would become so large as to raise both the size and cost of the supply out of reasonable bounds.

Figure 2 shows a simplified charged-capacitor circuit which delivers twice the battery voltage. In this arrangement;

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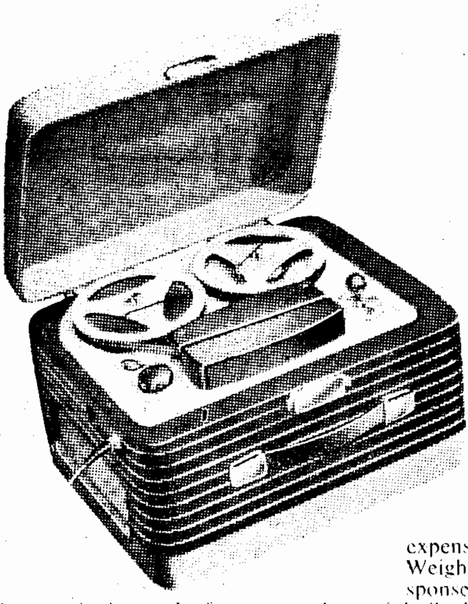

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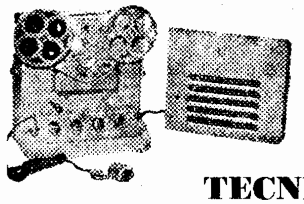

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when the dpdt switch temporarily is at its left-hand CHARGE position, capacitor C is charged from the 300-volt battery. When the switch is reduced to its normal, right-hand DISCHARGE position, the charged capacitor is connected in series with the battery.

The voltage at the output terminals then is the sum of the battery and capacitor voltages, or 600 volts.

Charged-capacitor supplies basically are low-current, short-interval units. At extremely low current drains, however, the time interval during which the voltage is maintained near its required level may be extended to a reasonable length by employing high capacitances.

For example: Consider 1,000 volts supplied by a total capacitance of 100 microfarads. At a current drain of 100 microamperes (load resistance of 10 megohms), the capacitor still will have 90 per cent of its charge (output voltage will have fallen 10 per cent from its original value) in 1½ minutes of operation. The circuit then may be pulsed with another charge to bring the voltage back up to the original level.

Afetr 16 minutes of operation, because of the exponential decay of the charge, the output voltage of this capacitor will be approximately 370 volts.

VIBRATOR CIRCUIT

A miniature vibrator-transformer and rectifier combination, similar in principle to the conventional automobile radio power supply, provides the basis for a high-voltage d-c operated from a small, inexpensive battery—often a single 1½-volt flash-light cell.

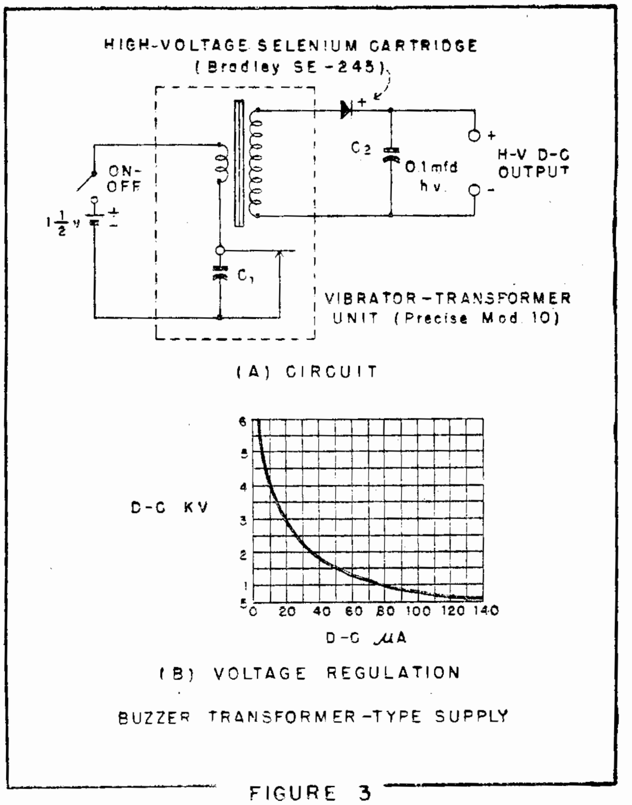
Figure 3(A) shows the circuit of a vibrator (buzzer) type high-voltage supply of this kind. This is a small unit such as Precise Model 10 (having about the same dimensions as a 6L6 metal tube) which plugs into an octal socket. The step-up transformer, vibrator, and spark suppression capacitor (C1) are self-contained. A single 1½-volt, Size-D flash-light cell supplies the DC driving voltage. Current drain is approximately 35 milliamperes.

The high-voltage AC, generated by the vibrator-transformer, is rectified by a single, high-voltage selenium cartridge-type rectifier and is filtered by the 0.1-ufd capacitor, C2.

The open-circuit output potential is 6,000 volts DC. Figure 3(B) shows the voltage regulation of the circuit. From this plot, it may be seen that the output voltage falls to approximately 500v at a current drain of 140 microamperes (load resistance of 3½ megohms). A potential of 1 kv is obtained at 70 ua drain. The output voltage may be regulated through the use of a filamentless miniature regulator tube such as Type CK5517 for 2.3 kilovolts, 5841 for 900v, or CK1036 for 700 volts.

At light current drains (under 150 ua), adequate filtering action will be provided by capacitor C2. In applications requiring increased smoothing of the output, a 100,000-ohm filter resistor and additional 0.01-ufd capacitor may be employed.

The vibrator-type D.C. supply is compact and tubeless and is light in weight. The size D flashlight cell, which drives it, is small and inexpensive and will give 150 hours service when used continuously two hours per day, and 60 hours on a 24 hours per-day basis.



(A) CIRCUIT

(B) VOLTAGE REGULATION

BUZZER TRANSFORMER-TYPE SUPPLY

FIGURE 3

Figure 4 shows the circuit of a high-voltage supply which utilises the rapid decay of plate current (flyback) through a high inductance to generate high-voltage pulses. The resulting pulse train is rectified and filtered for D.C. output.

In this circuit, a relaxation oscillator (comprised by the NE-2 neon bulb, capacitor C1 and resistor R1) is operated from the 135-volt battery, B2. The output of this oscillator is coupled, through capacitor C2, to the IT5 tube. (A miniature type 3S4 tube also may be used.)

Inductor L in the plate circuit of this tube is a miniature interstage transformer with its primary and secondary windings connected in series-aiding. Plate and screen potentials for the tube also are supplied by battery B2. Filament current is supplied by B1. The quiescent plate current is quite small. However, the rising positive-going portion of the saw-tooth pulses from the relaxation oscillator increases this current to a maximum. With the rapid fall or flyback of the saw-tooth the plate current collapses and a high voltage pulse (e) is generated across inductor L:c—L (di/dt).

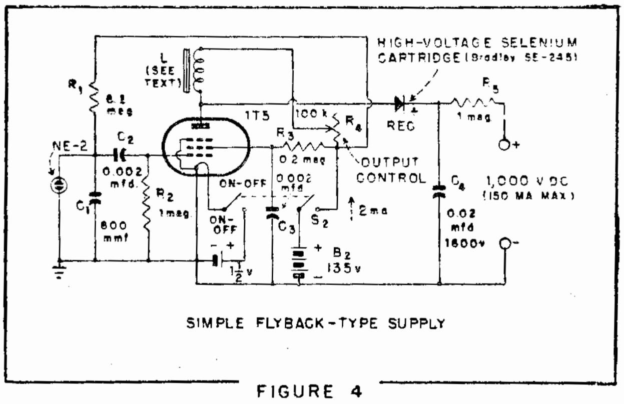
The high voltage selenium cartridge rectifier (R—EC) serves to pass the positive swing of the voltage pulses and to block the negative swing. The connections of this rectifier may be reversed for negative D.C. output if desired. Rheostat R4 serves as an output voltage control by permitting adjustment of the plate current. Screen current is limited by the 200,000 ohm resistor R3.

BATTERY OPERATED

The circuit may be operated from a 1½-volt, size D flashlight cell at B1 and two midget 67½-volt batteries in series for 135 volts at B2. Resistor R5 is included for output current limiting to protect the rectifier in the event of an external short circuit and to safeguard the operator in case of contact. This resistor may be omitted if it causes too large a voltage application.

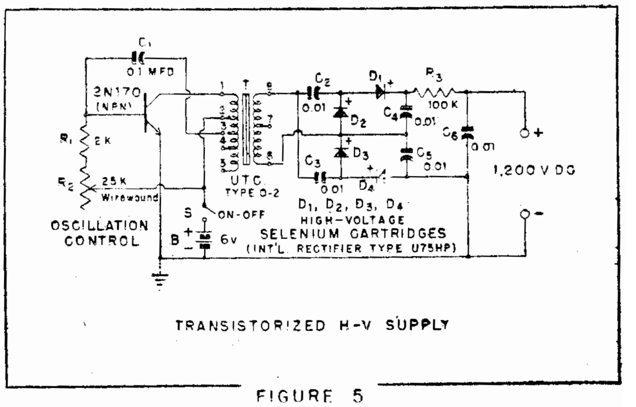
In the compact power supply shown in Figure 5, the signal-output voltage of a transistorised oscillator operated from a small 6-volt battery is stepped up by transformer T.

The secondary voltage of the transformer then is applied to a voltage quadrupler circuit (consisting of selenium cartridges rectifiers D1, D2, D3, D4, and capacitors C2, C3, C4 and C5,



SIMPLE FLYBACK-TYPE SUPPLY

FIGURE 4



TRANSISTORIZED H-V SUPPLY

FIGURE 5

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which delivers a D.C. output equal to 5.6 times the applied A.C. voltage. The transistor oscillator is a Hartley-type circuit. The required tapped coil is obtained by connecting to primary terminals 1, 2 and 3 of the miniature line-to-grid transformer (U.T.C.* type 0-2). The entire secondary winding (taps 6 and 8) is used.

Formerly, experimenters have been unsuccessful in boosting the voltage output of a low-voltage transistor oscillator because small transformers with sufficiently high turns ratios and primary inductance have not been commercially available. The type used here is known as the 0-2 "Ouncer."

The 25,000-ohm rheostat, R2 allows the base bias current to be set for easy starting of the oscillator and for full 1,200 volts D.C. output. This control should be set so that the oscillator starts up readily when the ON-OFF switch, S is closed. A D.C. vacuum-tube voltmeter, set to its 0-1,500-volt range and connected to the 1,200-volt output terminals, should be used as an indicator during this adjustment.

POLARITY IMPORTANT

The builder must be careful to follow the exact polarities indicated in Figure 5 for the transistor, battery B and the rectifiers.

Capacitors C2, C3, C4 and C5 are standard 500-volt mica components. Output capacitor C6, however, must be rated at 1,600 volts D.C. or better.

Current drain from the 6-volt battery is approximately 2½ milliamperes. This low requirement may be met even with four series-connected 1½-volt penlight cells.

Stock models transistorised high-voltage power supplies presently are available commercially in America in ratings up to 20,000 volts D.C. output. Custom units may be obtained up to 100,000 volts D.C. All of these units operate from one or two 1½-volt flashlight cells or from mercury cells. One such unit together with its cell is no larger than the Geiger tube it is designed to power.

One company has developed a miniature version of the Wimshurst static machine, familiar to all science students. This reduced-scale model is spun by means of gearing operated by means of a pushbutton, and delivers several kilovolts from a charged capacitor.

Attention again has turned to the electret as a repository of high-potential charges. Electrostatically, this device is somewhat analogous and dual to the permanent magnet. It has been known for several decades but has found no noteworthy practical application up to this time. Essentially, it is a cake of carnauba wax that has been cooled down from the molten state while in a high-voltage electrostatic field. Research and development work presently is being pursued to determine the potentialities of the electret as a high-voltage D.C. supply.

HANDLE WITH CAUTION

Every high-voltage supply should be handled with caution. Miniature units are no exception. Although, in most instances, miniature supplies are incapable of delivering damaging currents, the voltages that they do put out can cause dangerous reflex actions which have been known to cripple the heart and cause death. High-voltage batteries are especially nasty.

Small, high-voltage supplies often are more deadly than full size units, simply because of their deceptive size. Being small and quiet, they just do not look dangerous. However, the false sense of trust they inspire encourages only a stupid technician to grow careless with them.

Regard all high-voltage supplies as threats to personal safety and well-being. Know your circuit well and avoid all bodily contact with its high-voltage points.

New TV tape recording machine for B.B.C.

(Continued from Page 15)

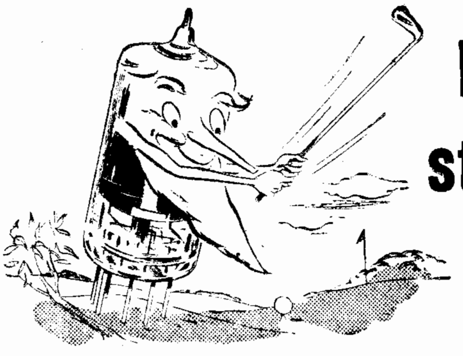
recording a requirement will arise in the use of magnetic vision recorders for the editing of programme previously recorded. Simple editing, in the form of replaying extracts from a previously recorded programme, may be achieved by starting the machine at any predetermined point in the recording. This facility is available because the machine is equipped with the usual facilities for spooling the tape backwards and forwards to find a desired point in the recording.

The method may be extended, as in magnetic sound-recording practice, by cutting and joining extracts from various recordings or different parts of the same recording. Individual frames cannot, however, be examined in a "gate", as in optical film editing, for the tape must be reproduced at the correct speed before a picture can be reproduced on a monitor.

A cueing arrangement for the "marking" of editing points has, therefore, been provided. The method adopted is to provide an extra cueing head, lying outside the isolated tape loop, which is fed through a separate recording amplifier from a 30 kc/s oscillator. When the tape is being normally reproduced and the observer wishes to mark some particular point for subsequent cutting or starting he presses a "Cue" key on the control panel of the machine which causes a 30 kc/s burst of signal to be recorded on the sound track of the tape.

At this frequency it will not appear in subsequent normal reproduction since it lies well below the frequency-modulated carrier signals which carry the sound programme and any interference effects it might otherwise have will be removed by the limiting process which precedes detection of the television sound signal.

However, when the tape is being slowly transported past the reproducing head, using the spooling speed control, at a fraction of the normal speed, the cue signal will produce an audible note in the loudspeaker or head-phone system so that the point previously marked is found. The cutting and joining of tapes is accurately and quickly carried out by the use of a splicing device provided and the resultant join provides no visible disturbance in the picture.



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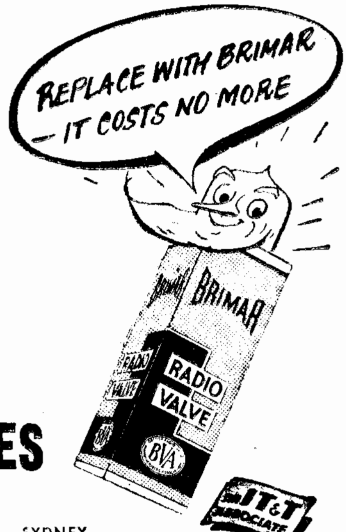

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FUNDAMENTAL TRANSISTOR THEORY

The second part of this article continues a discussion of how transistors work, and carries on into the field of standard circuit connection. On pages 4-7 of this issue you will find a picture story which tells how transistors are manufactured.

PART 2

We have now discussed two distinct types of germanium crystal, the N-type or donor material and the P-type or acceptor material. Figure 14 shows a piece of P-type material joined with a piece of N-type material. Since the N-type

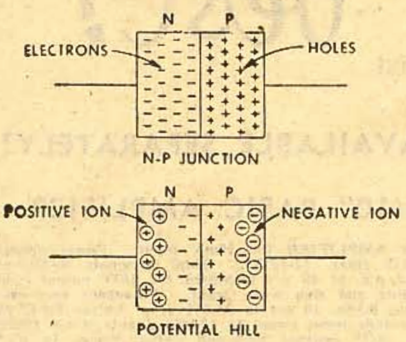


Figure 14

material has an excess of electrons and the P-type has an excess of holes, positive current carriers, it may seem logical that when these two materials are joined together, the excess electrons would flow through the junction and neutralise the excess of holes.

There will indeed be a tendency for the electrons to congregate at the junction in the N-type material and likewise an attraction for the holes to congregate at the junction in the P-type material. These current carriers will not completely neutralise themselves; how-

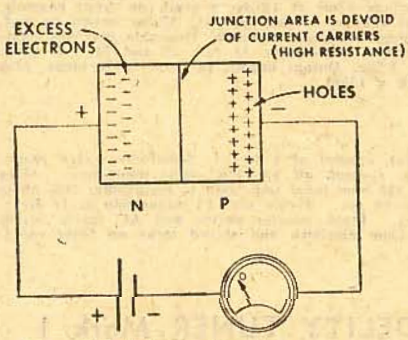


Figure 15—NP Junction with "reverse" bias.

ever, since movement of electrons and holes cause negative and positive ions to be produced.

This means an electric field is set up in each type material that will tend to obstruct the movement of current carriers through the junction.

The negative ions in the P-type material will repel the negative electrons in the N-type material and the positive ions in the N-type material will repel the positive holes in the P-type material. This builds up what is called a potential hill and although very slight recombination at the junction does take place, this potential hill is soon built up to a point that no further recombination will take place without the application of an external difference of potential. Now let's consider an N-P junction to which we do apply an external voltage.

In Figure 15, we see that a small battery has been connected in series with an ammeter so as to apply a voltage to the two germanium crystals. You will notice that the positive electrode of the battery is connected to the N-type material and the negative electrode of the battery has been connected to the P-type material. Since the N-type material has an excess of electrons, the positive voltage being applied to this material

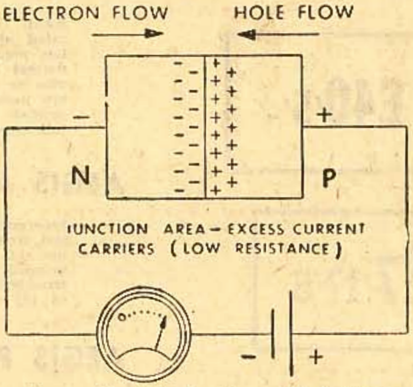


Figure 16—NP Junction with forward bias.

will attract these electrons toward the left end of the germanium crystal pellet. The negative voltage being applied to the P-type material, which has an excess of positive current carrying holes, will attract these holes toward the right end of that pellet and away from the junction.

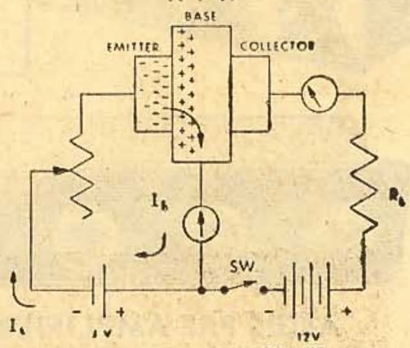
The ammeter indicates no current flow, since there is no possibility of recombination at the junction because the potential hill has been built up to a higher value by the application of an external voltage. We call this the reversed biased condition or high resistance circuit. You will notice that with this type of connection, the area around the junction is now a good insulator since few current carriers can be present. We can connect the battery in the opposite polarity and cause a different condition.

In Figure 16, we have reversed the battery polarity and now the negative electrode of the battery is connected to the N-type material. This negative voltage will repel the electrons in the N-type material toward the junction. The positive electrode of the battery is connected to the P-type material which will repel the positive holes toward the junction.

With this type of connection, recombination takes place at the junction resulting in current flow through the N-P junction as indicated by the reading of the ammeter. Since current carriers are plentiful in junction area of the two materials, it now offers a low resistance to the flow of electric current.

This method of attaching the battery is known as forward bias since it encourages current flow. It is important to remember that in this circuit, the electrons are flowing from left to right and the holes are effectively flowing from right to left.

Shown in Figure 17 are two germanium diode circuits. The one at Figure 17A has a low internal resistance because it contains a battery which is connected in the forward bias direction placing current carriers on each side of



COMMON BASE CIRCUIT

Figure 18

the junction so that electric current can easily travel through the junction. The low resistance of this circuit is represented as an equivalent resistor R shown in dashed lines.

Notice that in Figure 17B the battery is connected so that the holes in the P-type material and the electrons in the N-type material are attracted away from the junction, leaving an insulating area on each side of the junction. This is the reverse bias connection and results in an extremely high resistance as explained above.

The resistance to the flow of battery current is now so great that it may be illustrated as an open resistor in comparison to the circuit in Figure 17A. No appreciable current would now be able to flow through the load Resistor R even with the increased battery voltage, and there would, therefore, be no voltage drop produced across it.

From Figure 21, we see that we have connected two pellets of N-type germanium and one pellet of P-type germanium in the form of a sandwich.

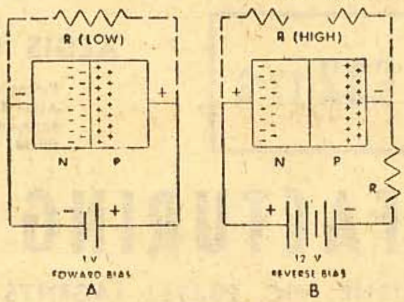


Figure 17

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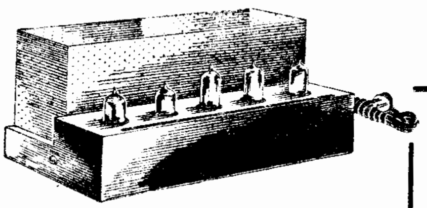

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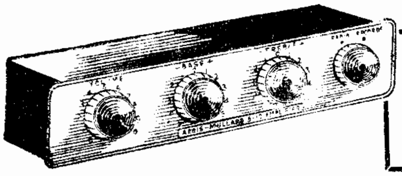

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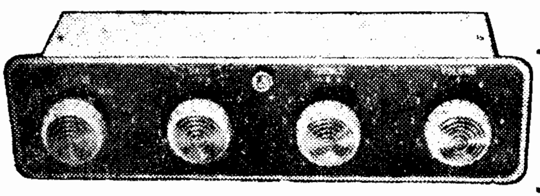

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(for 40mV across volume control at 1 Kc/s). Sensitivity: Tuner 100mV; pickup LP 50mV; pickup 78, 60mV all at 100K ohms input impedance. Microphone 10mV at 1M ohm input. imped. THD 0.1 p.c. on tuner and pickup: 0.15 p.c. on Mic. Average control of bass plus 18 minus 12db at 30 cps: Treble plus or minus 15db at 10 Kc/s avail. on front controls. Input selector switch and AC Mains switch on vol. comprise remaining controls. Desirable playback characteristics built-in for 33 1-3, 45 and 78. 1 valve: type EF86. Output imped. to amp. 250K ohms. 12in x 3in x 1¾in.

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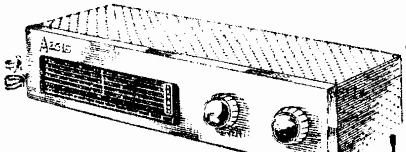

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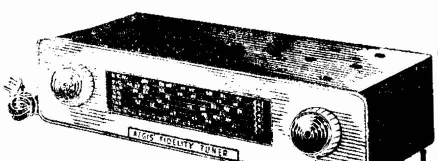

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The N-type material is the bread or bun of the sandwich and the P-type material is the meat. The names emitter, base and collector have been given to the three elements of the sandwich. We can see that the collector circuit is open. The emitter is returned to the base through a small battery and you will notice that this battery is connected so as to put the base-emitter circuit in forward bias. The negative voltage at the

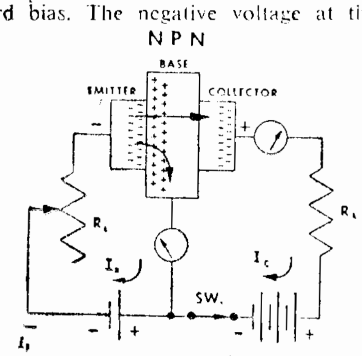

Figure 19—Common base circuit.

emitter will repel the electrons in that material toward the junction and the positive voltage at the P-type material base will in turn repel the holes toward the same junction.

Recombination then takes place resulting in the current flow, labelled Ib. We now have the forward bias condition or low resistance circuit in the emitter-base circuit. Looking at the collector circuit, we see that we have the positive electrode of the battery connected to the N-type material collector.

The negative electrode of the battery is connected to the P-type base when the switch is closed. You will notice that this biases the collector base circuit in the reverse bias condition, which as we discussed before, would not allow any current flow through the collector base circuit. Now, let's close the switch in the collector circuit and see what takes place.

With the switch closed in the collector circuit, (Fig. 19) we notice that we now have some current flow in the collector circuit. This is true even though we have the collector base circuit biased in the reverse or high resistance direction. Let's see how we obtain this current flow.

The negative voltage being applied to the emitter will set its electrons into motion. They will move toward the junction and break through. Base material is relatively thin at that point and approximately 95 per cent of the current carriers will pass right on through and enter the collector circuit. With the collector biased reverse, all of the electrons are attracted toward the positive pole of the battery.

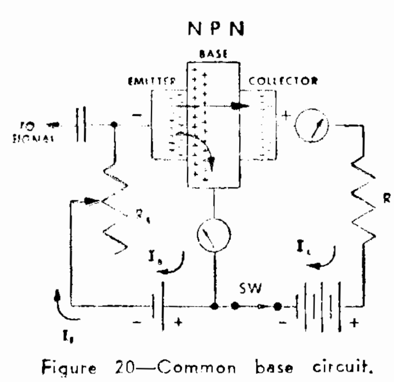

Figure 20—Common base circuit.

As electrons leave the emitter and pass into the base material, they come under the influence of this strong positive field and are accelerated into the collector. As one electron enters the collector, it will force another out of the collector through the load resistor and to the battery, resulting in current flow.

As mentioned above, approximately 95 per cent or more of the electrons passing through the emitter base junction will enter the collector circuit. That leaves only five per cent or less of the electrons to recombine with positive holes in the base material which will constitute our base current. You might say at this point that all we have really accomplished is to create a device that will result in current loss. This is true since the emitter current will always be greater than the collector current in this instance. However, let's look at it in another way.

The emitter-base circuit, which would be the input circuit in this case, is biased in the forward direction resulting in a low resistance circuit. The collector is biased in a reverse direction which results in a high resistance circuit. You will notice that the collector current will be only slightly smaller than the emitter current but with the difference that the collector current is flowing through a much higher resistance circuit than in the emitter. This will result in voltage gains developed across the load resistor Rl, or amplification.

We now have a complete transistor and we can see where the device gets its name. The input circuit is a low

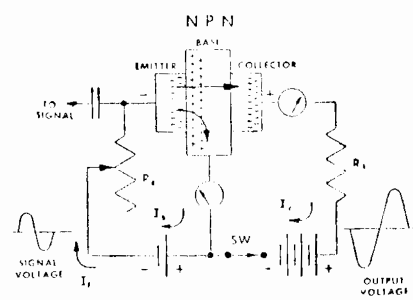

Figure 21—Common base circuit.

resistance circuit; therefore, we have to transfer from low to high resistance or a transistor. We call this type of circuit a common base circuit since the base is common to both the input and the output. Let's put a signal voltage into this circuit and trace the electron flow to see what takes place.

Looking at Figure 20, we see that a coupling capacitor has been added which is used to couple the signal into the emitter base circuit. A potentiometer, Re, has also been added to the base emitter circuit.

This potentiometer can be adjusted for the right amount of forward bias on the emitter base circuit. In other words, this potentiometer will be adjusted so that under static conditions, we will have a certain amount of current flow in the emitter base circuit. This will also result in some collector current. Let's trace the electrons through this circuit under static conditions.

The electrons will leave the emitter and travel through the junction into the base material, at which time, five per cent or less of these electrons will recombine with holes in the base and result in base current as indicated by Ib.

Ninety-five per cent or more of the electrons will pass on through the base material due to their high velocity and the strong positive field at the collector base junction and will enter the collector resulting in the flow of collector current as indicated by Ic. All of these currents are indicated as electron flow.

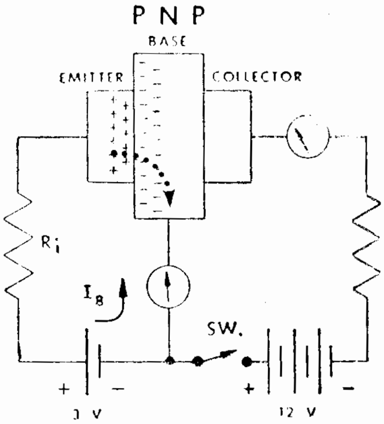

Figure 22—Common base circuit.

In Figure 21, we see the same circuit as before, only now we have a signal voltage being applied. You will notice that as the signal voltage rises in a positive direction, the emitter will be made less negative with respect to the base. This will result in a reduction of the forward bias of the emitter base circuit and therefore reduction in current flow through the emitter.

Since the emitter current is reduced, the collector current will likewise be reduced at the same proportion. As the signal voltage starts increasing in a negative direction, the emitter will now become more negative with respect to the base resulting in increased forward bias in the emitter base circuit and increased current flow activity in the emitter. This will result in a corresponding increase in collector current.

We have now reproduced the signal being applied to the emitter base circuit in the collector circuit, however it has been greatly amplified due to the fact that the current flowing in the collector circuit is through a higher impedance network. This can be seen by the relative size of the signal voltage present across the load resistor Rl as

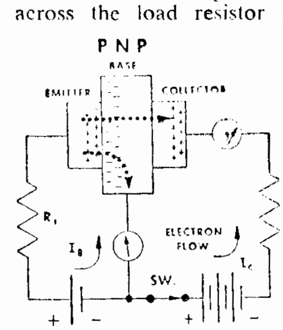

Figure 23A—Common base circuit.

compared to the size of the signal voltage curve in the input circuit.

We have discussed the operation of the N-P-N type transistor. It is also possible to reverse the sequence of the germanium pellets giving us a P-N-P type transistor.

In Figure 22, we can see a common base type circuit, similar to the one we just discussed in which the N-P-N tran-

sistor has been replaced with a P-N-P transistor. Notice that the switch in the collector circuit is shown in the open position, and the battery in the base emitter circuit is connected so that the positive electrode is to the emitter and the negative electrode to the base. This

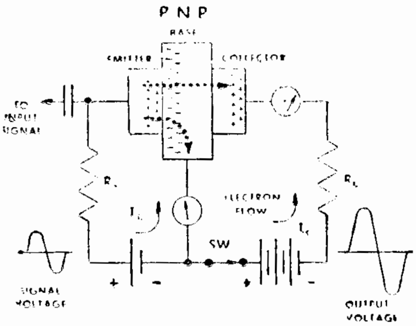

Figure 23B—Common base circuit.

is just the opposite of what we had with the N-P-N transistor; however, this connection also will give us forward bias.

The application of the positive voltage to the P-type emitter will repel the positive holes in that element toward the emitter base junction. The negative voltage being applied to the N-type base will repel the electrons in that element toward the base emitter junction. The holes in the emitter will move at high velocity and puncture the junction, thereby allowing an electron to enter the emitter from the base. The movement of these holes through the base emitter junction will constitute our base current Ib. This current will occur under static conditions and will constitute our forward bias current.

When the collector circuit switch is closed, Figure 23A, we again see that collector current results since the holes passing through the base emitter junction will enter the strong negative field set up by the reverse bias connection on the collector base circuit. Therefore, 95 per cent or more of the holes leaving the emitter will pass right on through the base region and enter the collector circuit.

When a hole enters the collector circuit, an electron will enter the collector from the battery through Rl to neutral-

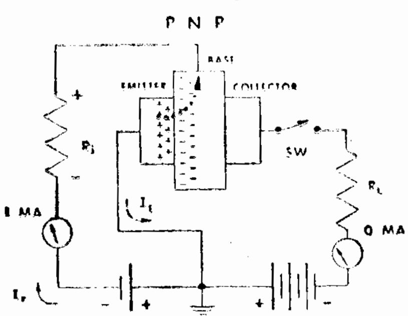

Figure 24—PNP Common base circuit.

ise the excess hole that now exists there. This results in electron current flow through the external circuit. Here again our collector current is slightly less than our emitter current, but the collector current will result in voltage amplification across Rl, a much larger resistance.

In Figure 23B, we see that we have applied a signal through a coupling capacitor to the emitter so that the input signal is developed across R1. As the signal voltage causes the emitter to be driven more positive with respect to the base, the emitter base current will naturally increase. This increased activity in the emitter will also result in an increased collector current, resulting in an amplified voltage being developed across the load resistance Rl.

As the signal voltage swings the emitter in the negative direction, the emitter forward bias is decreased resulting in less current flow through the collector circuit and giving us an exact duplicate of the input signal across the load resistor Rl, except that the voltage has been amplified.

Common Emitter

Another circuit that will be encountered quite often will be the common emitter circuit. You will notice in Figure 24 that the base is returned to the emitter and the collector is also returned to the emitter. We have the base emitter circuit biased in the forward direction by means of a small battery with the negative electrode connected to the N-type base and the positive electrode connected to the P-type emitter.

Here, as before, the positive voltage on the emitter will repel the positive holes toward the base emitter junction

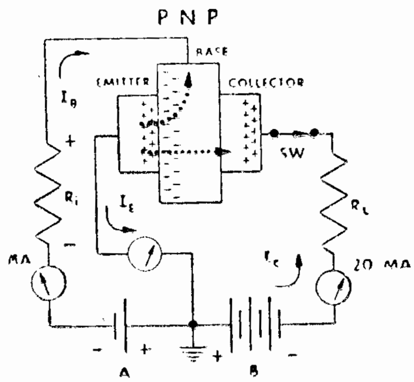

Figure 25—Common emitter circuit.

through which they will pass giving us base emitter current. With the switch in the collector circuit open, we notice that we have one milliamp of base emitter current. You can see also that the battery in the collector circuit is placed so as to inject reverse bias between the collector and emitter. When we close the switch, we will find the result to be rather startling.

You will notice that with the switch in the collector circuit closed, (Fig. 25) our base emitter current is still one milliamp and our collector current reads 20 milliamps. Since the input is across the base emitter and the output is across the collector emitter, we see that we now have a current gain of 20. Let's see how this takes place.

As we said before, the holes that leave the emitter will enter into the base region, but due to their high velocity, and due to the strong negative field put out by the collector, will pass right on through the base material and enter the collector. Only five per cent or less of those carriers leaving the emitter will enter the base and return to the emitter through that circuit.

The other 95 per cent, or more, will enter the collector and constitute collector current. Now we can see that under static conditions, we do have base emitter current and we also have collector current, even though the collector is biased in the reverse direction.

As Figure 26 shows, we have injected a signal into this common emitter circuit. You can see that the signal is injected between the base and emitter, which is a low impedance, low current circuit. The output is taken from the

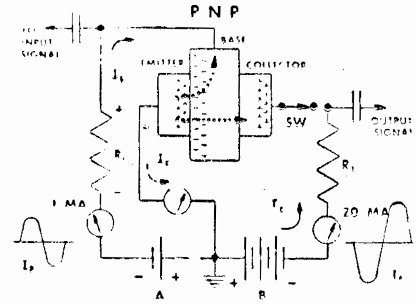

Figure 26—Common emitter circuit.

collector, which is a high impedance, high current circuit.

As the input signal causes the base to swing positive with respect to the emitter, it decreases the forward bias of the base emitter circuit, thereby causing a decrease in the collector current as is shown by the negative half cycle of the collector voltage.

During the negative half cycle of the input signal, the base is driven more negative with respect to the emitter, increasing the forward bias and allowing more current carriers to be released from the emitter which will result in an increased collector current.

This can be seen by the positive half cycle of the collector voltage. You can readily see that this type of circuit would be an excellent voltage amplifier as well as a good current and power amplifier. Current gains of values up to 99 are possible with this type of circuit.

For instance, if 96 per cent of all the current carriers leaving the emitter went on through to the collector and only four per cent combined with electrons in the base region, our current gain would be 24. If the percentage of current carriers reaching the collector was 98 per cent and only two per cent combined with electrons in the base mate-

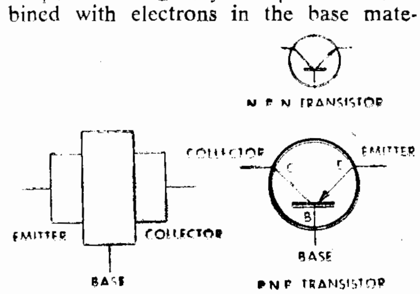

Figure 27—Schematic symbol.

rial, our current gain would be 49. The common emitter type circuit will probably be the most frequently used type of configuration in transistor circuitry.

Up until now, we have indicated the transistor by means of blocks for each of the three elements. The common type of symbol that you will encounter in circuit diagrams on transistorised radios is shown by means of Figure 27. The emitter element is always indicated by the line with the arrow on it. If the arrow is pointing in toward the base, this signifies a P-N-P type transistor. If the arrow points away from the base, this signifies an N-P-N transistor. The

(Continued on Page 93)

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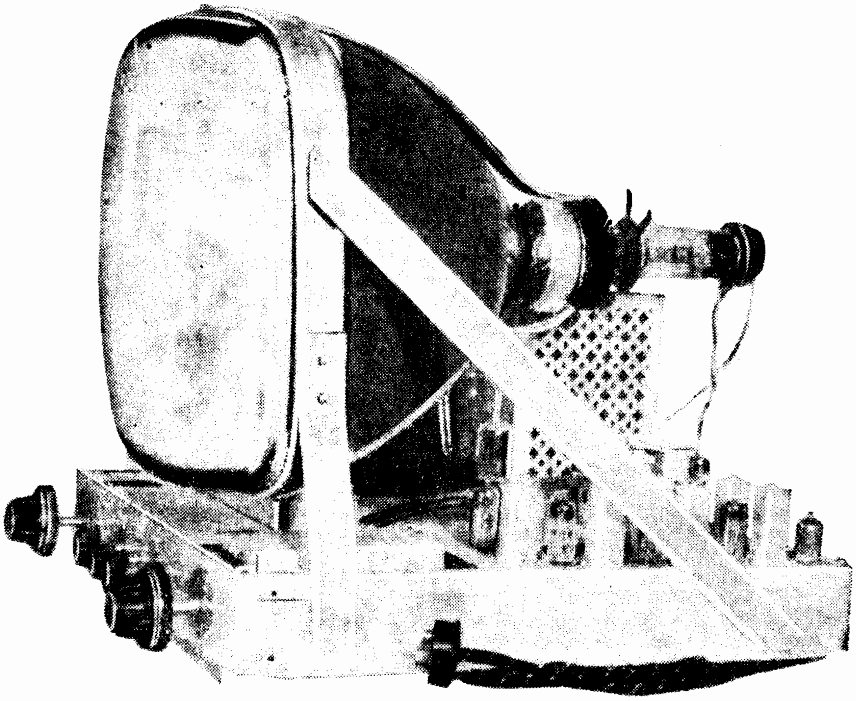

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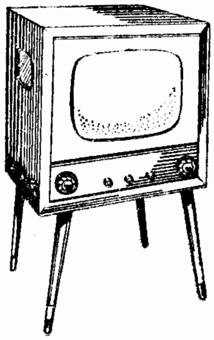

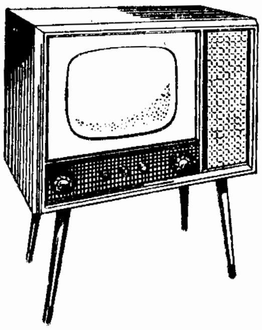

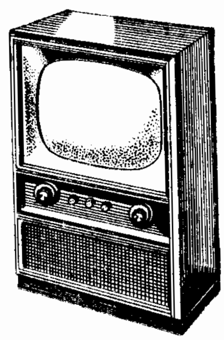

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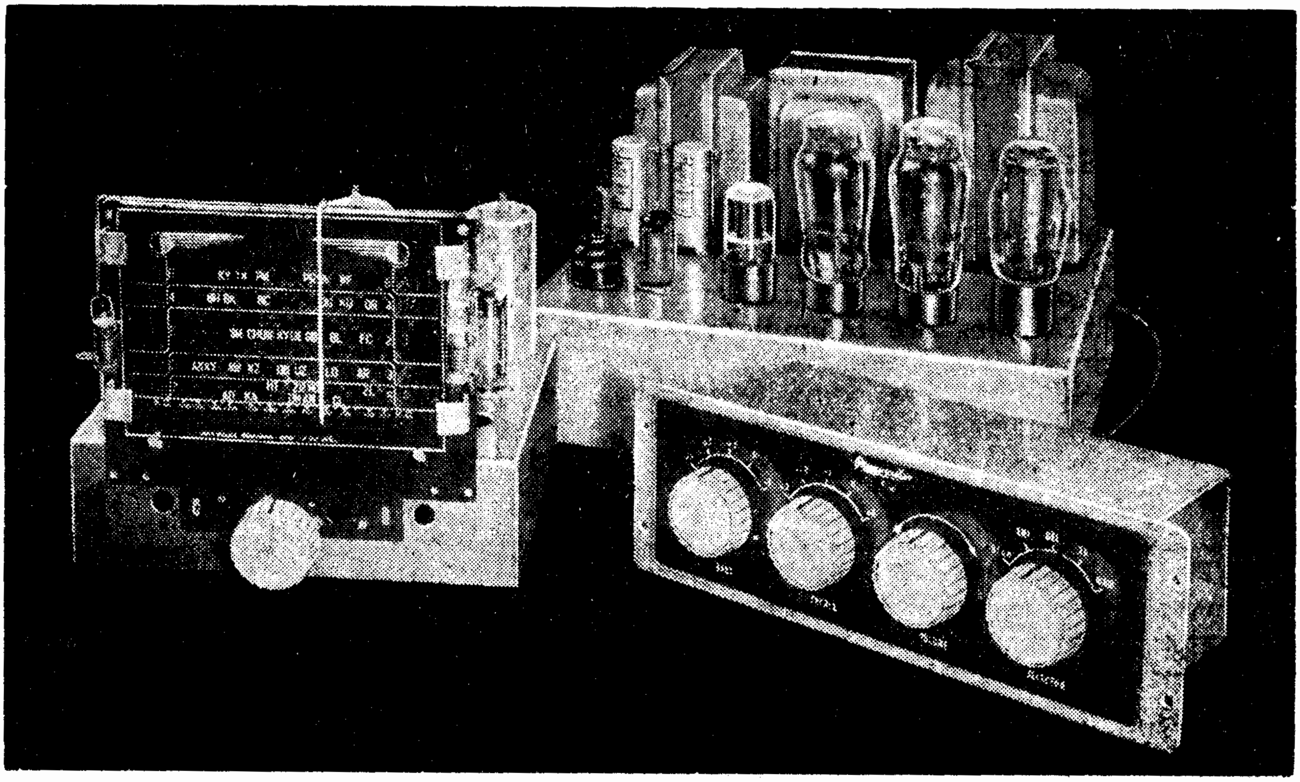

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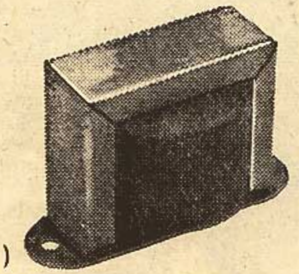

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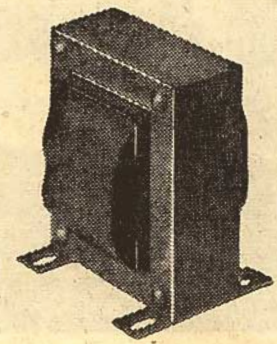

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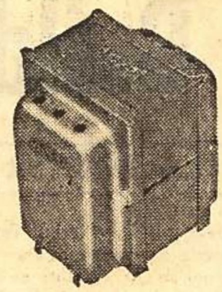

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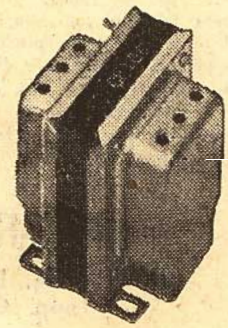

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● F14-60	14	60	550	1
CF102	15	60	300	1
● CF103	30	60	475	3
● CF105	15	80	325	3
● CF104	30	80	580	3
● F6-100	6	100	210	1
● F12-100	12	100	265	1
● CF106	12	100	200	3
● CF107	30	100	375	4
● CF196	20	125	255	4
● CF108	12	150	180	4
● CF109	20	150	225	4
CF396	4	200	50	3
● CF110	12	200	105	4
CF111	16	200	165	4
● CF112	10	250	80	4
CF113	5-20	250-5	80	4
● CF388	1	285	26	2
● F1-285	1	285	48	1
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FIRST TEST WITH THE NEW STEREO RECORDS

Ever since the stereo disc became a possibility I have been looking forward to playing some for myself. A few days before going to press I received both a pick-up cartridge and some records.

IN so short a time, and with a limited program material, it would be premature to be too dogmatic about my reactions. But there are a number of impressions which might be of value, although some of them apply to stereo as such and not merely to stereo records.

The pick-up I used was an Acos preproduction sample which Amplion received by airmail and made available to me. The records I imported from America, where they are sold in limited quantities so that experimenters will have something to use.

The pick-up has twin elements driven by a common stylus to which they are linked by a nylon bridge. It looks quite simple and should not be unduly expensive, remembering it is virtually two heads in one with a diamond stylus.

LIMITED PROGRAM

The program included two sides of railway noises, mainly engines shunting backwards and forwards, a pop singer with orchestral accompaniment, and some swing bands. For the sake of my sanity, I am hoping for more variety soon.

The amplifiers were two Playmasters with individual controls — the speakers a set of Wharfedales and a Rola 12UX. I had not enough time to adjust pick-up loading etc. for best results, but the head worked well enough using much lower loads than recommended so that characteristics approximated magnetic output. There was no time to check reponses, etc.

The stereo effect is present to a most satisfactory degree. There isn't the slightest doubt about the spatial presence it gives over a single channel on any kind of program. The railway record is a good gimmick type, for it clearly registers the movement of an engine shunting across the room, an excellent sense of distance for whistles and sirens, and a general air of movement and depth.

The same aural 3-D effect can be heard with the orchestra together with a distinct separation of sections, often remarkable when the recording plays it up.

A BIG FUTURE

In brief, the stereo disc works. There's a new, tantalising future in it. It will open up a wider and different kind of reproduction.

And now for some brief comments on details.

Channel separation, although dependent largely on pick-up and speaker placement, is very marked. The pick-up claims about 20 db, if so that's enough to clearly separate a drum and a trumpet —not a bad test.

In my room, good separation is obtained with about 5ft between speakers. More than this gave a hole in the middle. Even closer spacing — 3ft between centres — gave good stereo, indicating that a wide, single cabinet can successfully be used in average rooms.

Balance between channels must be good for best effect. One record had a steady 1 Kc band for balancing, but a special test disc would be invaluable. You can balance fairly well on surface noise, but it's very difficult on program. The speakers should have the same general character—if one leads in the middle or upper range, that prevents good balance over the full band and degrades the effect. I had difficulty here with my vastly different set-ups.

There is a noticeable separation in the bass, or at least the upper bass.

Single source speakers, or close grouping of multiples, give best stereo. More elaborate systems, while giving better sound, need larger rooms or they will be hard to control. Diffused high, a la Wharfedale, might well be out.

The room is very important. Wall reflections, etc., are significant. There's a good deal of experiment to be done, and every case is likely to be different. I have a feeling that the subtle differences will be more important than the obvious ones for serious music. It would be easy to overdo the phenomenon of sound separation.

DIRECT RADIATION

The technique of bringing the speakers close together and facing them outward mightn't be so good. The direct radiation from the speakers is the prime consideration, not reflected sound.

The speakers should be mounted at the same height and in the same plane.

The quality of the records I've heard is quite on a par with the best monaurals. Frequency range is excellent and I was not aware of any significant distortions. First impression is that the discs are first-rate, and that recording amplitude is high.

Surface noise doesn't seem to be greater than normal, but I'd like to adjust responses before saying more. If present,

by John Moyle

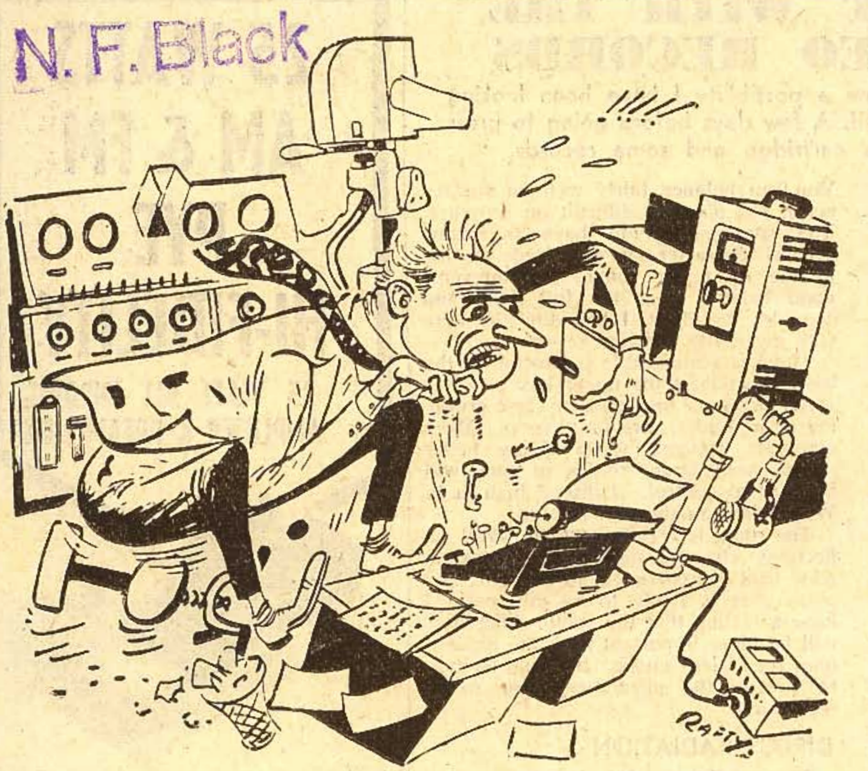
it will degrade the stereo effect, as does anything which is completely common to both channels. Fundamentally it doesn't seem to be a problem.

A good pick-up arm and good tracking are essential, as side pressure will degrade at least one channel. Groove tracing is a much more complicated matter. The motor I was using is good, but not faultless, and I had no rumble troubles.

High volume is not favoured, and can degrade the stereo effect if too high for the room. Splitting the power into two channels makes the whole thing sound louder. As I suspected, we are in for a drastic revaluation of the things that make a record sound good.

By the time the next issue is due, I hope to have some further comments to make, and perhaps a suggested circuit for a simple stereo amplifier. I also hope to get some more records.

If not, I'll have to learn to love those train whistles, or go balmy.



Let's Buy An Argument

A correspondent to the editor of "The Proceedings of the Institution of Radio Engineers (Aust.)" has raised what I think is an important matter at the right time. He draws attenion to the need for standardising values for high impedance voice coils. Read his letter opposite.

TO some, the mere reading of the letter will be sufficient. Many others, however, will wonder what it is all about — this sudden interest in high impedance voice coils. Well, if you are so wondering, a brief review of the situation may be helpful.

Over the last thirty years, we have accepted the moving coil loudspeaker as being the standard type for receivers and amplifiers. We have understood that the coil must have as little mass as possible, consistent with mechanical strength, and be thin enough to work inside a narrow gap in the surrounding magnetic circuit.

A VAST GULF

To meet these requirements without undue difficulty, voice coils have conventionally been wound with comparatively few turns of wire and the summaation of their mechanical, inductive, capacitive and resistive quantities has given nominal impedance values lying, for the most part, within the range of 1 to 15 ohms.

This "practical" range of voice coil impedance values is so far removed from the orders of plate load required by power amplifier valves, that we have accepted, almost automatically, the principle of using a coupling transformer between the valve plate circuit and the voice coil terminals.

The turns — and therefore the impedance — ratio is arranged so that the impedance of the particular voice coil is "transformed" to whatever higher value is required as a load for the output stage.

Incidental to its main job, the transformer provides a DC path for the valve plate current, adds the divergent plate current effects of push-pull stages and also isolates direct current and voltage from the voice coil circuit.

These functions are all very useful in themselves but, in other respects, the transformer can be regarded as a "passenger," a definite nuisance, in fact.

In cheap receivers and amplifiers it occupies space somewhere, adds to the overall cost, introduces a significant quota of distortion and manages to waste anything up to a third of the audio power fed into it.

In high fidelity equipment it adds much less distortion and absorbs much less power — but only because it is designed as a very bulky and very expensive item of equipment. Hi-Fi enthusiasts know this only too well.

PHASE ROTATION

And, for all its bulk and cost, the transformer manages to introduce enough phase rotation at very low and very high frequencies to complicate the use of extensive negative feedback.

Then why not get rid of it?

Well, "transformerless" output circuits have been a forlorn kind of dream for many years, but transformers have gone on and on. Right, now, however, the idea is undergoing a certain amount of re-examination, stemming from two main sources.

First and foremost, transistor power amplifiers require much lower orders of output load than their valve counterparts, figures running from just above the present range of voice coil impedances to a few hundred ohms.

Since the gap between the two sets of values is so much narrower, it leads to the obvious thought . . . why not reduce the gauge of wire and increase the number of turns on the voice coil to produce directly the required order of impedance? The need for a step-down transformer would thus disappear.

A FURTHER STEP?

Now comes step two: If it is shown practical to wind voice coil impedances as high as several hundred ohms, why not go a little higher again to bring them into the range where they will meet the requirements of valve amplifiers specially designed to work into (for valves) a low load impedance?

If it should be necessary to provide a centre-tap for either application, what of it? Two connections have to be provided anyway, so why not a third? In all cases the cost and bulk of an output transformer would be avoided while, for wide range amplifiers, the phase shift problem it presents would be relieved also.

Such is the train of thought, on a superficial basis.

by Neville Williams

To those of us who are not expert in speaker manufacture, first reaction to the suggestion is that it may be impractical to wind voice coils of increasingly high impedance. without involving prohibitively fine gauges of wire. Or, if such wire is used, can it possibly be terminated reliably or not be unduly subject to fracture or chemical decomposition?

Alternatively, if the bulk of the coil is allowed to increase, in order to accommodate a more practical wire gauge, will not the sensitivity and frequency response of the speaker suffer, as compared with lower impedance types?

Strangely enough, the proposition of using very fine wire gauges does not appear to dismay speaker manufacturers unduly. It is more difficult and therefore more costly, but not impractical. Nor do they seem to be very worried about fracture or decomposition of the wire.

The real difficulties arise from the absence of those transformer functions which might hitherto have been regarded as incidental to the main one of impedance transformation.

THE DC PROBLEM

Thus, while speaker manufacturers can wind and terminate high impedance voice coils, they aren't at all happy about them being subject to direct current or potential. In fact, for the higher orders of "high impedance," involving extremely fine wire, DC is definitely "out."

Nor is it just a matter of arcing and fusing current. Unbalanced DC through the voice coil produces a magnetic force which carries the voice coil from its normal central position. Therefore, DC has either to be blocked off or else the voice coil suspension must be offset initially, and the speaker thereafter wired into circuit so that just the anticipated amount of DC flows through the coil and in a specific direction.

The thought of critical, polarised speakers certainly isn't a very appealing one.

Well then, why not standardise on push-pull circuits, with a centre-tapped voice coil and with the DC component cancelling out?

From what I can gather, speaker manufacturers aren't very keen on centre-tapping the voice coil but that's not the end of the story.

In an output transformer, with a proper magnetic circuit and, in better types, sectionalised winding, the balance and coupling between the two halves of the primary can be very good. The signal currents of the two output circuits are therefore added magnetically to produce what should be a substantially undistorted output envelope.

The further the amplifier departs from pure class A operation, the more important does this function become.

But a voice coil isn't a transformer by a long way. It normally has to be layer-wound and some proportion of it is always outside the iron circuit, anyway. How successfully it will add the output of a push-pull circuit is open to some query.

And even if it does so well enough, in the ultimate mechanical movement of the cone, whence can one derive feedback if there is not also a simultaneous electrical addition between the two output plates (or collectors, in the case of transistors)?

Well, then, having eliminated the output transformer, and its very useful "secondary" functions, are we going to demand high impedance voice coils, section-wound with maximum coupling between all sections? It begins to sound rather silly.

In valve circuits class B operation is the exception rather than the rule but, for transistors, it's the other way around. Nearly all transistor output circuits operate in a highly "overbiased" condition to make the best of collector dissipation ratings. Balance and coupling in the output circuit are therefore important but there's still another aspect to consider.

WORK ALTERNATELY

Under such conditions, only one transistor delivers substantial power at a time, during alternate half-cycles and each into its own half of the load. At all times, therefore, half the voice coil winding is just so much useless wire occupying precious space in the air gap.

As a result, there is a fundamental loss of efficiency in the system which puts it at an immediate disadvantage.

Having said all this, the case for high impedance voice coils looks a lot less attractive than might appear at first glance.

Conventional circuitry, involving a DC component, would necessitate either a special speaker construction or an isolating choke and capacitor. If the latter, then one may as well use a transformer and be done with it.

Push-pull systems would involve a centre-tapped voice coil, about which manufacturers are wary, while presenting the aforementioned problems of balance and the effective use of feedback.

These problems may not be insuperable and thoroughly practical arrangements may well be evolved, even in the next few months. Only time will tell.

UNTAPPED LOAD

In the meantime, a couple of new circuit approaches have been developed with valves and transistors, whereby the output of a pair is combined into a single untapped load. *If we are prepared* to drop more popular or more convenient circuits in their favour, then the high impedance voice coil approach may be widely adopted using such methods.

Once again time will tell!

In the letter, which prompted these remarks, John Goldthorpe hasn't concerned himself with all these pros and cons, although doubtless he has quite a few definite ideas of his own.

The important point he makes is that, if the scheme is adopted, we should see to it right away that speakers are ordered and produced to the preferred value system of numbers. If they are not, we can hardly blame our children, when their turn comes, for thinking us rather stupid!

PREFERRED VALUE VOICE COILS

Dear Sir,

With the introduction of transistors to entertainment equipments such as portable radio receivers and record players, design engineers are seeking to eliminate the output transformer and couple the output transistors directly to a loudspeaker of suitable voice coil impedance. Such loudspeakers are commonly known as "high impedance voice coil" types and by far the most common circuit technique to permit this method of connection is for the output transistors to be arranged in asymmerical or single ended push pull.

A wide variety of load impedances appears necessary to match not only different types of output transistors but also for different operating conditions—supply voltage and the ratio of peak to quiescent collector currents — for any given pair of transistors. As a consequence, it could be that loudspeaker manufacturers will be besieged by setmakers requesting all sorts of odd values of high impedance voice coils, which is not only uneconomical to the loudspeaker manufacturer, but a factor which I feel the industry will realise in years to come is a rod for its own back

The solution would appear to be obvious, but as to date I have not seen in any of the current literature a plea for standardisation in this regard, I would suggest that loudspeaker voice coil impedances for this application be confined to E.I.A./R.E.T.M.A. values extrapolating from the already standard 15 ohm voice coil, and thus I foresee loudspeakers of 22 ohm, 33 ohm, 47 ohm and 68 ohm. These values can cope with the majority of applications, as indeed tentative measurements indicate a variation in load impedance by 20 per cent will reduce the available power output by less than 2 db.

It is not the intention of this note to suggest that a loudspeaker manufacurer would of necessity make loudspeakers with voice coil impedances of these four values, but rather where he has a demand for a loudspeaker of this type that he should standardise his voice coil impedance at the nearest E.I.A./R.E.T.M.A. value. It could well be that for some special application the intermediate 10 per cent values of 18 ohm, 27 ohm, 39 ohm and 56 ohm may be desired, but measurements to date indicate that for commercial equipments the marginal increase in performance does not warrant the addition of these further preferred values.

Yours faithfully,
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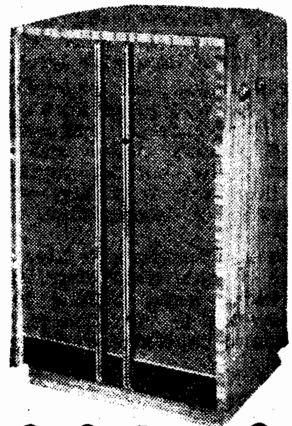

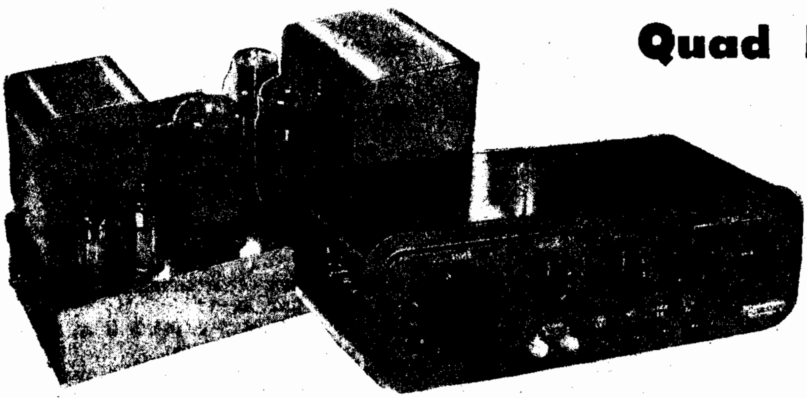

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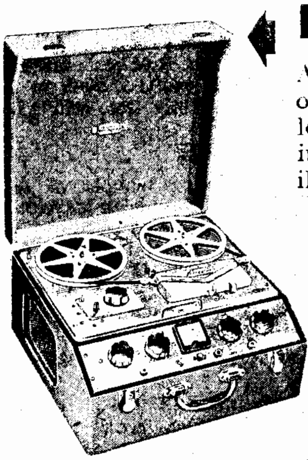

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IN DEFENCE OF LIVE TV SHOWS

Dear Sir,

I feel your contention in the March issue of using only high quality films and tapes for television in lieu of live performances, is strictly from the home viewers' point of view.

It is saddening enough to consider the present high proportion of films used in television—a medium that is essentially to give the home-viewer the theatre rather than a pocket-sized picture theatre.

Opportunities for Australian actors and actresses in the theatre and in motion pictures are, in comparison with other parts of the world, very limited. Television can be a means of discovering new talent, especially in a country as Australia where, if judging by the output of motion pictures produced, is limited to a few capable actors.

The complete use of films and tapes would mean television is reduced to the production of English and American films, for surely they are the only ones of high enough quality that you, Mr Williams, would tolerate.

Congratulations to the A.B.C. for their intention of producing more live plays and let it be an example to Australians that television is not dependent on imported celluloid.

Yours faithfully,
A. W.

P.S. Being a television cameraman I might add that the introduction of your idea everywhere would put me out of a job.

My remarks in the March issue about the relative merit of plays, either telecast direct or pre-recorded on film or tape, have brought forth a rejoinder from a reader who is currently working overseas as a cameraman.

This reader apparently sees my remarks as a "contention" in favour of films, in lieu of live performances, leading to a situation where our local TV programs would be — or should be — entirely dependent on "imported celluloid."

That is something which, in framing my remarks, I tried NOT to say. I hold no brief for overseas film interests, and have a natural patriotic desire to see Australian talent exploited to the fullest degree.

My remarks were made on a purely objective basis, as under:

(1) It is inevitable that live drama will be compared with cinema films, because they are here sharing a common medium — the television screen.

(2) Live drama can easily suffer by such comparison, because there is no opportunity for ragged scenes to be corrected by remake and editing.

(3) Because of the above, it may prove more satisfactory in the long run for efforts to be directed toward pre-recorded drama, rather than the directly telecast variety.

LOCAL TALENT?

A.W. sees in this a threat to local talent and to his own standing as a cameraman. But why?

Cameramen are still required for pre-recorded drama — television cameramen, in fact, if the pre-recording is done on tape rather than film. And actors are just as necessary either way.

The discussion, insofar as I pursued it, was limited essentially to the method of presentation, with the suggestion that pre-recording techniques might allow local production to be seen in better light.

The correspondent's further observation that my contention is "strictly from the home-viewer's point of view" rather reminds me of the tourist's classic complaint that "the scenery in Switzerland isn't as good as it looks."

Surely the whole purpose of a television program is to capture the viewer's interest so that he will continue to watch it, thereafter to be educated, amused or cajoled as intended. He is under no compulsion to watch the particular program or even to leave his set switched on.

MUST HAVE AUDIENCE!

His acceptance of the program is fundamental to its success, unless A.W. relishes the idea of his video signals going to waste in space. Every program is a potential training ground for somebody, but TV stations can't run programs just to train personnel, even if they are "real good Orstralians."

I must say, in all fairness, that some of the live drama offered since the original remarks were made has shown a good deal more maturity, and that must be very encouraging to all concerned.

But it doesn't alter the basic fact that local talent will either have to compete with imported material on equal terms or else be given completely artificial precedence by regulation.

There's one other point which I'd like to debate. I refer to A.W.'s assertion that television is a medium designed essentially to give the viewer theatre rather than a pocket-sized cinema.

This looks to me like an exact parallel to the longstanding argument about gramophone records and the reproduction thereof.

Countless audio enthusiasts have based their approach to the subject on the tacit assumption that the job of record playback equipment is to transport the orchestra to the listening-room or, conversely, to transport the listener to the auditorium in which the particular work is being performed.

Many others—and our Editor is one of them — conflict sharply with this view.

BASIC LIMITATIONS

They point out that fundamental limitations of the record, amplifier and listening-room have made the illusion impossible of achievement. At the same time, however, microphone placement and electronic facilities enable a record to carry audio information which is not available to the direct listener.

This fact and the universal use of records has established them as a means of producing music in their own right and it is therefore wrong to presume that the ultimate sound should conform to or be limited by what is heard in a "typical" seat in a "typical" concert hall —if indeed there is such a thing.

Television is, I think, even more definitely a medium in its own right.

Limitations of the system, as we know it, make it impossible either to bring the stage to the viewer or the viewer to the stage. The screen size, definition and facilities are such that the pictorial emphasis cannot be on the scene as a whole but rather on close-ups and significant fragments of the whole.

This is the exact converse of the live theatre and every close-up can serve only to remind one of the fact.

The television screen and the cinema screen have rather more in common, in their content but, once again, television as we know it cannot vie with modern cinema presentation, with its wide screen, its clarity, colour and stereophonic sound.

Television is visually unimpressive, an essentially family entertainment, devoid of building or audience glamour. People watch it in their best clothes—or their pyjamas.

But the vital fact is that they watch it, or will watch it, in greater numbers than any other medium of entertainment. More and more features are being developed and produced expressly for television.

To reason that these features must conform to or be limited by the concept of a theatre stage, or a cinema, or any other medium, is plainly fatuous.

It may borrow techniques and try to recreate atmospheres for special programs but, all the time, television must go on essentially serving itself.

Am I talking down the theatre and all its associations? Am I talking down the cinema? Hoping that theatre and cinema alike will be engulfed in the tide of television? No, certainly not.

I'm merely pointing out that a new medium of entertainment has arisen on a scale which dwarfs anything which has gone before. It is quite inevitable that it will set its own standards and concepts.

A POSTSCRIPT

Having written the above and ended on what seemed to be a conclusive kind of note, I pushed the typewriter aside and turned to other matters.

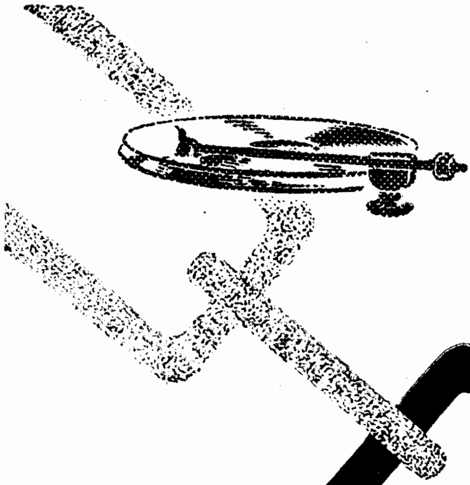
Hardly had the ink dried on the paper, to use a well-worn phrase, when advance samples of stereo records and pickup arrived in the office. Ever since, the Editor has been rushing round the place with ears askew and a strangely bifocal expression on his face.

To say that he's keen about the result is an understatement but that's not why I mention it here.

I can forsee that it is going to restart the whole argument about transporting the listener acoustically to the auditorium or vice versa, because it has the potential of communicating reverberation and direction effects foreign to a monaural system.

However, it doesn't affect what I had to say about television in its present form. If and when we get large-screen, high-definition, third-dimension TV, not forgetting colour, we can start talking about transporting our audience or atmosphere visually from place to place.

Until then, what I said about television still goes.



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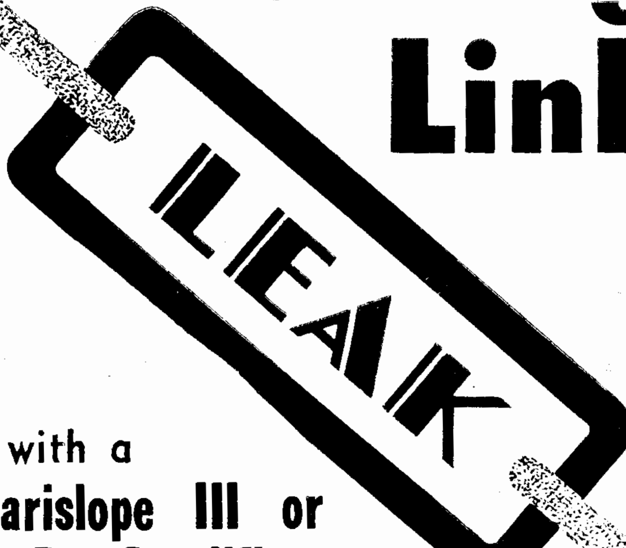

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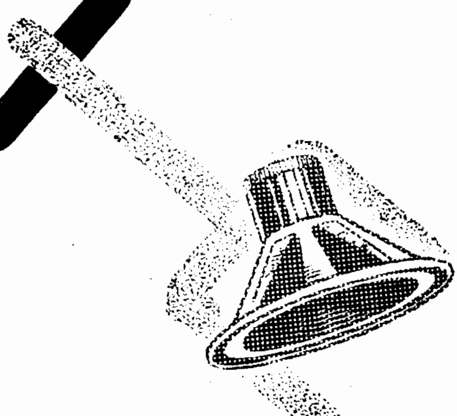

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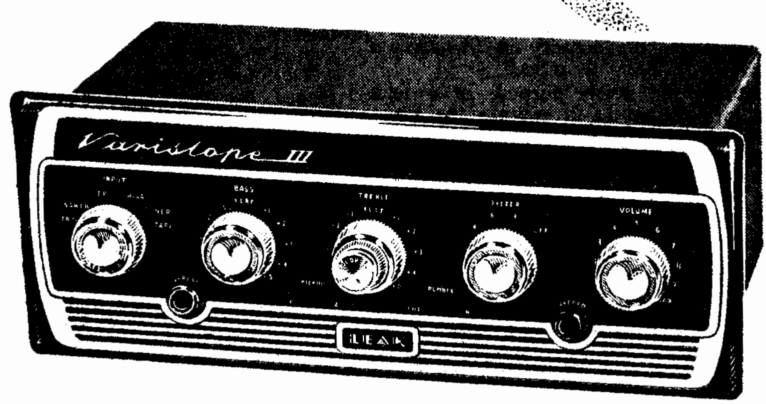

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OFF THE RECORD — NEWS & REVIEWS

One of the questions fired at me most consistently concerns the type of loudspeaker enclosure I like best. The matter most commonly in mind is bass response, for after all that is the prime reason why an enclosure is used at all. And there is no doubt that an answer is expected in terms of domestic listening.

by John Moyle

It's hard to answer such a question in a few words, for there are so many ifs and buts about it. A good many of these were considered in some detail in a couple of articles which appeared about a year ago concerning enclosure design.

I don't know of any reason to change my ideas based on the points made at that time.

You can't talk about the best enclosure, really; rather should you think of the enclosure which will give you the kind of results you are looking for.

Even more important is to choose an enclosure that suits your type of loudspeaker.

The kind of bass I like best comes from a large bass unit (15 inch variety) with a very low resonance, (round about 25 cycles), mounted in a completely enclosed box or "infinite" baffle of generous proportions. The usual advice as to size is 8-9 cubic feet and I would endorse that, even though the one I use most isn't quite as large.

SMOOTH AND CLEAN

With such a box, very sturdily made and lagged internally, I think the bass response is smoother and cleaner than with any other system suitable for domestic use. Impedance curves support this.

It is true that the back radiation is lost and the efficiency from this point of view suffers by comparison with some other types of enclosures.

But speakers of the type I have mentioned are invariably sturdy and often quite efficient, and can easily stand some extra power to make up for this loss, if indeed it should need making up.

Nor is output power really a problem with modern amplifiers.

In my opinion, the biggest source of unbalance I have noticed in domestic sound systems is too much bass. This is particularly so with users of vented enclosures and horn-loaded systems, or combinations of each method.

Properly adjusted, they are equivalent to using extra bass boost, for they increase the efficiency of a speaker system by an indeterminate amount.

But unfortunately nearly all are fundamentally afflicted with peaks and resonances which create problems for the user.

The horns are notorious efficiency raisers, particularly if they are back loaded types. Because they can produce most impressive output down to their cut-off point, their owners nearly always seem to develop a heavy bass complex which I find tiring, and often ruinous to the overall result.

HIGHER RESONANCES

But, with speakers of higher resonances, horns and vented enclosures are often the best solution. In very low resonance cones size rules them out, for appropriate dimensions related to the resonance frequency would be enormous.

Even the closed box is pretty big, but I think that is a small price to pay for a smooth response curve.

There is usually no trouble in obtaining output down to very low frequencies with such an arrangement. A suitable box might lift the cone resonance by only a few per cent, so that response should hold well as low as 30 cycles.

To approach this result from a higher resonance speaker, some enclosure reinforcement is unavoidable, and that means a coloured or peaky response.

The extra efficiency from horns isn't confined to the bass register. I have always found that horn-loaded middle and top speakers exhibit effective boost in their appropriate range, due to the increased efficiency.

It makes the matter of balance very hard to handle, because one's first reaction to such spectacular reproduction is to be understandably impressed.

But if you find yourself worried over consistently high surface noise, valve hiss and the like (with an amplifier above reproach, particularly in the matter of super-sonic oscillation) you can strongly suspect that you are over-doing the fireworks.

Where multiple speakers are concerned, I am highly suspicious of microphone tests as a means of balancing up speakers. The complications of arranging such things in an ordinary listening room are immense, and they have no value if taken anywhere else.

The room is a vital and integral part of any speaker system. The better the system, the more important is the room.

The prime purpose of bass is not to shake the floor at all costs, nor of highs to drag every triangle out into space.

Only your ears can tell you when the total effect is just right, and only after long periods of careful listening on all kinds of material. Even so, different people like different balance, although most eventually turn away from extremes at either end.

EARS MUST JUDGE

Up to the loudspeaker stage, instruments are fine. After that your ears must be the final judge, but you must draw upon your commonsense, listening experience and musical feeling as well.

My preference is for the smoothest bass response at the expense of efficiency if you like, and a top range which is dispersed rather than concentrated.

That's one reason I like multiple speakers, because with a varied sound source one has much more flexibility in this matter.

It's not easy or desirable to control the bass speaker, but it's not hard to balance the others.

Balance is perhaps the most important point of all, in my opinion.

And after all, that's what I was asked for.

Long Long Players

A highly interesting news item this month concerns long playing records at 16 2/3 rpm.

Vox have released some in U.S.A. with approximately an hour's playing time on each side.

I have been watching for such an announcement for some time, for it has been obvious that all recording companies have been working on extended playing time, with highly concentrated groove spacing. Vox in particular have exploited very long playing 33 rpm records, but they are not the only interested party.

It was only a matter of time before someone went a step further and dropped into low gear.

Reports, as might be expected, comment that the quality isn't top grade, particularly in the high registers. A finer groove would be required to avoid appreciable loss of highs.

But when stereo pick-ups arrive, and they can't be far away, their finer points might be used to advantage.

These pick-ups should have no trouble in tracking fine groove 16 rpm records, and my bet is that eventually these will be made.

If there is one thing more attractive than a hour's music on a single disc it is two hours. Using a fine groove almost four hours might be possible.

We might then have all Beethoven's symphonies on a couple of discs, with enough room left for a few Overtures as well.

That would be something that stereo couldn't match at least within present horizons. It could be an attractive monaural answer, and even at a considerably higher price would have many talking points.

Smaller discs, of course, would be just as feasible. American Columbia have made them for some time, to be played, of all places, in motor cars. As I've remarked before, I have some of them, but no fine points to play them with.

RECORDS OF THE MONTH

WAGNER — Overtures to Meistersinger and Tannhauser; Tristan and Isolde, Prelude and Liebestod. Played by the Berlin Philharmonic Orchestra conducted by Herbert von Karajan. Columbia 330CX 1496.

Very good indeed—hard to fault in any way Both Overtures are among those most frequently played, but here they are far from being routine exercises.

Tannhauser, particularly, isn't easy to make sound so interesting.

The Meistersingers I liked better, perhaps because there is more in it to bite on. The Philharmonia plays that intricate and exhilarating final section with complete assurance and exceptional clarity.

With the volume turned well up the sound is rich and thrilling, just as it was intended to be.

But it was the Tristan side I found the best. I don't think the word magical is too fulsome for this sensitive and lovely string playing, for it is on the strings that the main responsibility lies in building both the emotional and sonic line.

Maybe Karajan is restrained, particularly in the Liebestod. I prefer it that way, for there is also a more subtle and mystical atmosphere in this closing scene which is often missed, an emergent quality which Furtwangler, particularly, was so good at building up.

You will admire, too, the way in which Karajan has judged his dynamics, how unfaltering is the way in which he moulds that wall of sound.

It's a pity the surface noise is not lower. My copy had an attack of crackles which I had hoped had dis appeared from modern discs.

★ ★ ★

TCHAIKOWSKY — Excerpts from the Sleeping Beauty. Played by the London Symphony Orchestra conducted by Pierre Monteux. RCA Li6103.

This is one of RCA's most musical releases of recent months. All the best known selections from the ballet are here.

I don't know whether the English origin of the tape has anything to do with it, but the sound has much more reverberation than the average RCA made in U.S.A.

By any standards it is quite appreciable, but I thought it gave a most attractive, airy quality, not unlike many English Deccas.

The recording is rather too remote for showcase quality but the frequency range is quite good and the orchestra has a pleasant, cohesive sound.

The conductor has dealt gently with the music, but on the whole the LSO has played extremely well for him.

I liked the record best when reproduc

KLEMPERER OUTSTANDING IN BRAHMS

BRAHMS — Symphony No.1 in C minor. Played by the Philharmonia Orchestra conducted by Otto Klemperer. Columbia 330CX 1504.

The list of Brahms Firsts is quite formidable. There are too many for me to undertake a comparison, for I'd need a whole evening to hear them, and I doubt whether there would be much point in it.

Whatever your reactions might be to this record, it is without doubt one of the best there are.

On a profit and loss basis it could easily top the list, but I'd need more than a couple of hearings to say why.

That's the kind of record it is. Its quality and worth are evident from the first bar.

It has the same musicianship and lofty approach which marked Klemperer's fine Beethoven symphonies recently released.

He has concentrated on the stature of the work, and built it into great proportions at the expense of everything else. Often I feel he becomes ponderous, and frequently I could wish for a smoother and less potent treatment of well known passages .

But his meaningful and purposeful progression is so consistent, so reasonable, and so lofty that he has little difficulty in impressing you with his point of view.

And after all, I have often sighed over performances because they failed in just those things which Klemperer has done so magnificently.

Yes, it would be foolish to consider any other version until you have rejected this one.

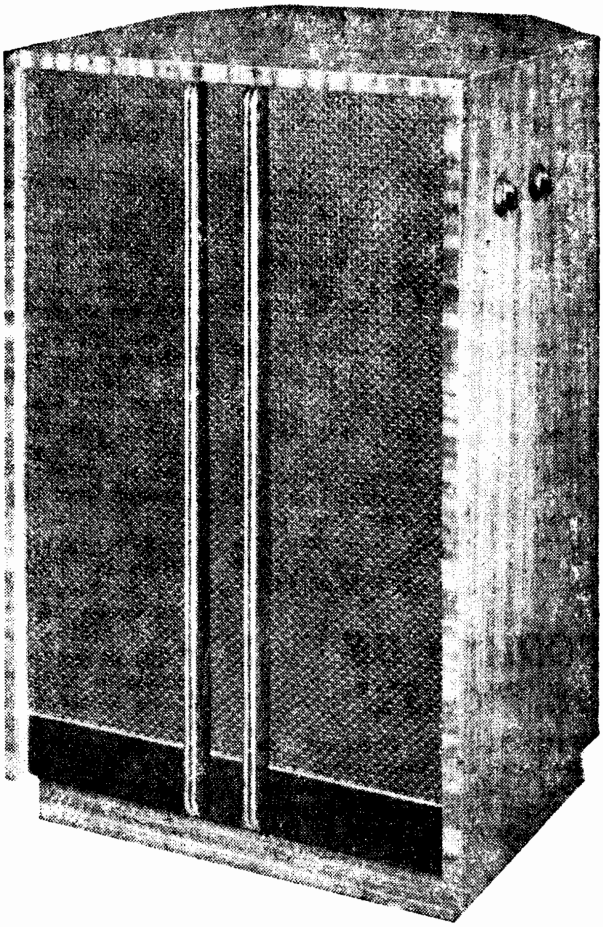
The sound is good, but not the Philharmonia's very best; rather dry in quality. The violins sound a little oppressive in loud passages, but its very hard to handle the heavily charged texture of this music. In the huge finale to the last movement, the recording stands up very well.

One of the month's outstanding discs.

Goodmans

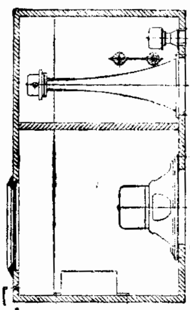
'315' reproducer

COMPLETE MULTI-UNIT HI-FI SPEAKER SYSTEM



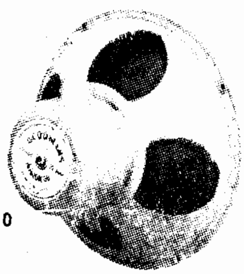
No compromises whatsoever have been adopted in the design of the Goodmans '315.' Each component is the result of exhaustive development aimed at producing an integrated system which provides the utmost accuracy of high-fidelity sound reproduction. The '315' contains three speaker units: 12" direct radiator type bass unit which operates from 30 c/s to 750 c/s; pressure-type mid-range unit operating from 750 c/s to 5 Kc/s; pressure-type treble unit operating from 5 Kc/s to 16 Kc/s. The mid-range and treble units are provided with variable constant impedance attenuators, externally operated. Network XO 750/5000.

When using the Audium 60 as the bass unit, the reproducer is known as the '315'; when using the Audium 70, the '320'; and when using the Audium 80, the '325'



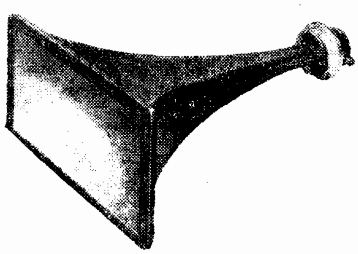
The enclosure is internally divided into two parts: the upper portion containing the treble and mid-range units and their attenuators; the lower portion containing the bass unit loaded by an Acoustical Resistance Unit in the rear wall of the chamber.

AUDIUM BASS LOUDSPEAKERS



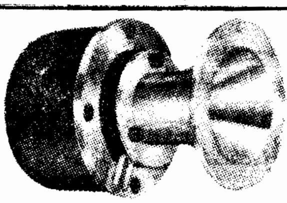
AUDIUM 60

	AUDIUM 60	AUDIUM 70	AUDIUM 80
Flux Density	14,000 GAUSS	17,500 GAUSS	14,500 GAUSS
Bass Resonance	35 c.p.s.	35 c.p.s.	35 c.p.s.
Power Handling Capacity	15 watts	20 watts	25 watts
Impedance at 400 c.p.s.	15 ohms	15 ohms	15 ohms



MIDAX MID-RANGE PRESSURE-DRIVEN HORN UNIT

Frequency Range	400 c.p.s. to 8 Kc/s
Impedance	15 ohms at 400 c.p.s.
System Power Handling Capacity	25 watts
Crossover Frequency	750 c.p.s. and 5,000 c.p.s.



TREBAX HIGH FREQUENCY PRESSURE UNIT

Frequency Range	2,500 c.p.s. to 16,000 c.p.s.
Impedance	15 ohms at 10 Kc/s
System Power Handling Capacity	25 watts
Crossover Frequency	5 Kc/s

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.... R.H/6/58 ed at fair volume and with an extra notch of bass boost.

Groove echo can be heard, something which RCA should watch more carefully, but it could have passed with a mild caution had it not been for a bad example after the final chord on side 2.

The surface is satisfactory although not above reproach. A very safe recommendation.

★ ★ ★

WAGNER—Overtures to Tannhauser and the Flying Dutchman; SIBELIUS — Valse Triste and Finlandia. Played by the Florence May-Festival Orchestra conducted by Vittorio Gui. World Records TT2.

The interest value of these items is pretty much on a par, so that they go well enough together. As a matter of fact it is unlikely that they will be found similarly grouped elsewhere.

The recording has a somewhat muffled quality about it, partly due to a high reverberation content and partly to microphone placement.

It sounds very much as though taken from a concert performance with most of the qualities of the hall acoustics.

I thought it sounded best when played back with the original Decca curve which, by its lesser suppression of higher frequencies gave a more acceptable balance.

Played this way it is good average quality although not as good as that of the Philharmonia which provides several opportunities for comparison.

There is a disagreement, too, with Karajan in the Tannhauser; The Florence orchestra, or the recording engineers, favour a pitch which is raised by a full semi-tone.

Of the items, I thought Finlandia the most successful.

The surface is good.

★ ★ ★

TCHAIKOWSKY—Serenade for Strings Opus 48; ELGAR—Introduction and Allegro for Strings; SAMUEL BARBER—Adagio for Strings. Played by the Strings of the Boston Symphony Orchestra conducted by Charles Munch. RCA L16112.

The Adagio is very good—a lovely little work and quite a surprise if you think that all American music is made of wild noises and strange harmonies.

The Elgar is the least successful. Somehow I feel that he is on the wrong side of the Atlantic — I don't think I have ever heard his music played with understanding by any but an English orchestra. And because he was so English, and Edwardian English at that, it's not surprising.

The machine-like precision of the Boston strings just isn't flexible enough, either, to cope with the considerable light and shade which makes the music.

Nor is there enough reverberation in the hall to remove a hard-driven atmosphere.

This type of sound isn't so merciless to the Tchaikowsky, but there are long passages where its forward and unvarying presence becomes monotonous. String quality has to be well-nigh perfect to stand such close proximity.

There is a trace of hum in the recording and the surface noise, although not really low, is mostly lost in the high cutting amplitude.

The Adagio has a lower recording level than the remainder.

Plays best with some bass reinforcement.

★ ★ ★

GRIEG—Lyric Suite Opus 54; Norwegian Dances Opus 35; Wedding Day Opus 65 No. 6; Holberg Suite Opus 40. Played by the Bamberg Symphony Orchestra conducted by Edouard van Remoortel. Vox APL-9840.

Grieg's charm is something unique in music. Rarely did he reach moments of great stature or profundity.

On the other hand the simplest of his ideas are rarely banal or uninteresting, despite the fact that his most frequently repeated devices are of the simplest nature, such as a run down the scale against a melodic and-or harmonic pattern.

As the label reveals, this is a mighty lot of Grieg on one disc, including two of his best Suites (both long favourites of mine) which alone would be worth the money.

I could be rather critical and suggest that in the Air of the Holberg the orchestra is over elaborate, or that in the Rigaudon both cello and violin have shortcomings.

Occasionally the orchestra betrays the fact that it isn't quite top class, but mostly the strings do their part smoothly and flexibly, with that peculiar sense of romantic grace which Grieg requires.

The recording chamber has more reverberation than average, but I think this has turned out as an asset.

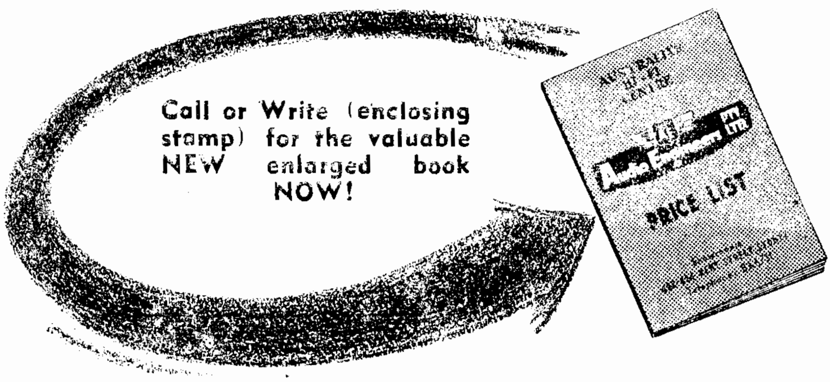
The surface is very quiet. A faint trace of echo can be heard due to close grooving. Mostly it will be missed, but in the Dances there is one bad example.

RAVEL.—Gaspard de la Nuit; PROKOFIEFF.—Visions Fugitives. Played by Andre Tchaikowsky, pianist. RCA L16096.

SCHUBERT.—Wanderer Fantasy, PROKOFIEFF — Sonatas Nos. 2 and 3. Played by Gary Graffman, pianist. RCA L16102.

Both pianists are apparently recording here for the first time, and their brilliant display augurs well for future success.

Tchaikowsy is a pianist of very rare talent. Technically, he appears to be faultless. He plays not merely with dexterity and speed, but with perfectly proportioned timing and great sensitivity.



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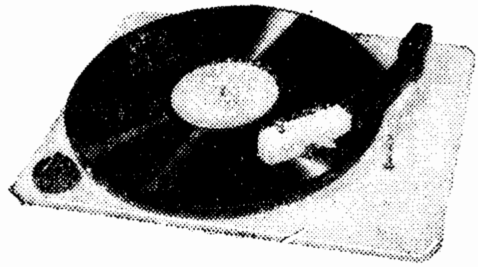

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He can play, too, with considerable power but this record shows him best in moments of exquisite and crystal clarity.

Added to this considerable competence is notable musicianship. He has the ability to project beyond the keyboard with a youthful vitality and a fine sense of co-ordination.

Of the two discs, he has the better piano tone, recorded at modest quarters and with a slight tendency to break on an occasional peak. The bottom end sounds a little tubby.

Graffman I judge to be a somewhat different type of pianist, a virtuoso in the modern American manner in which steel fingers, lightning attack, and high power have become almost a way of life.

In this disc he reminded me in many ways of Katchen, although I doubt whether even Katchen would have attacked the Schubert with such vicious force.

An excuse on the jacket says that Schubert wrote it for brilliance of effect on the audience in a concert hall, rather than for affectionate communication among friends.

That may be so, but it shouldn't be hammered.

For this reason, if no other, I liked his Prokofieff best.

Some of this impression might be blamed on the recording, which produces a hard piano. But I think Graffman must share it; the tone flattens out completely under his full assault.

I'm sure that further recordings are likely to reveal a good deal more of both men; both are worth watching. Neither disc has a completely quiet surface in the softer passages.

OFFENBACH.—La Vie Parisienne. Star cast, Grand Orchestra, and Rene Alix Choir conducted by Marcel Cariven. Philips P77107L.

I note that this record was a Grand Prix du Disque winner, probably in the light opera section, and I don't begrudge it success.

From a recording viewpoint it is outstanding.

It is, of course a humorous and thoroughly disreputable opera, appropriately tuneful if not considered worthy of inclusion in standard works on opera such as the famous Kobbe.

It is also an only recording, as far as I know, although Coronet have a fine Gaitie Parisienne ballet disc in which some of this music appears.

Most of the tunes will be familiar to you.

As for its quality, listen to the vivid presence of all vocal parts, including the chorus.

So clear is their enunciation that they are literally word perfect, that is, assuming your French is fast enough to follow the high speed.

And because the surface is so quiet, the voices almost hang on the air.

The well balanced and suitably placed orchestra has a genuine hi-fi sound to it, its presence being located skilfully by the use of reverberation.

As to the voices, I always imagine that French singers have a sharpness not always kind to my ear. For better or for worse, the microphone hasn't removed it, and I found their impact lessened by dampening them a little.

But I certainly couldn't complain about the enthusiasm of the cast, or the deftness with which they handled the fast work of the text.

I'll add my five stars to its honours. It's a beauty.

TCHAIKOVSKY—Waltz of the Flowers from Nutcracker Suite; PONCHIELLI — Dance of the Hours. Played by the Royal Philharmonic Orchestra conducted by Sir Thomas Beecham. Coronet KGC 109.

FERDE GROFE—Sunrise; On The Trail from Grand Canyon Suite. Played by Andre Kostelanetz and Orchestra. Coronet KGC 111.

TCHAIKOVSKY — Overture 1812. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KGC 110.

ROSSINI—William Tell Overture. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KGC 112.

KABALEVSKY — The Comedians; KHATCHATURIAN — Gayneh Ballet Suite. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KG3 113.

BRUCH—Adagio from Concerto No. 1; LALO—Rondo from Symphonie Espagnole. Played by Isaac Stern and the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KGC 114.

HUMPERDINK—Excerpts from Hansel and Gretel. Soloists and Chorus and Orchestra of New York Metropolitan Opera conducted by Max Rudolph. Coronet KGC 115.

BACH—Toccata in D minor played on the organ of St. Jacobi Kirche, Hamburg (1516). Toccata and Fugue in D minor, played on the organ of the Festival Hall, London (1954) by E. Power Biggs. Coronet KGC 116.

A month or two ago I reviewed some new Coronet discs similar in size to the standard 45s, but recorded at 33 r.p.m., and containing "Gems from the Classics"—actually dubbings from sections of already successful Coronet records.

My main point of criticism at the time was that the sound had suffered in the transfer process, and couldn't compare with that of the original.

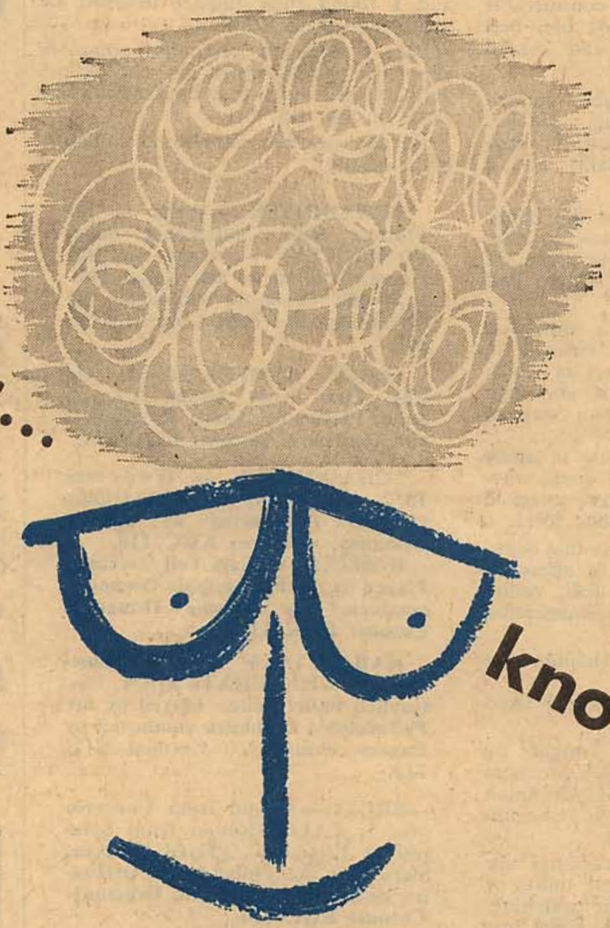
No such criticism can be levelled at this second batch, for the picture is completely different.

They are now made directly from the original tapes, and a comparison in several instances with the full-sized discs showed very little difference.

The sound is now quite comparable with the best to be found on competitive 45s, and in some cases it is even better.

In all cases the cutting amplitude is very high—decidedly higher than in the original masters. This may have been done to improve the signal to surface noise ratio, which it does, although I don't think the recording engineers have left themselves much to spare. This will worry only the super critical, as will a slight falling off in quality at the end of a long side.

grey matter...



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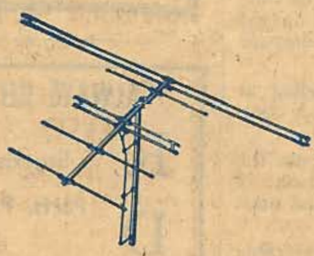

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But on the whole Coronet can be assured they will not invite unfavourable comparisons if they keep up this standard.

Quality is too even for me to pick and choose. I was very interested in the organ record for its recording of the Festival Hall organ.

But I liked them all.

★ ★ ★

VERDI—Willow Song and Ave Maria from Otello. Sung by Victoria de los Angeles with the orchestra of the Rome Opera House conducted by Guiseppe Morelli. H.M.V. 7ER0 5084.

Well-nigh perfect singing by one of today's finest sopranos. Her voice is a little robust for the music, but not for the part; in any case her artistry is equal to it all.

I think these two arias are among the most beautiful for soprano in all operas.

★ ★ ★

Sounds and Music of the R.C.A. Electronic Synthesiser. R.C.A. Experimental Record L16101.

When I was in U.S.A. two years ago, I visited the Princeton Laboratories of R.C.A. There, among other things, I saw the Electronic Music Synthesiser which Dr Harry Olsen and his colleagues had developed to imitate various instruments, and to create new sounds, in the course of experiments into the nature of sounds.

When I left, they gave me a record, of which this is a copy, containing an illustrated lecture of sound analysis, and some examples of how a number of sounds, including that of a complete jazz band, had been made up by the synthesiser.

In order to understand the significance of this disc, it is important to remember that the sounds it contains were built up electronically by adjusting the harmonic content, changing the attack and decay time, and otherwise modifying a waveform until it resembled that of the instrument it was designed to imitate.

The changes in pitch and loudness were similarly made, so that the artificially created instrument appeared as though played in the normal way.

The process is quite different from that used in the Hammond organ, for instance, for here there is a standard keyboard and tone-controlling stops for a player to use.

No one ever heard the sounds of the synthesiser until they were played back from recording tapes. They were not made by manipulating keyboards, but by setting oscillators, filters, resonators and wave-shapers.

Nor has the process anything to do with electronic music as we know it, or musique concrete.

The latter employs all the gimmicks of a tape recorder operator in playing backwards previous recorded sounds, altering their pitch and so on, not forgetting multiple heads and echo effects.

The synthesiser starts from the very beginning and builds up the sound quality entirely by the setting of electronic circuits.

The lecture - demonstration, among other things, shows exactly how it is done, how the instruments of the orchestra are imitated, one by one, and finally played together to produce a full band.

Naturally, there is a mechanical character to the sounds because it would have been too laborious to have built-in the subtle touches which only human hands can produce.

But you will marvel at what has been achieved if you have any appreciation at all of the difficulties which lay behind it.

The disc was not produced for entertainment, but for interest and instruction, and records the results of experiments made as early as 1953. It is possible that results are even better today, and I hope that the attempt to imitate the human voice, however miraculous, is now more convincing.

I found this record perhaps the most interesting and important of any I managed to collect in my travels, and highly commend R.C.A. for releasing it here. I did not even realise it had been cleared for sale.

★ ★ ★

BEETHOVEN.—Concerto for Piano and Orchestra No. 4 in G major Opus 58. Played by Wilhelm Kempff and the Berlin Philharmonic Orchestra, conducted by Paul van Kempen. DGG LPE 17084.

This record has the sound of a few years back, not that it's bad or unpleasant, but there is a rather dull atmosphere about it, and the inner parts aren't as clean or distinct as they would have been today.

The bass is heavy as compared with the upper registers and can do with some taming for better balance.

The piano tone is quite good although its weight against the orchestra is somewhat variable.

In the last movement, for instance, it is just right. In the first movement there are times when it is almost inaudible.

To a certain extent this is Kemff's fault, for he displays a marked tendency to vary his pace and dynamics in a manner which it is often hard to follow.

As a result, I had the feeling that the work doesn't really get going.

The cadenzas I have not heard before, and frankly I didn't think much of them. But then you might be tired of those written by Beethoven and welcome something new. As there is no mention of their origin on the jacket, I presume Kempff exercised his pianist's privilege and write them himself.

Although I can't award a top place, there are many nice points to this disc. Not the least is that it's complete on a 10-incher.

And the surface is extremely quiet.

★ ★ ★

BRAHMS.—Sextet No. 1 in B flat major Opus 18. Played by Isaac Stern, Alexander Schneider violins); Milton Katims, Milton Thomas (violas); Pablo Casals, Madeleine Foley (cellos). Coronet KLC643.

Most composers wrote some works for unusual combinations of instruments —some of them up to nine or ten. Quite often they were intended for use by a certain group of the composer's friends, or one which had gained fame.

Many such compositions are rarely played, very largely because it is generally difficult to collect enough performers of high standard and congenial tastes, and then almost never for public performance.

The sextet should be easier than most,

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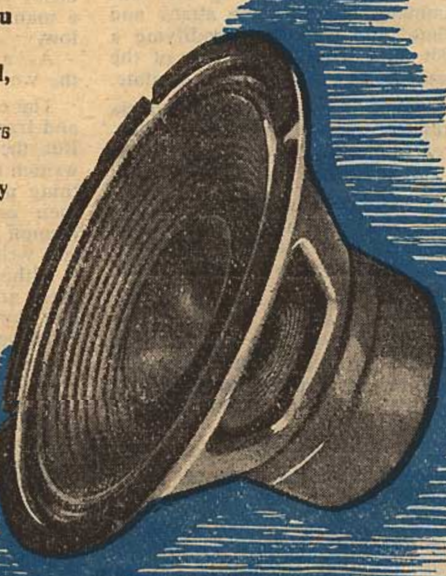

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THE BOULEVARD, RICHMOND, E.1, VICTORIA. TELEPHONE JB 3921 for it is virtually the extension of a string quartet into a small orchestra.

The gatherings of musicians at Prades, the home of Casals, present an ideal opportunity to play such music and it was during one of these recent occasions that this record was made.

It is therefore interesting for two main reasons—the unusual one of performance at all, and the high standard of the players.

In common with many others, I have never heard the music before, which makes worthwhile comment difficult. Brahms could be pretty heavy going in such matters, and I often think he was occupied as much with his experiments as with his music.

What I think doesn't matter much, as anyone who buys this disc will do so for his special interest, and I don't imagine he will be disappointed.

Some of the Prades records haven't been top class but I have no particular reservations about this one. Engineers have done a worthy job of balancing it all up, and the instrumental playing as might be expected is very good indeed.

The surface is inaudible.

★ ★ ★

HI-FI A LA ESPANOLA: FAITH—Brazilian Sleigh Bells. LECUONA — Andalucia, Malaguena; GRANADOS — Goyescas: Intermezzo; BENJAMIN—Jamaican Rbnmba; FERNANDEZ — Batique; REXIDOR — Amparito Roca; FALLA—Fire Dance; TURINA—Bullfighter's Prayer; GUARIERI—Brazilian Dance. Played by the Eastman-Rochester Pops Orchestra conducted by Frederick Fennel. Mercury MG50144.

A good deal of Espanola on a single disc, and all of it good. This isn't shatteringly high-fi, but the balance is very satisfying for all that. It has considerable variety, too, which is one of its attractions. It mixes the well-known with the unexpected and the unusual, and all of it most competently played.

★ ★ ★

CHOPIN — Les Sylphides; TCHAIKOWSKY—Sleeping Beauty Excerpts. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KLC641.

The "Sleeping Beauty" I would pick as a more modern recording than "Sylphides" —it could be by a couple of years.

It is very good, indeed — very clean, almost crystalline in its quality, but it hasn't the brilliant background of "Sleeping Beauty" or the opportunity of scintillation.

There is far more body and presence in the Tchaikowsky, which I would almost rate in the same class as the "Swan Lake" mentioned last month — almost, but not quite. It could have been made about the same time, but let me split hairs and say that the balance isn't quite as good.

One point annoyed me — the break between the various sections on both sides is far too long. When listening to music so homogenous in quality, there is no need for more than the smallest pause. I doubt whether many people will need to use the identifying bands which cause the delay, but I know that many will curse their presence.

Definitely one for everybody's list.

SHORT-WAVE NOTES BY ART CUSHEN

TAIWAN ADDS ADDITIONAL FREQUENCIES

Broadcasts from Taiwan are now carried on additional frequencies in the Home Service, and news has been received on the extension of the Overseas broadcasts.

THE broadcasts from the Voice of Free China radiated from Taipeh in Taiwan are featured this month with information on the local programs which are frequently heard here. The overseas service from Taiwan has been reported in the transmission at 8.05 p.m. when they commence the broadcast in English. This program is carried on 7235, 9573, 11815 and 15345 Kc. The frequency of 7130 Kc was recently replaced by the 7235 Kc channel.

Appreciation for the many reports received from listeners in the South Pacific was recently shown by Taiwan who plan to also beam the program at 8.05 p.m. to this area as well as Japan and Korea, when suitable frequencies are found. This information was contained in a letter from George Liu, editor of Voice of Free China. Appreciation for an interesting and accurate report was expressed in a verification letter. As the station is trying constantly to improve the program, any suggestions from listeners are appreciated.

The Broadcasting Corporation of China, which raidates programs from Taiwan, is at present broadcasting its Home Service on a variety of frequencies.

Transmissions are now as follow:

3215 Kc, Taipeh, 1; BED59, 8.00 a.m.-4.00 p.m., 7.00 p.m.-2.30 a.m. 5980 Kc, BED29, Taipeh, 2, 3. Second program is 12.55 p.m.-2.30 a.m. Third program 8.00 a.m.-10.00 a.m., 1.00-3.30 p.m.

4150 Kc, Taichung, 2; BED44, 8.00 a.m.-9.30 a.m., 1.50 p.m.-2.00 a.m. Broadcasts to Chinese mainland are carried 7.55 a.m.-11.05 a.m., 1.55 p.m.-4.00 p.m. and 7.50 p.m.-4.05 a.m. on 9555, 9685, 11730, 11970, 15280 and 15370 Kc. The calls of these stations are BED35 (9555), BED36 (9685), BED39 (11730), BED37 (11970), BED34 (15280), and BED38 (15370). These are several new stations now operating. BED22 in Taipeh on 7280 Kc broadcasts at 8.00-10.30 a.m., 1.30-5.00 p.m. and 7.30 p.m.-2.00 a.m., and BEC25, Hualien, on 7270 Kc, 8.00-11.00 a.m., 1.30-4.30 p.m. and 7.30 p.m.-2.00 a.m. Others new to the shortwave fields are You Shih (Young Lion) Broadcasting Station, BEG23, on 7180 Kc, 8.30-11.00 a.m., 1.30-4.00 p.m. and 7.30 p.m.-3.00 a.m. Fu-Hsing Rehabilitation Broadcasting Station on 3375 Kc, 755 a.m.-12.05 p.m., 1.50-5.05 p.m. and 7.50 p.m.-2.50 a.m.

New Iquitos stations

THE Peruvian city of Iquitos has been heard with two new stations in the 31-metre band during the afternoons. Radio Atlantida, which has the call sign of OAX8K, operates on 9625 Kc, and has been heard to closing at 3.00 p.m., with some interference from nearby stations. The station has at times remained on the air as late as 3.30 p.m., and a report to the station has resulted in one listener receiving a verification in less than a month.

The station is located at S. Martin 125 in Iquitos, Peru. Broadcasts from Radio Larica have been heard on 9595 Kc, from after 2.00 p.m. to closing at 2.35 p.m. The station suffers interference from Hilersum on 9590 to 2.00 p.m., after which it is heard clearly, with broadcasts also radiated from Iquitos.

ZYR on 9635Kc

THE number of signals from Brazil are such that a month hardly goes past without the hearing of a new call.

ZYR83, which operates on 9635 Kc, is a little away from the usual stations, as this one broadcasts religious programs. The station opens at 8.00 p.m., giving the call and location. Then follows the playing of "Ave Maria" and for the next 15 minutes a religious program is presented. The session is closed with the same theme music and at 8.15 p.m., after further identification, the station commencies its normal musical program.

ZYR83 uses the slogan Radio Aparecida and broadcasts rom this city in Brazil. The mailing address is Praca N.S. Aparecida, No. 315, Aparacida.

The signal is strong to 8.20 p.m. at which time the Seoul station on 9640 Kc commences broadcasting and this severely interferes with the Brazilian station.

Cotonou on 4900Kc

THE recent change of frequency of Radio Cononou in Dahomey, French West Africa, from 4870 to 4900 Kc, has resulted in improved reception. The station, which opens with the French Anthem usually, is received at fair strength. Some Morse interference from Radio Ghana on nearby 4910 Kc causes some trouble. Radio Cotonou uses 4,000 watts and can also be heard in the morning transmission. The full schedule is 3.45 to 6.00 p.m., 9.15 to 10.15 p.m. and 4.00 to 8.45 a.m. The station director is M. Rene Weill, and the address is Radio Cotonou at Cotonou in Dahomey, French West Africa.

TOKYO, in its transmission to India, Pakistan, and Ceylon, is using the new frequency of 11780 Kc, and this transmission is well received on this frequency. The transmission, which opens at 1.30 a.m., has the usual identification, and after broadcasts to India reverts to English at 1.45 a.m. The call sign of JOA25 is assigned to this frequency, and JOB21 in the same program uses 15325 Kc.

FEBC to 50 Kw

THE Far East Broadcasting Company in Manila is at present working on the installation of a new 50 Kw transmitter, reports Australian Norman Blake, who is electronic co-ordinator at FEBC.

The new installations are at Bocaue, the site of the antenna farm and new transmitter buildings.

The new antenna towers of 400ft will be erected before June, when the rainy season commences. Four of the towers are in place and work is proceeding on the guying of the masts. Work on the concrete base and guy bases is proceeding, and when the foundations are completed five more masts will be erected.

The antenna systems will be rigged later this year. They will be single and double extended lazy "H" types. Some have reflectors for one-way transmission, and others have no reflectors to allow bi-directional transmission.

This year only the beams on North-South and West will be finished, and later North-West and South-East curtains will be put into action.

Transmission lines of some 12,000ft will carry the signal from the transmitters. The 2 Kw and 10 Kw transmitters at present in use will be moved in early 1959 to this site and will be used alternatively with the 50 Kw station. When finished there will be two programs broadcast at one time. Two different areas, and larger blocks of time, will be in a single language. More English will be used for the increased schedule to provide alternate listening.

The new 100 Kw transmitter for Okinawa has not yet been commenced as the design of the building is not yet completed. This station will not be commenced until 1959, and, like the Manila station, will be devoted to Gospel broadcasting.

NOTES from readers should be sent to ARTHUR CUSHEN, 212 Earn Street, Invercargill, N.Z. All times are Eastern Australian.

AUSTRALIAN DXERS CALLING

THE popular session of dx tips from Radio Australia in Melbourne is on its winter schedule, and the session can be heard as follows:

SUNDAY 5.15 p.m. on 11710 Kc for New Zealand-Europe. 11.30 p.m. for North America, East Coast.

MONDAY 2.00 a.m. on 11810 Kc North America, West Coast. Also to Asia on 11710, 9580, 7220.

SUNDAY 3.30 p.m. on 15200 Kc to South Africa.

SUNDAY 8.00 a.m. on 15240 Kc to North Pacific Islands.

FLASHES FROM EVERYWHERE

CANADIAN station CKUS has been reported by Kevin Dunham, of Narrandera, N.S.W., on 15105 Kc, with transmissions to the Caribbean. CKUS is tuned when commencing transmission at 7.45 a.m. The station identifies in English and French. Programs in French follow to 8.05 a.m., when the program reverts to English. The frequency is subject to some interference from nearby stations, with the B.B.C. on 15110 Kc and Lisbon on 15100 Kc, being the main signals which cause the interference. Montreal program is also heard on CKNC on 17820 Kc, which broadcasts the same program.

MEXICAN station XEXF, broadcasting from Leon, has been heard at fair signal level to sign off at 4.00 p.m. on 9535 Kc. The station relays the programs of Radiodifusora Mexico XEX, and, when closing, used the tune "Over the Waves" as the theme.

The station is best heard from 3.00 p.m. to shortly before 4.00 p.m. on Sunday, when the frequency is clear, of Berne, Switzerland, which is using this frequency before and after these times.

BRAZILIAN ZYZ8, with broadcasts from Rio de Janeiro, transmits throughout the night on Sunday, and is heard in this area at 4.00 p.m. ZYZ8 operates on 9610 Kc, and was formerly ZYC8. The station suffers from side interference from Tangier-9 operating on 9615 Kc. Popular music is featured in the program, and the slogan Radio Tamanio is frequently given.

DJAKARTA has recently been observed in its transmission to Australia and New Zealand on the new frequency of 11720 Kc, which is in chain with the outlet on 9710 Kc. In the past the Indonesian station has used the additional frequency of 4910 at 9.00 p.m. in the English broadcast to this area, but this has not been a successful channel, because of the interference from the Brisbane station on 4920 Kc. The new 11720 Kc transmissions are subjected to interference from the Singapore relay station of the B.B.C., as the British Far Eastern station is at present using 11725 Kc at this hour.

VATICAN has put into service two new 16-metre frequencies, according to a Californian report. The new channels are heard on 17760 and 17735 Kc, and give good results at 4.00 a.m.

NIGER, which has recently been reported as installing a new 4000-watt transmitter, is now expected to put this station into operation in September, and to use the frequency of 5020 Kc. It is expected that preliminary tests will be conducted before this date, when the station will be the new radio voice of this area of French West Africa.

Radio Naime will be put into service with a schedule which at the present is being ascertained with tests to find the best listening times for the population.

CANADIAN station VE9AI, broadcasting from Edmonton in Alberta, has again made its appearance in the late evenings. Last winter the station, which operates on 9540 Kc, was verified, and the power of the transmitter was given as 20 watts. Reception is again good from opening at 11.00 p.m. This commercial broadcaster is usually received at fair readability, when relaying the breakfast session of its medium wave relay CJCA.

ARGENTINE is the location of LRY Radio Belgrano, which opens at 7.45 p.m. on 9760 Kc. The Buenos Aires station has typical Latin music and frequent commercial announcements. At 8.00 p.m. a further station in this city, LRS2 Radio Splendid, on 5985 Kc, also opens transmission.

BAGDAD is reported from Europe as giving good signals on 6188 Kc, and 7180 Kc, with an extended schedule to 11.00 a.m. The station is further reported in the afternoons on 7055 Kc, from opening at 2.30 p.m. Broadcasts are on new high powered transmitter of Radio Bagdad located in the Irak capital.

VATICAN Radio, with broadcasts directed to Brazil on 17840 and 11685 Kc, have been heard in Europe from 9.00 a.m. It has also been reported that tests on 9646 Kc from 10.30 a.m. has also provided good signals, states a Danish listener.

NORWAY is using two very low-powered transmitters in experimental broadcasts on 25900 and 6130 Kc. A verification for a report on the signals of LLA, when using the 13-metre frequency, states the transmission is experimental and that only 100 watts is used on the frequency, all other frequencies on the air at that hour using 100,000-watt transmitters. A letter from the station also discloses that it operates on 30 watts on 6130 Kc, also on an experimental basis, except for the period 11.00 p.m. to 1.00 a.m., when higher power is fed on to this frequency.

THE HAM BANDS WITH BILL MOORE

The Radio Amateur Population of the world is growing steadily and from figures available some countries show high yearly increases. The annual influx of new amateurs in the U.S.A. is estimated to be 12,000 due in some degree to the classes conducted by commercial organisations free of charge.

INSTRUCTION carried out by radio clubs and societies is the usual method by which intending amateurs acquire the know-how to obtain a licence. At times individual amateurs provide the required guidance.

An outstanding feature of the tremendous growth in the radio amateur population in the U.S. is the contribution of a large number of commercial radio firms who provide facilities for instruction.

These courses, especially for the beginner, are often run in the lunch hour or after normal business hours. Novice licences are reasonably easily obtained and instruction is generally directed along these lines.

However, a number of firms provide general class licence examination instruction. Some typical examples of the facilities available are as follow:

The Fort Orange Radio Distributing Co. conducts two courses of 10 weeks' duration each year.

Over 300 novices, ages running from eight years to 80, have acquired their licences as a result of this instruction.

Two 14-week courses are run every 12 months by the Allied Radio Corporation. Approximately 150 members are in each class; 75 per cent complete the course and 95 per cent of these are successful in the examination. The company supplies the A.R.R.L. Licence Manual and a Code Booklet free of charge to all students.

One radio retailing firm in Memphis has a "drop-in" code practice service. Anyone interested in obtaining code practice can call in during business hours. Practice receiving is available from novice or advance speed tapes and a key and oscillator is on hand for sending practice.

An eight-lesson weekly course, aimed at the Novice Licence, is conducted during the evenings.

World Radio Laboratories go even further with their training scheme and co-operate with local adult education programs.

They invite youth groups, such as the Boy Scouts and Y.M.C.A. members, to participate in the 10 classes they hold each year.

Classes conducted by the Valley Electronics Supply Co., California, over three years, have seen 780 of their students become novice licencees. In view of these and many other contributions it is no wonder the American amateur population is growing apace.

Similar facilities could be provided by radio firms in this country.

Commercial organisations find that employees in the radio field who are enthusiastic amateurs take a keener interest in their work. Organisations willing to assist would be performing a public service and could also gain some advantage from such a scheme.

Praise for amateurs

PRESS cables received in Sydney early in May praised the work of Australian radio amateurs for their co-operation in observing signals from the American satellites during their orbits over Australia.

Australian moon-watching teams were also praised in a release that covered technical data on the operating of satellites Alpha, Beta and Gamma. The Americans anticipate launching a satellite each month after the completion of the I.G.Y.

The observing team, VK2WH, VK2DR and VK2ANF, are still checking a number of orbits each day with Alpha appearing in the morning, Gamma in the evening, and Beta around midnight.

The question of power

WILFRED HILL, ex-G5WI, now a resident of the West Coast of U.S.A., from experience gives an interesting review of QRO and its problems in a letter to the R.S.G.B. Bulletin.

The subject of QRO in countries only permitting low power operation is often debated. Many radio amateurs in these countries vigorously support the granting of higher power. To offset this fact, a number of W stations would like to see a reduction of the 1 Kw power permitted in the U.S.A.

Wilfred makes the following points against high power for amateur operation:—

The chaos caused on amateur bands by the use (and misuse) of QRO facilities must be heard to be believed. 1 Kw transmitters will block the most modern and selective receiver over considerable distances.

The conditions caused by power-happy operators striving for supremacy chasing rare DX and so carving channels in the HF bands are fantastic.

The bedlam caused by teenage operators with QRO facilities and the selfish use of 1 Kw transmitters to yarn across the town are additional features that must turn serious-minded operators away from QRO.

He also states the 1 Kw licensed input is at times exceeded by a few of the irresponsible licencees, causing even greater QRM problems.

Wilfred expressed the view that many amateurs of good standing are in favour of an all-round reduction in maximum power.

They consider that the maximum input permitted should be around the 250-watt level and that power requirements be strictly policed.

The QRP versus QRO argument will always be with us while ever amateurs have sufficient interest in the movement to foster debate.

Amateur conferences W.I.A. news

AS a forerunner to the I.T.U. conference to be held next year, National Amateur Radio Societies in Europe will hold a Region 1 I.A.R.U. conference in July in Germany.

Already most national societies have been in contact with their own licensing authorities and propounded their views on amateur frequency allocations.

The conference in Germany will provide an opportunity to compare the reception received to their suggestions. Societies will be able to prepare a specific plan of action for Region 1 representatives at Geneva.

The prospects of retaining frequencies at Geneva are being discussed at length by amateurs throughout the world. Most nations have been working on their frequency allocation plans for submission at Geneva and some 80 different countries will be represented at the conference.

Currently there is plenty of gloom being spread on amateur bands concerning our prospects of retaining amateur frequency allocations. It is all rather premature: as far as is known no nation has formulated concrete proposals.

The A.R.R.L. paints a brighter picture when they state they think the eventual U.S. proposals for the conference will be pretty fair to amateur radio. The league has been participating in the discussions to date.

The U.S.A. and British Commonwealth nations from past experience at I.T.U. conferences have proved to be the most ardent supporters of amateur radio.

Frequency planning

A GOVERNMENT committee for frequency planning has been set up in the U.K. by the G.P.O.

Terms of reference are as follow:—"To advise the Postmaster-General on the broad aspects of radio frequency planning with a view to the efficient use of the radio frequency spectrum and economic development of equipment for that purpose by the radio industry."

The members of the committee represent the radio industry, user organisations and Government departments.

John Clarricoats, G6CL, secretary of the Radio Society of Great Britain, will be acting for amateur radio on the committee.

RECORD MEMBERSHIP IN N.S.W. DIVISION

THE outstanding feature of N.S.W. Division's April general meeting was the fact that 49 new members were elected, an all-time high in the history of the division. The membership now totals 882.

Lecturer at the meeting was Ken Pincott, VK3AFJ, Technical Editor of "Amateur Radio." Ken described the problems of the Magazine Committee, an entirely voluntary body.

He offered valuable information on how amateurs could assist their magazine.

Members also offered suggestions that Ken promised he would relay to Melbourne.

Recent elections held in N.S.W. saw the following W.I.A. members elected to official positions.

New president of the N.S.W. VHF and TV section is Jim Cummings, VK2PM, while the past president, Bob Winch, VK2OA, is now vice-president. Secretary Les Cook, VK2ZAQ, and the committee members comprise Dave Andrews, VK2AWZ, Allan Hennesey, VK2ZAL, and Jim Webster, VK2ZCW.

The inaugural meeting of the S.W.L. section, N.S.W. Division, elected the following officers: President, Mr B. J. Smyth, of Strathfield; vice-presidents, Mr J. H. Dawson and Mr R. Luther. Secretary, Mr B. Cartwright; assistant-secretary, Mr Forman; QSL officer, Mr D. O'Dea.

At the meeting 25 N.S.W. W.I.A. numbers were issued and country members can obtain such numbers by writing direct to the secretary, W.I.A., N.S.W. Division, Box 1734, G.P.O., Sydney.

Country SWLs can obtain official numbers by first joining the division. Associate membership is available to listeners at a cost of 25/- and on being elected to membership in the division, numbers will be issued. Write the secretary at the above address.

Incoming and outgoing cards will be handled by a listener's QSL bureau in the same manner as the State bureau. David O'Dea, the section's QSL bureau, will be responsible for its operation.

First 50 Mc W.A.C. award was finally presented to Paul Boberg, W6BAZ. The six confirmations submitted all showed S9 signal reports—you could not better that on any band.

The special trophy (see May issue) for the first accomplished W.A.C. on 50 Mcs was won as anticipated by K6GDI, who finally resolved his QSL problems.

Quite a number of special 50 Mc W.A.C. certificates have now been granted to stations in W6, W9 and W zero.

These 50 Mc W.A.C.s would not have become a reality had not several European countries permitted their amateurs to operate on the band during the I.G.Y.

In view of the excellent work performed on 50 Mcs, and that next year might even provide better VHF propagation conditions, moves will possibly be made to ask for the use of the 50 Mc band until these frequencies are required for TV transmissions.

After the excitement of February and March, April was rather quiet on the 50 Mc band.

Record sunspot activity

IN the year 1957 sunspot activity was the highest ever recorded since data gathering was first commenced in 1778.

At the beginning of this year the level was so high it was thought the peak had been reached but the count is still rising. The peak, however, cannot be far away.

The next two years should see extremely high levels of sunspot activity with propagation conditions excellent on all the HF and lower VHF bands.

During 1957 sunspots were of sufficient magnitude to affect radio communication on nearly 60 occasions, 21 of these causing major disturbances. Most of the latter occurred during June and September, a period when shortwave communication was particularly unreliable.

May and June are predicted to see the MUF well down in South-Eastern Australia and it is hoped that paths are available to areas enjoying similar conditions.

It is their hope that some of the VK2/VK3 VHF enthusiasts may emulate the feats of the VK4s earlier this year on the 50 Mcs. So far in this DX working session stations in South-Eastern Australia have only worked with JAs. They have spent many hours listening and deserve some reward for their patience.

Lecturer at the May meeting of the N.S.W. VHF section was President Jim Cummings, VK2PM, who lectured on map and compass. In view of the regular field events that are conducted, a very important subject. Jim is well versed in such matters.

A.R.R.L. Century Club

THE big phone boys have nearly reached the tallies of their CW colleagues in the A.R.R.L.'s DX Century Club. They have rapidly overhauled the CW gang in the past three years. In 1955 they were 19 countries behind; now it is only six countries. Chas. Mellon, W1FH, and Don Wallace, W6AM, are still the CW leaders with 275 countries confirmed, while Brazilian PY2CK has 269 recognised for telephony operation.

Jock White, ZL2GX, is still the leader around these parts with 268 confirmed on CW.

To stop at the top of the A.R.R.L.'s DXCC honour roll station set-ups are invariably quite complex. Many country broadcasting stations would be pleased to own such equipment.

W6AM, for instance, has six 1 Kw RF units singly connected to a common power supply and modulator. Don's antenna farm with its Rhombies and Yagi arrays is well known.

More activity is expected from the VP8 area during the winter; amateurs are generally busy on routine jobs during the long summer days. Stations likely to be operating include VP8CZ and VP8CT, South Shetlands, VP8AY and VP8BC, South Georgia. Main band in use is 14 Mcs.

The CMs and COs will be missing from the air for a period. In late April they were ordered to turn in their equipment for the duration of the Civil War. There have been various uprisings on the island in recent years, but it is the first time since World War II that amateurs have had to surrender their transmitting gear.

A new award

A NEW award, "The Award Hunters' Club," is now available to enthusiasts collecting the various operating certificates. It will be presented to holders of 25 awards or more with special endorsements for greater numbers. The full details may be obtained from the honorary secretary, V. J. Velamo (OH2YV), Isokaari, 4-B-30, Lauttasaari, Helsinki, Finland.

The R.S.G.B. QSL Bureau now handles in excess of 2,000,000 cards per year. It would appear that nearly 40 per cent of these will never be collected.

The W.I.A. QSL Bureaus provide one of the best services in the world. In few countries are cards sent out regularly to national society members or are available at meetings. Most overseas bureaus require that a stamped and addressed envelope be made available for the returns of QSLs.

Aerial structures

RADIO amateur aerial masts and towers and their erection in thickly populated areas are often in the news. Considerable opposition to tower erection has been offered by local municipal authorities on many occasions. The latest case, in Leicestershire, England, concerns the erection of two simple 40-foot poles and local authorities have banned their erection. The matter is subject to an appeal.

The R.S.G.B. has arranged and will pay for legal representation for the amateur concerned to ensure efficient handling of such an important case (the solicitor acting is also an amateur). A decision against the erection of simple poles could have wide effects on amateur radio activity. It would create a precedent that could be used in other appeal courts.

Tape clubs

TAPE clubs are becoming popular overseas; there are at least five in the U.S.A. One can at least yarn to one's friends by just recording 40 minutes of rag chew and receive an answer of similar duration with no QRM TVI or BCI and in privacy. A number of amateurs are exchanging tapes these days.

On joining a club a new member receives a list of other members together with their addresses and interests.

You can then select the person you would like to talk to and mail away your tape.

The friendships of these ventures are akin to those in amateur radio. No need to stop up late for a schedule, just record your reactions at your leisure. Blind persons are obtaining a great deal of pleasure from membership in these "Tape" clubs.

High-power mobile operation is receiving much support in the U.S. W9JCI, 50 Mc, activity is worth reporting; he runs no fewer than 500 watts on that band from his mobile transmitter. Using a two-element beam, he has contacted stations 75 miles away, while mobile, and 300 miles, while stationary. The modulator uses class B 811As, and two 4X150As are the final tubes —the vehicle an old hearse.

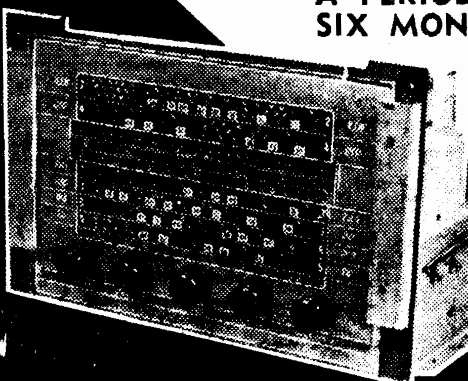
before purchasing your radio see our—

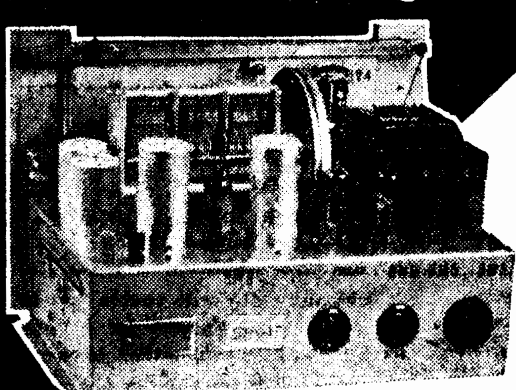
Hi-Fidelity

RANGE

and compare these NEW features..

ALL CHASSIS GUARANTEED FOR A PERIOD OF SIX MONTHS





NEW:

Ultramodern circuit using nine high gain valves including "magic eye" tuning indicator. Permatuned iron cored coils and intermediates giving excellent interstate reception and a short wave range of 12,000 miles. All valves used are the new Mullard nine pin Innoval series.

NEW:

Tone control and audio stages incorporating the Mullard 5/10 amplifier circuit with separate bass and treble controls giving plus or — 15 db. boost or cut at 50 cycles L.F. and 10,000 H.F., combined with push-pull output with inverse feed-back gives you really high fidelity reproduction from your radio or favourite recordings.

NEW:

Dual Speaker combination, using a heavy duty woofer (12in M.S.P. Jensen AU54 special) with matching 6in tweeter and cross-over network giving a frequency response of 46 to 13,000 cycles. Speakers are mounted coaxially making only one 11in mounting hole necessary.

NEW:

If required the new Magnavox high-fidelity twin coned speaker can be supplied. Large calibrated edge-lit dial in plate glass (11in x 7in) with main stations of each State in prominent type. Dial fitted with counterweight drive, giving smooth tuning. Indicator lights are fitted showing which band is in operation. Dial can be supplied in cream, black or brown with matching knobs and escutcheon to suit contemporary blond or walnut finished cabinets.

NEW:

Sensitive "magic eye" tuning indicator (EM80) making tuning simple and positive even on interstate, overseas and country stations.
All chassis are wired for the fitting of an F.M. tuner or tape recorder, special plug being provided on back of chassis, also pick-up terminals and outlet for gramo motor.
Power switch is fitted to volume control, radiogram switch, combined with wave change switch. Audio end of set can be used with TV receiver if required.

A NINE VALVE HIGH-FIDELITY RADIOGRAM CHASSIS

Nine and ten valve chassis incorporate the Mullard 5-10 AMPLIFIER CIRCUIT Frequency response 40-13,000 cycles. Max. output 10 watts.

£41/15/0 F.O.R.

NEW SEVEN-VALVE HI-FI CHASSIS

This new compact dual wave seven-valve chassis uses the same tuner circuit as our 9-valve unit with the Mullard tone-control circuit giving separate bass and treble controls. Push-pull output using two of the new 6BM8 dual purpose output valves and heavy duty M.S.P. speaker

£31/15/- F.O.R. PACKING 10/ EXTRA.

Also available with Magnavox 12W.R. Hi-Fi speaker and Ferguson output transformer at £4/15/ extra.

A NEW 10 VALVE DUAL WAVE RADIOGRAM CHASSIS

WITH BASS AND TREBLE BOOST

The ideal chassis for those difficult locations where reception is doubtful. Specifications are nine valve unit, but with the addition of high gain tuned R.F. stage giving greater sensitivity and selectivity on both broadcast and short wave bands.

£44/15/0 F.O.R.

Write for full specifications

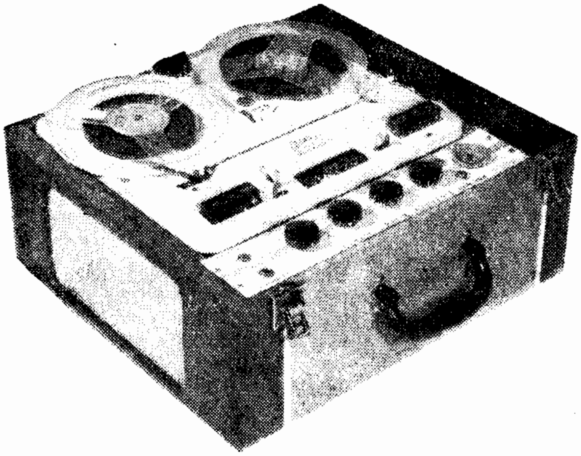
ALL 4 SPEED RECORD CHANGERS AND PLAYERS STOCKED

Classic Radio

245 PARRAMATTA ROAD, HABERFIELD, N.S.W. PHONE UA2145

Buying a Tape Recorder?

First see and hear the new Hi-Fi Recorder by Classic incorporating the new Collaro Mark 111 Transcription deck. The only deck with ALL these features.



THE COMPLETE UNIT IS SUPPLIED IN ATTRACTIVE AND DURABLE TWO-TONE PLASTIC COVERED CASE COMPLETE WITH ACOS MICROPHONE

The six-valve amplifier incorporates the latest "Mullard' tape recorder circuit equalised to C.C.R. standards giving perfect reproduction from recorded tapes. Record monitoring and outlet to power amplifier. Extension speaker outlet and "magic eye" level indicator Amplifier is completely shielded and fitted with perspex dress plate to match deck.

- **HIGH FIDELITY**
Heads are double coil wound and will reproduce up to 12,000 c.p.s. at 7½ inches per second. Azimuth adjustments on both impedance "record" and "playback" heads. Output of heads is approximately 5 milli-volts at 1 Kc at 7½ inches per second.
- **INSTANTLY REVERSIBLE**
Instantaneous changes can be made from one track to the other. Fast rewind in either direction.
- **CONSTANT TAPE TENSION**
A special Collaro device ensures a constant tension on the tape on the take-up spool as it leaves the capstan.
- **FULLY MECHANICAL**
No solenoids are used in the construction of this Transcriptor The braking is entirely mechanical.
- **FINISH**
Cream Polystrene cover plate with maroon controls.
- **THREE SPEEDS**
3¾, 7½ and 15 inches per second.
- **FOR HEADS**
Two "Record/Play-back" and two "Erase" heads are sited on two different levels and head wear thus halves for any given length of track.
- **TWIN TRACK OPERATION**
One pair of heads for each track. Both top and bottom tracks can be recorded or played back without removing tape.
- **PAUSE CONTROL**
This has the effect of stopping the transit of the tape past the "Record/Playback" and "Erase" heads and applying the brakes to the spools while leaving all switches and mechanical functions in their selected positions. Typical application is to pause whilst recording to omit speech interposed between musical selections. Control will only work whilst it is held in position.
- **TAPE MEASURING & CALIBRATING DEVICE**
The three digit counter makes the location of any recorded passage the simplest of operations.
- **TRANSCRIPTION TECHNIQUE**
A large diameter flywheel with ground and lapped steel shaft running on a ball at the bottom of long bearing reduces friction and virtually eliminates "wow" and flutter to less than 0.15 of 1.0 per cent.
- **TWO MOTORS**
Each dynamically balanced motor does only one job at a time. Motors never act against each other and are of low wattage input with consequent reduction in heat and wear

COMPLETE RECORDER WITH MIKE—80 GNS. f.o.r.

DECK WITH AMPLIFIER, POWER SUPPLY & 6in x 9in SPEAKER 70 GNS.

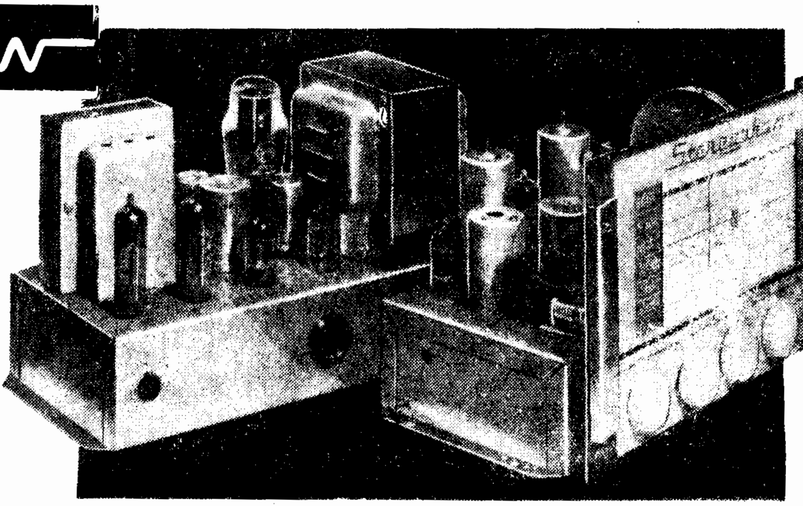
Stereophon

—LIVING SOUND—

A compact 11-Valve High-grade Radiogram in two chassis featuring a variable band-width Tuner, multi-input preamplifier and Tone Control in one unit and a 10-Watt Ultra-linear Amplifier. Ideally suited for use with High-grade pick-ups and speakers.

65 GNS.

F.O.R.



Classic Radio

245 PARRAMATTA ROAD, HABERFIELD, N.S.W. PHONE UA2145

THE PUBLIC SERVICE OF

PAPUA AND NEW GUINEA

VACANCIES

DEPARTMENT OF POSTS AND TELEGRAPHS

RADIO INSPECTOR, GRADE III — **£1,693-1,873 p.a**

Qualifications: First-class P.M.G. Commercial Operator's Certificate of Proficiency or equivalent; wide experience interference suppression investigation, conducting of P.M.G. type wireless examinations, telecommunications procedures and staff management.

Duties: Responsible for the efficient functioning of Radio Inspection and Operating Section.

Accommodation: Married or single available.

Location: Port Moresby, but frequent inspection zone centres required.

SENIOR TECHNICIAN (RADIO). — **£1,258-1,318 p.a.**

Qualifications: Qualified as P.M.G. Senior Technician (Radio) or equivalent; H.F. and V.H.F. experience; supervisory ability.

Duties: In charge zone transmitting and receiving stations (transmitters 500 W power); V.H.F. M.F./H.F., C.W. and radio-telephone trunk and out-station services.

TECHNICIAN (RADIO) — **£1,088-1,198 p.a.**

Qualifications: Qualified as P.M.G. Technician (Radio) or equivalent; H.F. and V.H.F. experience.

Duties: Assist in maintenance and operation zone and out-station radio equipment.

GENERAL INFORMATION

Salary: Rates quoted are actual for unmarried appointees and include allowances and adjustments. Married officers receive a further £125 p.a.
Additional Territorial Allowance of £25 p.a. after 5 years' service and a further £25 p.a. after 7 years' service is also payable.

Eligibility: Adult male British subjects under 45 years of age.

Appointment: Permanent subject to satisfactory probationary period.

Location: Appointees are required to serve anywhere in the Territory.

Accommodation: Except for Radio Inspector single quarters only available. Married accommodation not available under 18 months from date of appointment.

Separation Allowance: Payable at discretion of Territory Administration; designed to compensate for added expense of married appointees obliged to maintain family outside Territory.

Leave: Three months after 21 months in Territory. Additional three months' leave after each six years' service and six months' furlough after 20 years' service.

Taxation: Income derived by residents of Territory from sources within the Territory is not at present taxable under Commonwealth legislation.

Further Information: An information handbook on the Public Service of the Territory is available from the Department of Territories, Canberra, or Sydney, or from any Commonwealth Public Service Inspector, Commonwealth Employment Office or official country Post Office. Other enquiries to Department of Territories, Canberra ('phone U0411, extension 29A).

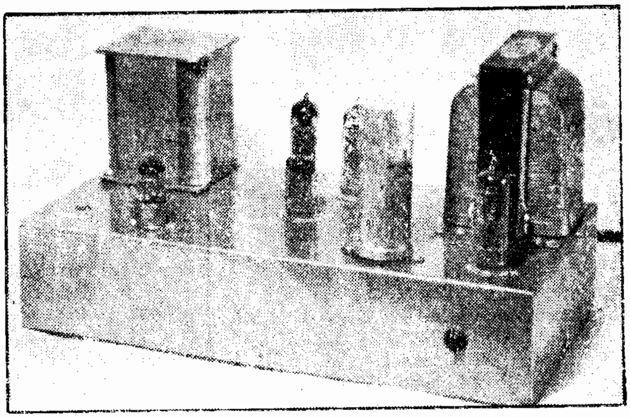
Applications: Submit on prescribed form available from offices mentioned under "Further Information":—

To the Secretary, Department of Territories, Canberra, by 14th June, 1958.

TRADE REVIEWS AND RELEASES

NEW A. & R. AMPLIFIER USES C-CORE TRANSFORMER

The first grain oriented output transformers produced for sale in Australia are being made by the A & R company in Melbourne. We have received a sample for test wired into a Mullard 5/10 amplifier, and expect to find some available soon for Playmaster circuits.



☆

The amplifier chassis measures 14 x 7 inches. The new grain - orientated output transformer is on the left.

THE amplifier gave a most impressive performance, largely reflected from the quality of the transformer.

In this circuit its main resonance is pronounced but occurs virtually at one spot, so that, when compensated for in the plate circuit of the first valve, ringing and overshoot are almost completely suppressed.

There is no compensation across the feedback resistor, which may account for the remarkably good stability, even with appreciable capacitive loading, despite a feedback of 25 db.

The power response was again very good, virtually full output being obtained from 25 cycles to well beyond audibility.

Frequency response was flat to 50 Kc at which spot it dropped 1 db. The 3 db point occurred at about 90 Kc, 6 db at 130 Kc and 12 db at 200 Kc. This is a very nice, safe roll-off, and indicates sound design.

The amplifier shown here is built round the A and R kit set which includes the transformers and basic chassis. It is intended to be used with a separate tone control unit as designed for the 5/10.

The output transformer is no smaller than the standard types, as it uses the same case, but it is obvious that the grain orientation has allowed better characteristics.

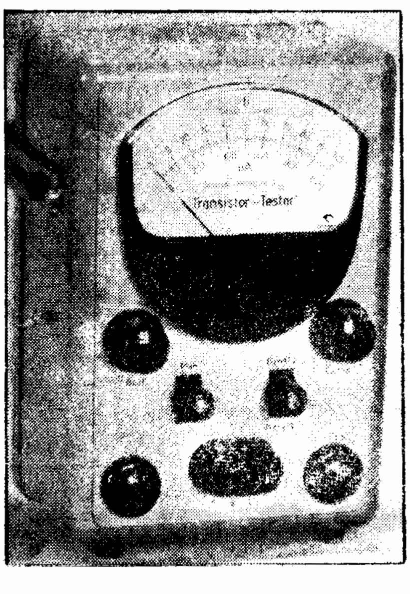
We are most impressed by the performance of this new line.

Transistor Tester is compact and efficient

With local manufacture of transistors already under way, we can expect to find them used extensively from now on. The problem of providing a simple means for testing transistors now arises.

POSSIBLY the only means of testing a transistor for all important characteristics is by means of a dynamic curve tracer.

However, the average constructor is more interested in an instrument which is capable of giving a quick check. The Gossen transistor tester is such an instrument.



A particularly valuable feature is the special socket which permits new transistors with long leads to be connected in an instant. However, the omission of a simple means of connecting transistors with short leads is to be regretted.

Either PNP or NPN transistors are connected in the common emitter circuit and the current gain and standing collector measured. Current amplification factors up to 200 are measurable in two ranges while the standing collector current is measured on a 1mA scale.

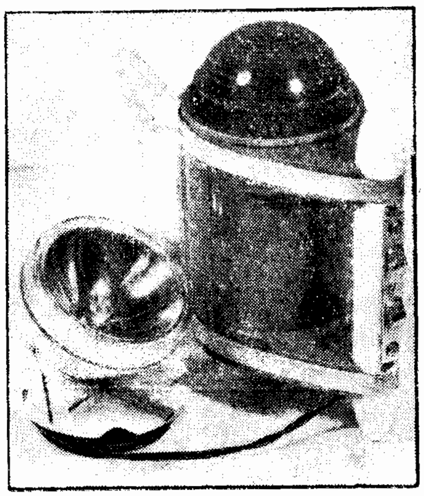
The main limitation of the instrument, in common with all other relatively simple testers, is that it checks the current amplification factor at one point only.

At the same time we found the instrument extremely useful during the period it was made available to us for sorting out damaged transistors and obviously out-of-balance pairs.

The price is £30 plus sales-tax where applicable. Further information is available from Jacoby, Mitchell and Co. P/L., 469 Kent Street, Sydney.

MANLEY SAFETY "FLASH-R-LAMP"

Marketed under the name Manley "Flash-R-Lamp", a new release from Amplion (A'sia) Pty. Ltd. is designed particularly to remove the hazard from night breakdowns on the road.



IN its assembled form, the lamp can be used as a portable, completely self-contained electric lantern, providing a powerful white forward beam with signalling facility and a red rear light with automatic blinker operation.

It can be carried or rested in a horizontal or vertical position, is completely waterproof and will, in fact, operate completely submerged.

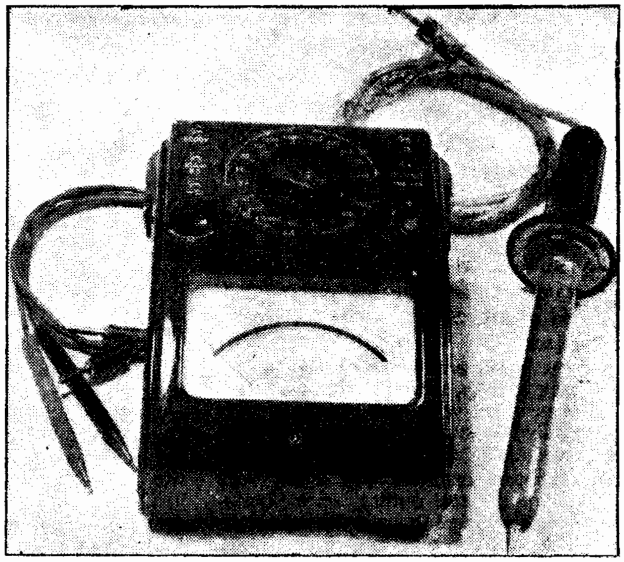
A valuable feature is that the white lamp can be detached and used as a trouble light at the end of a cord, leaving the red flasher on the road as a warning.

The Flash-R-Lamp, is attractively finished and is completely unbreakable, showing no reaction even to deliberately being tossed on to a cement floor. (Amplion A/sia Pty. Ltd., 101 Pyrmont Bridge Road, Camperdown, N.S.W.)

French Multimeter is Easy to Use

Not having had an opportunity to handle French test equipment before, we were agreeably surprised at the quality and general finish of the "Metrix" Mod. 430 multi-range meter recently forwarded to us for review by Electronic Industries Imports Pty. Ltd. of 718 Parramatta Rd., Leichhardt, N.S.W.

THE instrument is based on a 0 to 50 uA meter and provides AC and DC ranges up to 5,000 volts internally and up to 30,000 volts by means of the external probe shown in the photograph. The accuracy is given by the manufacturers as 1.5 p.c. of FSD up to 1,000V on the DC ranges. The accuracies cannot be expected to be as good on the AC and higher voltage ranges but at the same time will be found to be better than required for most service work.



A built-in series capacitor permits the use of the AC ranges for measuring output voltages as required in receiver alignment while DC current ranges and resistance ranges are also included. The highest of the latter is capable of giving an indication on 20 megohms.

For general bench use, one of the most valuable features of the instrument is the overload protection system. The manufacturers describe the device as a magnetic circuit breaker. While we are not familiar with the method of operation of the device we found that it was most efficient in practice, reacting immediately and without damage to the meter in the case of deliberate heavy overloads. In most cases the meter pointer only moved a fraction of full scale and it would appear that the meter movement is virtually indestructible by wrong setting of the selector switch.

The meter is fitted with a knife edge pointer and an anti-parallax mirror to assist in making readings with good accuracy. The layout of the scales in three colours and the large clear range selecting knob make the instrument a pleasure to use on the bench.

The price is £29/10/. for the meter plus £8/15/- for the 30 KV probe where required. Both prices plus tax.

USEFUL DB CALCULATOR FROM RADIOTRON

A VERY useful Decibel Calculator is available free and post free from the Amalgamated Wireless Valve Co. Pty. Ltd., 47 York St., Sydney.

Called the "DB Rota-Guide," the calculator consists of two circular cards, held together at the centre by a tubular rivet. By rotating the front card so that an arrow points to any voltage gain figure between 1 and 1,000, the decibel figure can be read in a window.

Power ratios in DB are obtained by halving the above figure.

Despite its relative simplicity, the calculator appears to be quite accurate, and is a handy item to have on the bench.

WM. J. McLELLAN ADVERT.

OWING to a production error, the quantity details for R, TV and H "35-Watt P. A. Amplifier" were omitted from the advertisement for Wm. J. McLellan and Co. Pty Ltd. appearing in the April issue. This advertisement now appears correctly on page 74 of this issue.

BASE, COVER AND PLUG FOR EASY CONNECTION

TELEVISION receiver owners will appreciate a base, cover and plug which permit easy connection of the aerial when the receiver has to be moved either for dusting or repair.

The SA12 base is of cream polystrene and is intended to be secured to the wall with two countersunk wood screws. It has two moulded-in screw terminals to facilitate the connection of attenuator pads and a knock out section permits co-axial cable as well as 300 ohm lead-in connection in the case of multiple installations.

A mica filled phenolic plug with cream polythene cover complete the pair. These are designed specially to take standard 300 ohm ribbon and go under the type number TA12.

The retail prices are SA12, 4/7 and TA12 3/1. Further information from Wm. J. McLellan and Co., 126 Sussex Street, Sydney.

FUNDAMENTAL TRANSISTOR THEORY

(Continued from Page 91)

base is readily recognisable because it will always be shown as terminated by a straight line. The collector is the remaining line which does not have an arrow on it.

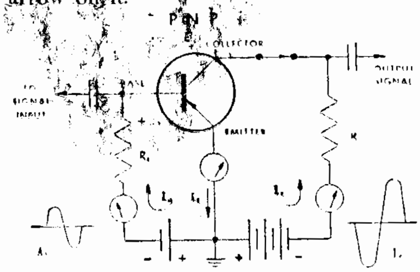


Figure 28—Common emitter circuit.

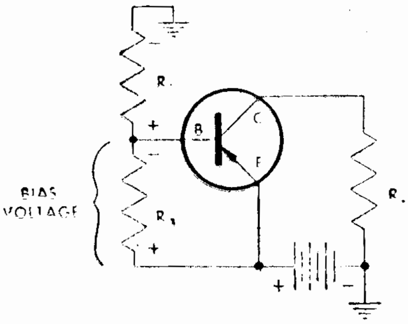


Figure 29—Biasing by voltage network.

To show the use of these symbols, Figure 28, you will notice we are using a P-N-P type transistor (the emitter arrow is pointing in toward the base). Again we have forward bias applied to the base emitter circuit by means of the small battery which causes a small amount of static base emitter current.

The collector circuit is biased in reverse since the negative electrode of the larger battery is connected to the positive or P-type collector. Here again, the signal being applied to the circuit is varying a small base emitter current and thereby varying the larger collector current. The current carriers leave the emitter, enter the base region, and at least 95 per cent of them enter into the collector.

Although we have until now always provided bias by means of two batteries, in Figure 28 we can bias a transistor circuit by means of a single battery and a voltage divider network. Notice that we accomplished a reverse bias on the collector by means of the negative terminal of the battery being connected to that collector. From the positive terminal of the battery to ground we find a two resistor series network.

With this arrangement there will always be some current flow through the two resistors and the voltage developed across the resistor R2 due to this current will be the bias voltage for the emitter base circuit. Since the voltage developed across this resistor will be negative on the base side and positive on the emitter side, this voltage will bias the base emitter circuit in the forward direction. Some circuits using transistors will also use the self-bias method which is a very common system used with vacuum tubes.

SCIENCE TODAY IS HELPING ARCHEOLOGY

(Continued from page 19)

ditch will, for instance, cause corn to grow taller and greener than elsewhere so that a line of corn of this nature viewed from the air will most certainly indicate a filled ditch. Buried walls or buildings will show up as an area of weaker growth of vegetation or grass because of the difference in moisture content in the shallow earth.

Dry weather is a time which suits the aerial photographer very well for moisture-starved grass growing in shallow ground over buried walls or old Roman roads will show up against the greener grass of the surrounding area.

Ditches which have been filled in over centuries show up darker against the background of undisturbed soil or gravel. This is particularly noticeable in England on chalky areas. Many Roman works have been found by this method.

AERIAL PHOTOGRAPHY

Another method of finding filled-in pits or ditches without the aid of aerial photography is the resistivity-surveying method.

This consists of measuring the difference between the electrical resistance of disturbed and undisturbed soil. Even when no visual trace above ground is evident this method will discover filled-in ditches.

Having found a site it is desirable that digging take place at a point where it was most densely occupied by the ancient inhabitant.

The procedure of "phosphate determination" does this for the archelogist. Rubbish deposited by settlement gives to the soil a higher content of phosphate than the surrounding area. Soil is taken from various parts of the site and analysed for phosphate content. That which contains the higher percentage of phosphate is almost certainly the part of the site which was more densely occupied. Excavation can then be carried out at that spot. Thus much time is saved by the excavator in searching for the most likely place in which to find relics.

SCIENTIFIC PROCEDURE

Modern excavation is a highly scientific procedure. All the haphazard digging of former years has gone and in its place is an army of geologists, surveyors, chemists, architects, physicists, builders, photographers and so on.

The site is surveyed and plotted. Marks for excavation are laid down. Digging is carried out in a highly organised fashion so that cave-ins of the earth are avoided. When anything is found it is photographed in situ. If it is fragile special methods are used either for hardening it before removal or lifting it with its surrounding soil.

Study is made of the layer of earth in which the relic is found and methods of dating it are used as described above. The modern archeologist and the modern detective now have much in common.

NEW VALVES AT BARGAIN PRICES

1T4	10/	1Q5G	5/	6U7G	6/6	KTW62/6U7	6/6
1S5	10/	1P5G	5/	6Y6GT	12/6	VR65A	2/6
3S4	10/	1C7G	5/	6X5GT	10/	CV6	3/6
3V4	12/6	1K5G	2/6	6J79	5/	36	7/6
1R5	12/6	6AC7	2/6	6U7G	5/	7193	3/6
1A7GT	9/6	6C8G	7/6	6J6	15/	954	4/6
1D8GT	9/6	6SS7	8/6	6F8G	10/6	955	10/
6A8G	10/6	6F6G	9/6	6A3	15/	12A6	10/
6K8G	9/6	6H6	2/6	7C7	3/6	EF50	2/6
6SJ7GT	9/6	6H6GT	1/6	7A6	3/6	110TH	£2/9/
6X5GT	10/	6J7G	7/6	78	7/6	811	£1
12K8	10/	6K7G	3/6	71A	7/6	866/866A	15/
12SK7	7/6	6K7GT	7/9	EL32	10/6	828	£1/9/
EK32	10/6					12SH7	5/
6SA7GT	9/6					12SL7	10/
830B	12/6					6K7G	4/6
6SH7	3/6					100TH	20/

Please add Postage on All Valves.
SPECIAL PRICES FOR QUANTITIES.

New Power Transformers

60mA prim.: 240v with 230v tapping, Sec. 285 x 285 with 6.3v filament winding 60mA.

27/6

Plus Postage: N.S.W., 3/6; INT., 5/3.

NEW 4in Per-Mag. Speakers

5T. or 7T. Trans., 30/-.

30/-

Post. and Packing, 3/6.

New Midget Power Trans.

40mA Prim. 250v Sec. 225 x 225 with 6.3v. Fil. Winding. Upright or Flat Mounting. Size 2in x 2½in.

25/-

2/6 Postage, N.S.W.; Interstate, 4/6.

30mA. 240v. Prim. 150 x 150v. Sec. with 6.3v. Fil. Winding.

22/6 **Postage, N.S.W., 2/6; Interstate, 3/6.**

BUILDING R. TV & H. TV SET

All Major Parts in stock, including R.C.S. IF Strips and Tuners, Valves, Power Transformers, Chassis, etc.

NEW DYNAMIC HEADPHONES

These headphones made by Rola are a high-quality unit giving excellent tone. Fitted with comfortable ear pads.

25/- **Post 4/6.**

New No. 7 HAND MICROPHONE

with Switch Dynamic Unit.

25/-, plus Post.

VALVE SPECIALS

20/- will purchase any one of the following Valve Specials.

5	1P5	3	6K8G
6	1C7	6	6SH7
5	1Q5	8	6AC7
12	1KS	5	6J7G
6	954	4	6U7G
6	6C8G	4	12A6
10	EF50	2	6X5GT
12	VR65A	7	6K7G

Post and Packing, 4/6 extra.
ALL VALVES ARE NEW.

NEW 6H6 OR 6H6GT VALVES

Individually Cartoned.

12 for 20/-

Post 2/6.

New Transmitting Valves

803	30/
100TH	£1
866	12/
811	15/
830B	12/6

New Micro-Ammeters

New Paton Micro-Ammeters

0-500 mA, 1¾in diameter. Flush mounting.

25/-

Post and Packing, 2/6.

CONDENSER SPECIAL

Boxes of 100 new mica paper and electrolytic condensers in values ranging from 50pf mica to .5 400v. paper. Values include .0001, .00025, .00075, .01, .02, .05, .1. Also 500 mfd/12v., 10 mfd/40v., 8 mfd/525v., 16 mfd/350v., electrolytics.

25/- **per 100.**

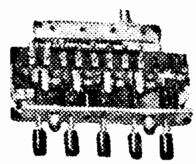
Post Extra: N.S.W., 2/6; Int., 3/6.

NEW VIBRATORS

A.W.A. Oak 6-volt Synchronous 7-pin base 6/6

A.W.A. 12 V Synchronous octal base. **7/6. Post 1/6.**

NEW PUSH BUTTON SWITCHES 20/-



Five pole push-button switches.

New control box fitted with above switch, also 5 bezels with globes and multi-contact by key switch.

Post: N.S.W. .. 2/-
Int. .. 3/-

NEW I.R.C. RESISTORS

I.R.C. carbon resistors, ½, 1 and 2 watt, in values 50 ohm, to 5 meg., including many popular sizes, 3T, 15T, 20T, 25T, 50T, 100T, 250T, 500T, etc. (Standard resistor colour code supplied)

100 for 25/-

(Plus 1/6 postage.)

New High Impedance Headphones

35/- **Post 1/6.**

Telephone Generators

New small telephone generators, ideal for bell ringing, etc.

10/6 **Postage 3/- extra.**

GERMANIUM DIODES

for that Crystal Set.

7/6. Post Free.

511A C.R. TUBES

These 12in tubes have been recommended for TV use in "Radio World." Uses same sockets as VCR97.

£4/17/6 **F.O.R.**

Please address all correspondence to 332 Parramatta Road, Stanmore, N.S.W.

METROPOLITAN RADIO SUPPLIES

332 PARRAMATTA ROAD, STANMORE, N.S.W. **PHONE LM7392**
640 KING STREET, ST. PETERS, N.S.W. **PHONE LA6087**

TRANSCEIVER SPECIALS

No. 22 TRANSCEIVERS

The 22 transceiver covers a frequency of 2 to 8 Mcs. and has been approved by the P.M.G. for use on fishing boats, small craft, bush fire brigades, etc., if converted to crystal control, for which it is easily adapted. These sets are supplied complete with valves, 12v. vibrator, power supply, dynamic headphones and microphone leads.

£12/17/6 F.O.R. PACKAGE 15/- EXTRA

No. 19 TRANSCEIVERS

These units cover a frequency of 2 to 8 Mcs. and contain 15 6.3v volt valves including 1-807, 2-6V6, 6-6K7, 2-6K8, 6B8, etc., also 500 micro-ammeter.

Units supplied complete with valves, leads, junction box, genemotor power supply and dynamic headphones and microphone operate from 12v. supply).

£7/15/- F.O.R.

No. 11 TRANSCEIVERS

Supplied complete with valves, high and low power genemotors, leads, headphones and microphone.

£6/15/- F.O.R. PACKAGE 15/- EXTRA

No. 108 TRANSCEIVERS

These 6-valve Walkie-Talkies are supplied complete with valves, headphones and microphone.

£7/15/-

AMERICAN HANDY-TALKIE, SUPPLIED WITH VALVES BUT LESS COILS AND CRYSTALS. TYPE BC/611, £6/15/-, POST AND PACKING 15/- EXTRA.

NEW 5 BPI C.R.O. TUBES £2/17/6

—IN ORIGINAL CARTONS—

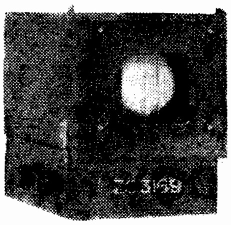
FOR THAT TV SET OR OSCILLOSCOPE

CERAMIC SOCKETS FOR ABOVE 4/6 EXTRA (Post and Packing Freight Rate—N.S.W. 12/6, Interstate 17/6.)

22 TRANSCEIVERS—CRYSTAL CONTROLLED

NEW CONDITION—FREQUENCY 2 TO 8 MCS.

The Ideal Set for Small Ships, Fishing Boats, Fire Brigades, etc. These Sets, which are air tested and approved by the P.M.G., are supplied complete with 10 valves, 12v. vibrator power supply, 9in x 6in oval speaker, microphone and crystal to required frequency. **£29/15/-** F.O.R.

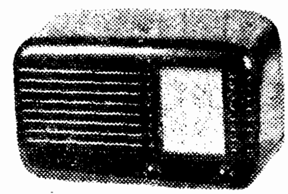


NEW INDICATOR UNITS

These new indicator units contain 3 valves, controls, etc., and V.C.R. ACR/10 C.R.O. tube and socket. Ideal for the small scope.

£3/10/- F.O.R.

MAKING UP THE "LITTLE GENERAL"?

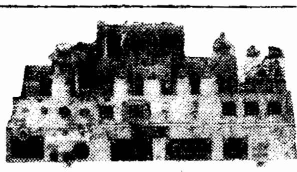


£12/17/6

Complete kit of parts for the 1957 "Little General" as featured R and H including attractive bakelite cabinet with slide dial. Price includes valves and Rola 5F speaker and kit is complete to the last nut and bolt. (Set wired and tested £2/15/ extra).

Cabinet size 11½in long, 7in high, 6in deep. Foundation Kit for above comprising Bakelite Cabinet, Chassis and Dial Assembly .. 57/6

Post and Packing: N.S.W., 14/6; Interstate, 25/-.



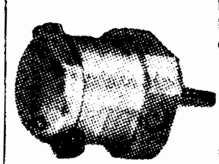
RADAR RECEIVERS

These radar receivers type ZC955 contain 16 valves and a 30 Mc. I.F. strip suitable for your TV experiment. Units are in new condition.

£2/17/6

Packing 15/- extra.

24 Volt Midget Motors Shunt Wound



Fully Laminated Fields Wound Armature Sixteen Segment Commutator, ball-bearing. Ideal for Model Trains, Hobbyists, etc. Condition new. Price, each

25/-

Packing and postage: N.S.W., 1/6; Interstate, 2/6.

SPECIAL—FREE VALVE OFFER

WITH ALL ORDERS OF £6 OR OVER SIX NEW VALVES SELECTED FROM THE FOLLOWING LIST WILL BE SUPPLIED FREE. (COUNTRY ORDERS, PLEASE ADD 2/6 EXTRA POSTAGE.)
1Q5GT — 1C7G — 6H6GT — 6K7G — VR65A — EF50 — 954 — 6C8G — 1P5GT — 1K5G — 7193 — CV6 — 6J7G — 12SK7.

NEW 12V GENEMOTORS

Input 12v. 4.5 amps. Output 220v. 100 mA. Suitable for Car Radio Amplifiers, etc.,

£2/7/6

Post: N.S.W., 6/6; Interstate, 9/6.

ROTARY CONVERTERS

Input 24 to 32 volts. Output 240 volt. 60 cycles. 150 watt. **£16/17/6** F.O.R.

New Condition.

A.W.A. H.F. Signal Generators

New Condition. Freq. 25 to 50 Mcs. Suitable for TV servicing, etc. Supplied with Calibration Chart. **£32/15/-** F.O.R.

METROPOLITAN RADIO SUPPLIES

332 PARRAMATTA ROAD, STANMORE, N.S.W. — PHONE LM7398
640 KING STREET, ST. PETERS, N.S.W. — PHONE LA6087

"WE HAVE EVERYTHING FOR THE HI-FI ENTHUSIAST–

and Gordon Davies and I will give you all the advice you need. Why? Because we love the business!

"Gordon Davies and I have been building hi-fi for years. Now we have our own modern workshop testing laboratory and auditorium. We'd be delighted to meet you and just show what you can build yourself with our hi-fi units. Drop in any time—you are not obliged to buy anything. Better still phone XJ5928 and make sure we will be there."

John Breakspear

BUILD YOUR OWN SET WITH MODULAR COMPONENTS AND KEEP COSTS RIGHT DOWN

STOCKISTS OF THE BEST HI-FI COMPONENTS!

AMPLIFIERS	LOUDSPEAKERS	RECORD PLAYER & PICKUPS
Modular	Wharfdale	Philips
Quad	Goodmans	M.B.H.
Leak	Philips	Elac
Armstrong	Jensen	Dual
Grampian	Peerless	Collaro
Aegis	Rola	Garrard
	and others.	Goldring
		Leak
		Thorens

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Modular has hundreds of discs; all types. Check them on our hi-fi player and be sure before you buy. We will post you any record you like, by the way.

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Just down from the Post Office.

★ **Country enthusiasts send coupon for catalogue of hi-fi units and components.**

To MODULAR ELECTRONICS, 579 Sydney Rd., Seaforth. N.S.W

Please send me catalogue of hi-fi equipment.

NAME ____________________

ADDRESS ____________________

RH 558

ANSWERS TO CORRESPONDENTS

R.B. (Amby, Q.) wants to know if we have ever described a transistor type 3-speed record player and whether it would be possible to buy all the parts for such a device.

A. We have never described such a unit, R.B., mainly because of the difficulty of obtaining parts until the present time. The position is improving, and most of the parts for the amplifier section are now available, but the problem of a suitable motor still remains.

G.A. (Punchbowl, N.S.W.) is anxious that we discuss the subject of Reflex Horns, Vented Enclosures, and similar forms of speakers, and suggests we cover this subject in the Answer Tom page.

A. Many thanks for your suggestion, G.A., and we will keep this idea in mind for possible use in the future. In the meantime we suggest you study the series of articles on the subject in the September, October, and November, 1956, issues. Copies of these are available through our query service.

P.L.O. (Seacombe Gardens, S.A.) sends us a portion of a circuit which appears to be from a 288 Mc super-regenerative receiver, and wants to know if we can suggest why it is not working properly.

A. There is not much we can do to help, P.L.O., particularly as we do not possess the entire circuit. The portion shown appears to be a perfectly standard audio amplifier, and, without some idea of the nature of the fault, we cannot suggest any reason why it should not work. We are glad to learn that you found the "Amateur Licence" articles so interesting.

D.R. (Villawood, N.S.W.) has an AR8 receiver which suffers from the defect that 2BL is received over the entire broadcast band. He also asks a question about the effect of daylight on shortwave reception.

A. The trouble you describe is more or less to be expected, considering that the IF is almost exactly on 2BL's frequency, and that you are within only a few miles of the transmitter. We cannot suggest any certain cure, but the best approach might be to shift the IF slightly until it was clear of this channel. What you say about daylight and night reception is correct, and is one reason why conditions vary from hour to hour. In the conditions you mention, the best that can be hoped for is that the major portion of the signal path will be in darkness, and that the transmitting and receiving aerials favour transmission and reception in the direction which ensure this condition.

L.B. (Inverell, N.S.W.) asks when we intend to describe a completely battery-powered gramophone.

A. The main difficulty at the moment is the supply of suitable battery-operated motors through ordinary commercial channels. The supply position of transistors is rapidly improving and we do not foresee any difficulties on this score. With minor modifications to the input circuit, a transistor amplifier along the lines of that described in the April issue would be suitable.

C.I.Y. (Bendigo, Vic.) in one and the same letter gives us both a pat on the back and a kick in the pants. He finds fault with the Amateur Bandspread Tuner recently described, while he describes the recent articles on obtaining the Amateur Operator's Certificate of Proficiency as "inspiring."

A. We have read and noted all your criticims of the tuner in detail. We can defend all the points of criticism on the ground that the tuner was designed to use only components readily available in this country and able to be built at minimum cost and with a minimum effort on the part of the constructor. For example, the use of hand trimmers immediately saves most of the work involved in trimming coils for a band-switched receiver in order to give exact coverages and make them track accurately. It is true that this method presupposes some frequency standard in order to obtain exact calibration when changing bands. However, such a standard is desirable even with the conventional arrangement. Thanks for the kind remarks and best of luck during your Electrical Engineering course.

D.B. (Kongwak, Vic.) wants to know whether the type 3A5 valve could be used in place of the 6SN7 and also seeks some information regarding copper oxide rectifiers and crystals.

A. Unfortunately, we have absolutely no idea of the circuit in which you propose to make this substitution, making it virtually impossible for us to say whether this is feasible or not. However, the two valves are not really very similar and such substitution is not likely to be very successful in many cases. We assume your reference to the copper oxide rectifier implies its use for a filament supply, but this could also introduce complications. It is difficult to compare the efficiency of copper oxide rectifiers and crystals, since they are normally used in quite different applications and it would be necessary to know the particular one involved. In general, crystals are used only as detectors and are not suitable as power rectifiers in any sense.

J.G. (Camberwell, Vic.) is one of our younger readers and has built a number of our smaller sets, including one of the transistor sets. He wishes to know if we can supply data for a "rush box" for use on 144 Mc.

A. By a "rush box" we assume you are referring to the super-regenerative type of receiver. If so, we are afraid we cannot help much, since the only data we have published is for a 166 Mc receiver of this type in October, 1947. However, receivers of this type are not looked upon very favourably for use on the 144 Mc band these days, due to the severe interference they create.

P.A.O. (Highett, Vic.) is interested in an imported type of flash unit using transistors and wants to know whether we can supply any circuit details.

A. We have seen the device to which you refer and it appears to use a heavy duty power transistor as an audio oscillator in place of a vibrator. The total energy does not appear to be more than about 30 joules, although the reflector and lamp appear to make good use of this limited amount. There does not appear to be much prospect of obtaining suitable components, particularly transistors, at this stage. The unit uses a normal electrolytic capacitor.

G.E.P. (Burwood, Vic.) has recently installed an elaborate amplifier and speaker system, and wants to know if it is possible to use a tuner with it. In particular he suggests a crystal or transistor set.

A. It would be possible to use a crystal or transistor set in the manner you mention, and there is little likelihood of damage to the equipment. However, the performance of such simple receivers generally leaves much to be desired, both in terms of selectivity and freedom from distortion. The idea would be worth trying, if only because it would probably not involve much work or expense, but we think you would find a more conventional tuner a better proposition.

G.F.M. (Darlington, N.S.W.) writes to tell us of his experiences with the Three Band S/W Receiver of May, 1957. He has logged 276 broadcast stations, Australian and overseas, not counting local broadcast stations. Similar performance has been obtained on the S/W bands, including American and English stations. He also inquires about 144 and 166 Mc receivers and suggests we describe something along these lines in the near future.

A. Many thanks for the report on the receiver, and it is gratifying to learn that you have had such success with it. Your log of stations is certainly impressive and an excellent example of what can be done with simple equipment when correctly handled. We assume you are referring to the simple super-regenerative type of receivers for use on 144 and 166 and a 166 Mc super-regenerative receiver was described in October, 1947. However, such equipment is not looked upon very favourably for these bands, due to the severe interference they cause. The superhet is almost universal now.

J.G. (Melbourne, Vic.) sends in a correction to a circuit submitted for the "Reader Built It" page.

A. Your circuit is still not right, in that you have the capacitors in series with the supply lines to the receiver instead of bypassing the lines to earth.

B.H.K. (Ingham, Qld.) asks about the Australian Shortwave Handbook.

A. The last edition of the book was published in 1950 and we have no immediate plans to produce another edition. Possibly there will be another edition at some time in the future but in the meantime you will find a proportion of shortwave material in the pages of Radio, Television and Hobbies.

I.J.A. (Perth, W.A.) includes items for "Here's Your Answer, Tom," and "Let's Buy An Argument" as well as a few suggestions regarding the running of the magazine in general.

A. All items noted. We find it hard enough to design, construct and test sufficient projects for new issues to be published monthly; a weekly issue would ensure that all members of our staff ended in an early grave. In order to list projects which are to appear in a following issue, it would be necessary for us to work about two months ahead of publication date, because not all projects which we begin actually appear in print. Some are discarded because they do not work as well as we had previously hoped and others because of parts supply and other reasons.

P.J.H. (Melbourne, Vic.) wishes to use a 1F5 valve as an extra stage on a small receiver and wants to know if a 10,000 ohm transformer would be correct for this valve.

A. The correct load for this valve is between 16,000 and 20,000 ohms according to the manner in which it is used. However, don't let that stop you, P.J.H., as the set will still work, and work quite well, with this order of mismatch. In fact we doubt whether you will notice the difference in practice, and it would certainly not justify spending money on a new transformer.

J.F.F. (Mangapehi, N.Z.) wants to know whether a version of the VCR97 can be used for the Small Oscilloscope circuit published in the October, 1957, issue. He also expresses his appreciation of our magazine and the interest and assistance it offers.

A. As a matter of interest some details on the VCR-97 tube appeared in the April, 1958, issue, and we would refer you to this in addition to any other data you may have. We doubt whether this tube would be suitable for use in the circuit as it stands, and would be more suitable for use in one of the simpler 5BP1 circuits we have published in the past. Copies of these could be obtained through our postal service. Many thanks for your kind remarks about the magazine.

The Radio, Television and Hobbies Query Service

All queries concerning our designs, to which a POSTAL REPLY is required must be accompanied by a postal note or stamps to the value of TWO SHILLINGS.

For the same fee, we will give advice by mail on radio matters, provided the information can be drawn from general knowledge. UNDER NO CIRCUMSTANCES, however, can we undertake to answer problems involving special research, modification to commercial equipment or the preparation of special circuits.

Whatever the subject matter, we must work on the principle that a letter is too involved if the reply takes more than 10 minutes of our time.

Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cut-outs in standard chassis can be supplied for 5/-. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, RADIO, TELEVISION and HOBBIES, Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

Learn while you build a receiver

(Continued from page 55.)

do not have the misfortune to strike a faulty component) it should be possible to test the unit as a simple audio amplifier. For a start, plug in the 6BV7 only, connect to the mains, and switch on.

It should be possible to see the filament of the 6BV7 as it warms up after a few seconds, and this will indicate that this part of the circuit is correct. If so, switch off, plug in the 6X4, and switch on again. Watch the 6X4 carefully for any signs of distress, such as sparks, blue flashes, etc., which would indicate a short circuit in the HT system somewhere. If nothing like this occurs the set may be left running.

It will be a good idea if you can obtain the use of a multimeter at this stage, and it may be possible to borrow one—and possibly the owner along with it—to help you check that all is well. A panel of typical voltages will be found elsewhere in the article, and your set should have approximately the same values. A tolerance of at least plus or minus 10 pc is allowable.

If all is well you can try feeding some signal into the volume control which should be heard in the speaker. The simplest source of signal—believe it or not—is your finger. If you place a finger on the "active" terminal of the volume control, with the latter fully advanced, you should produce a low but quite audible hum in the speaker. This is a rough, but fairly accurate, indication that the stage is working correctly.

A much more useful signal is that from a crystal pickup, and you may be able to borrow one of these from somewhere if you do not already possess one. It will normally be fitted with a shielded wire (i.e., single conductor in a copper braid) the conductor being the "active" and the shield the "earthy" side of the circuit. Simply connect the conductor to the active volume control terminal and the braid to the chassis. If all is well you should produce a useful signal level at the speaker.

And that is about all for this month enough, we feel sure, to keep you occupied until next month, when we will continue the story around the detector, AVC and IF amplifier stages.

(To be Continued)

ALL ABOUT AUDIO AND HI-FI

(Continued from Page 47)

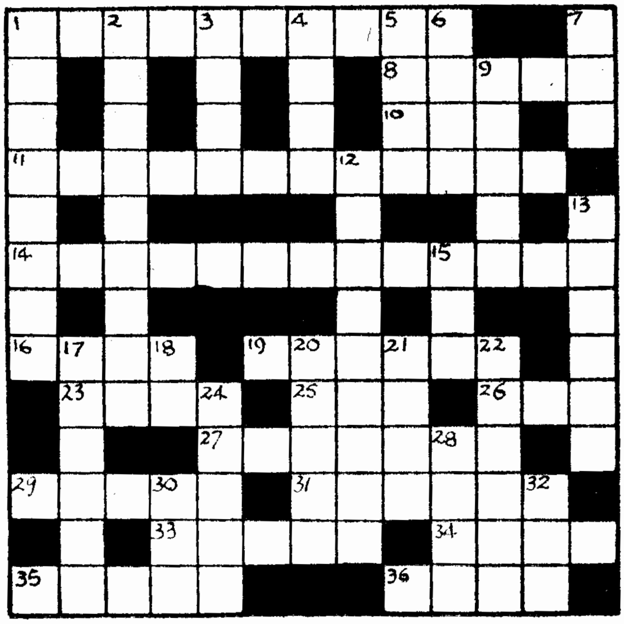
15-ohm output and then make all their tests with a 15-ohm resistor across the terminals. No wonder they produce such wonderful results. I ask you, how many loudspeakers look like a pure resistance?

Mr Cooke has already expatiated in Part 6 on the difficulty of matching electrostatic speakers to an amplifier and translating watts into sound without hidden losses. Many moving coil systems show a steep rise in impedance below 100 and above 2,000 cps. It is easy to remember that a rise from 15 ohms to 30 ohms reduces 10 watts to 5 watts; nevertheless this is often forgotten. The virtue of a level impedance curve cannot be over-emphasised.

(To be concluded.)

Solution and further crossword next month

THE R., T.V. & H. CROSSWORD No. 50



ACROSS

1. Due to electron emission (adj.).
8. Rises on wings.
10. Pounds, shillings, pence (abbrev.).
11. Electrical measuring instrument.
14. Needed by all radio servicemen (2 words).
16. An inert gas.
19. Duty list.
12. Emmet (pl)
25. To prosecute.
26. Largest Australian bird.
27. Water-course.
29. Major leg bone.
31. Young cat.
33. Supporting attachment.
34. Units.
35. Concur.
36. Before (prefix).

DOWN

1. Used for valve filaments.
2. Disruptive expansion of gas.
3. Supports electrodes in valves.
4. Man's name.
5. Island.
6. Price.
7. Inquire.
9. Girl's name.
12. To permit operation from power mains (2 words).
13. To increase.
15. Girl's name.
17. Freeing.
18. Northern Territory (abbrev.).
20. Japanese City.
21. Temporary dwelling.
22. To be sorry for.
24. Reference table.
28. English University.
30. Frozen water.
32. Born (Fr.).

FROM THE SERVICEMAN WHO TELLS

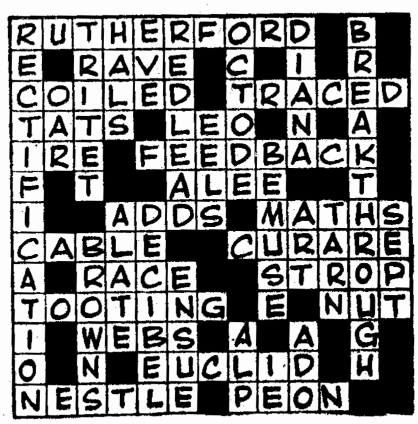
(Continued from page 61)

section, in this case biasing it almost to cut-off. As a result, it had virtually no gain, and the little signal which did force itself through was horribly distorted.

Thus the lower output valve was not only inadequately driven, it was fed with a badly distorted signal into the bargain. Small wonder that distortion showed up at such a low output.

So there we are; three classic cases of leaky coupling capacitors, each with its own little peculiarity. Enough variety to keep me satisfied for some time to come.

Last month's solution



HERE'S YOUR ANSWER, TOM

(Continued from page 63)

wards and forwards with no significant difference in most cases.

Your final question about the potentiometer could not be answered without knowing more about the circuit in which it is to be used. There are some cases where the difference would not be important but there are other cases where it would make a major difference to the operation of the circuit. In the case of most small receivers, the change would mean an increase in the distortion of a detector, a difference in the bass response of an amplifier or something similar and you need not normally be afraid of permanently damaging components by making the substitution.

Answers to correspondents

B.C.J. (Brisbane, Q.) offers a number of suggestions for projects and features in the magazine.

A. The tuner you suggest would not be greatly different from many we have described in the past, and which would at least serve as a basis for design if you should care to experiment. However, we are not quite sure as to the exact purpose of the complete project, and feel that better results may be obtained by a different combination of units. If it is proposed to operate the entire equipment from an accumulator, it would be necessary to consider the total power requirements very carefully, since it is quite likely that they would exceed the capacity of the vibrator supply unit. If you care to let us have more details of the exact purpose of the equipment we could probably advise you further. We are keeping in mind the subject of model control, and you may care to refer, in the meantime, to the September, October and November, 1950, issues for an interesting series on this subject. Many thanks also for the suggestion regarding the past projects reference, but we are afraid this would be difficult to introduce.

K.H.W. (Geebung, Q.) asks if we intend producing an amplifier handbook and also a number of questions on audio.

A. The amplifier handbook has not been forgotten but we have been faced with so many new and complicated projects over the last couple of years, notably television, that it has been impossible to undertake any new handbooks. Cathode follower output stages for amplifiers do not offer all the advantages that would first appear. While the output impedance and distortion of the output stage are both very low, the output valves require a high driving voltage and the design of a low distortion voltage amplifier becomes a problem. The relative merits of single and multiple speaker systems have been discussed in the magazine but no simple conclusion can be drawn. Some like one system, some the other and it largely resolves into a matter of individual taste.

A.D.R. (Bentleigh, Vic.) is anxious to obtain further information concerning the line filter mentioned in a recent Answer Tom article.

A. A complete line filter was described in the January and July, 1953, issues, and copies of the circuit and other details may be obtained through our 2/ mail service in the usual way.

R.B. (Artarmon, N.S.W.) requests that we publish details of a 5in TV receiver.

A. Such a set was described in the September, 1957, issue, and a few copies of this are still available if you require a copy. This, coupled with articles in the December, 1956, and January, 1957, issues (also available) makes a very complete discussion of the whole subject.

I.B. (East Preston, Vic.) reports that he has built the Three Band Three and has obtained excellent results from it. He also wants to know whether the ECL80 valve is readily available and what are the pin connections for this valve.

A. Many thanks for the report on the Three Band Three and we are glad to learn that you have found it so successful. The ECL80 valve should normally be available and we suggest you contact either Mullard or Philips if you have any difficulty in obtaining it. The pin connections are as follows: 1, triode plate; 2, triode grid; 3, cathode; 4 and 5, heaters; 6, pentode plate; 7, suppressor; 8, screen; 9, grid.

W.R.F. (Victor Harbour, S.A.) wants to know in what issue we described the 32 Volt Vibrator Receiver, and how to fit a pickup to the receiver.

A. This set was described in the October, 1950, issue and the circuit as it stands is provided with pickup terminals and the necessary switching.

G.F.C. (Parkes, N.S.W.) writes to tell us that he has now located a trouble which was previously bothering him regarding the 6in. TV Receiver. Apparently he is able to receive fairly regular reception of Channel 2 in this location, which is rather remarkable in itself. He also suggests that the shape of the picture may be improved by placing a ring of insulated wire around the screen of the VCR97 and connecting it to the EHT positive.

A. Many thanks for your report G.F.C., and we have noted the cure for your incorrect frame frequency. Since this did not appear to be necessary on the original, we can only assume that your trouble was the result of a combination of component values which, collectively, differed from the original by a significant amount. Your suggestion for an article is noted, but we have little opportunity to experiment under the conditions you describe. A description of some of the problems you encountered and how they may be overcome might be of interest to other readers if you cared to write about them.

J.S. (Arncliffe, N.S.W.) is anxious for us to describe a five valve communications receiver to cover the popular ham bands and having as many facilities as possible.

A. Many thanks for your suggestion J.S. and we will keep this idea in mind. A set of this general type was described some years ago (Communications Five, September, 1940) and it may be possible to produce a more modern version of the same thing. However, it must be realised that the facilities which can be provided in such a set are distinctly limited, and they may be inadequate for many of the crowded band conditions which are encountered at the present time.

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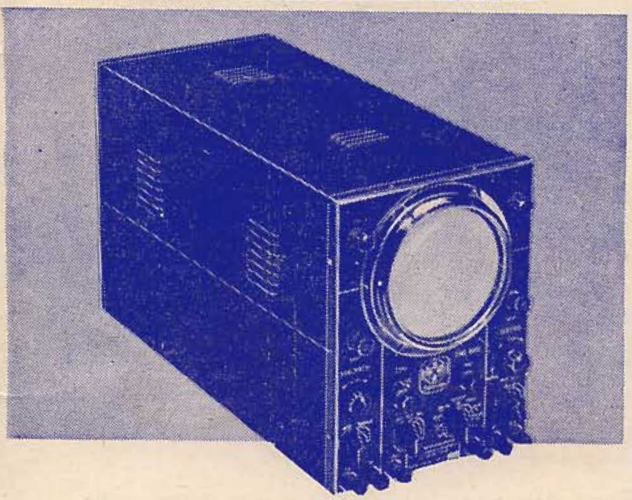

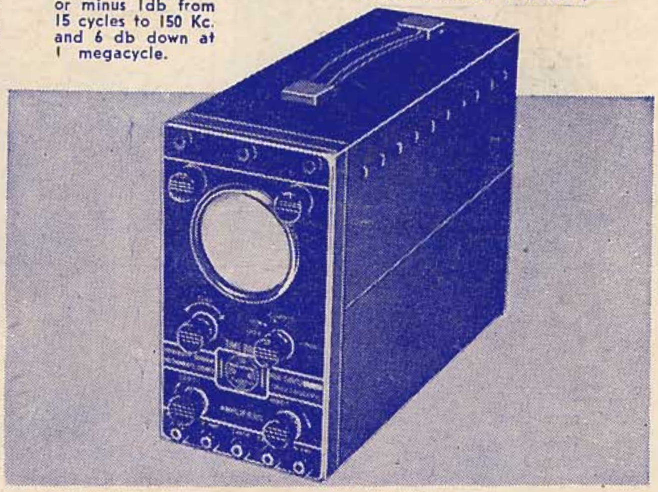

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