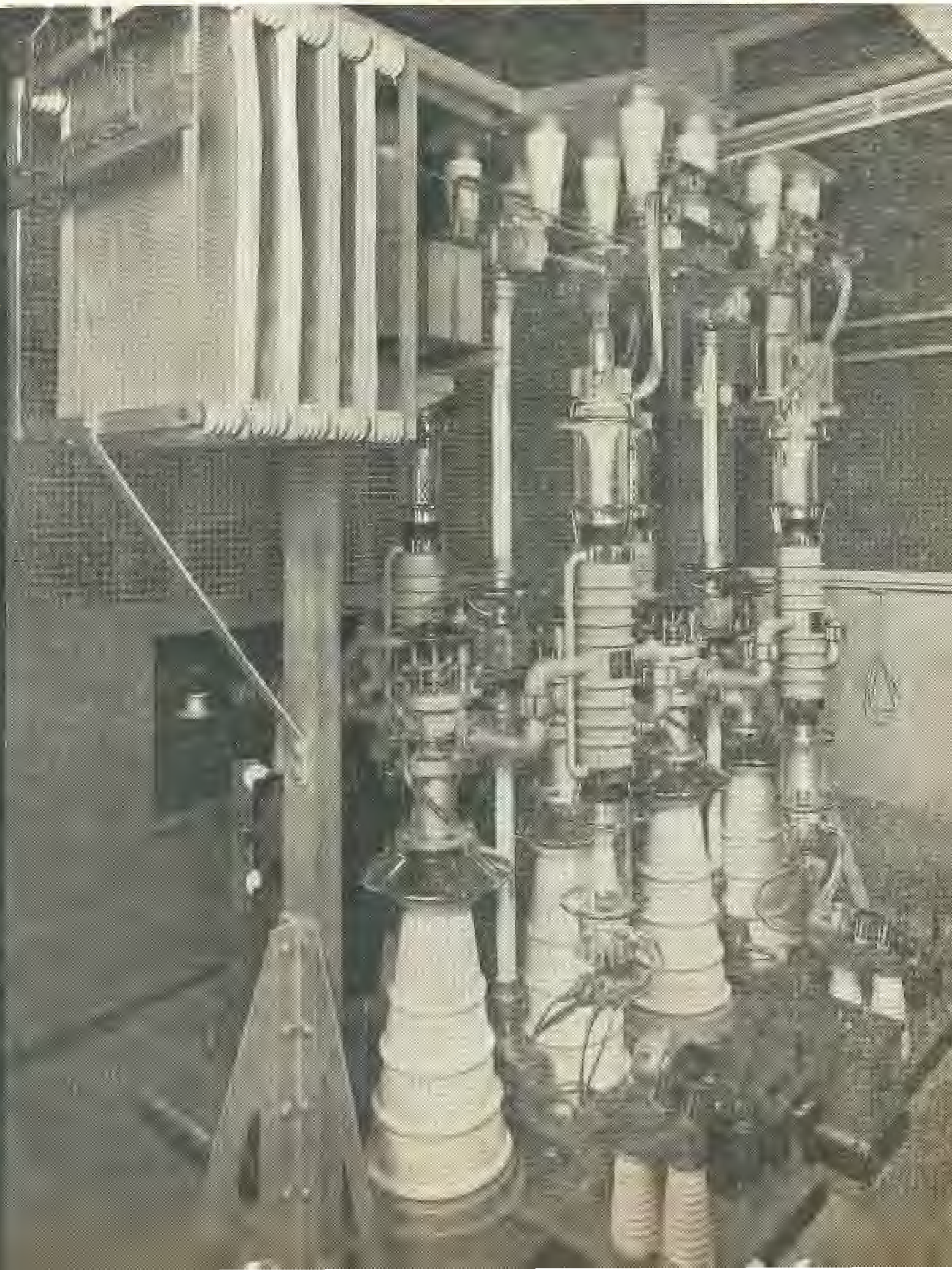
RADIO SCIENCE

Vol. 1.—No. 3.

APRIL, 1948

- MAINS OR VIBRATOR OPERATED AMPLIFIER
- URANIUM and GEIGER-MULLER COUNTERS
- SIMPLIFIED SIGNAL TRACER SERVICING
- ELECTRONICS—HIGH FREQUENCY HEATING
- COMPLETE BROADCAST AND S.W. NOTES



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As the third issue goes to press, it is gratifying to see the overwhelming response to our recent Editorials seeking the co-operation of all readers in formulating the contents of future issues of RADIO SCIENCE.

Letters have been received from all parts of the Commonwealth, as well as from New Zealand, and these practically without exception, all approve of the aims and ideals of this new technical Radio Journal.

Although, as was to be anticipated, many and varied suggestions were made—depending on what each individual considered should be included in the Magazine—a careful study of the letters so far received has indicated a concensus of opinions and ideas centering mainly around one topic —namely, the inclusion of more technical articles.

Whilst at this juncture, in the limited space available, it is impossible to immediately incorporate all the suggestions made, a vigorous policy of expansion is being adhered to, and our many thousands of readers can rest assured that future issues of RADIO SCIENCE will contain the type of material they have requested. In this regard, the requirements of the radio beginner have not been overlooked—his needs will be catered for by the inclusion of suitable constructional articles as well as technical and other items of interest.

Some complaints have been received from readers regarding difficulty in obtaining certain component parts necessary for the construction of our receivers, etc. In view of this, immediate arrangements have been made to ensure adequate supplies of chassis and cabinets being made available to the radio trade. If readers experience any further trouble in this respect, we would invite you to write in and advice will then be given as to where these parts may be purchased.

In This Issue

Much publicity has been given to the search for Uranium deposits in this country and consequently, the article on "Geiger-Muller Counters" is most timely and should prove of great interest to readers.

The main constructional article this month is the description of a small universal power supply and amplifier unit. This can be operated from either 240 volts A.C. or a 6 volt storage battery and is the type of equipment which should be popular with both city and country radio enthusiasts.

As test equipment represents a large outlay to the average serviceman, full details of a useful signal tracer kit set are included. This is a simple low cost unit and well within the means of many radio servicemen.

We again thank all readers who have kindly written in offering their many suggestions, advice and appreciative remarks concerning the Magazine. With this loyal co-operation and support, RADIO SCIENCE must become an integral part of the radio community.

RADIO SCIENCE

FOR THE ADVANCEMENT OF RADIO AND ELECTRONIC KNOWLEDGE.

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EDITORIAL CONTENTS

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OUR COVER:
A photograph of the final amplifier unit of the 200 kw Naval Transmitter situated near Canberra. The valves used are STC double ended water cooled triodes, and two working and two spare valves are shown mounted in position. —Photograph courtesy Standard Telephones & Cables.

ELECTRONICS IN INDUSTRY

HIGH FREQUENCY HEATING

BY REX R. GILES, A.M.I.R.E. (Aust.)

Nowadays, both Dielectric and Induction High Frequency Heating are being used in an increasing number of industrial applications. This article, written by a qualified technician in the field, covers in a practical manner some of the more important aspects of the subject.

High frequency energy has afforded us such wonderful service in the forms of radio, television and radar, that it is at first difficult for one to envisage that it holds unique advantages outside of its radiating properties—to consider it as a type of power suitable for industrial heating seems to be asking too much. In addition, it is also difficult to see how any new form of heating could improve on the well-developed orthodox means to such an extent as to warrant the high cost of equipment which is obviously necessary for generation of high frequency power.

Luckily not all experimenters agreed with these doubts, and when they applied the power developed by equipment similar to radio transmitters to heating problems, they were gratified by finding before them heating techniques which outmoded established concepts of heat generation and transmission and which were destined to radically change scores of industrial processes. These techniques we now know most generally by the terms *High Frequency Dielectric Heating* and *High Frequency Induction Heating,* but several other designations are also in use.

By use of one or other of these methods it is possible to heat almost any substance. Dielectric Heating caters for materials that are non-conductors (or at least are very poor conductors) of electricity, but it cannot be applied to metals and other materials which pass electricity with comparative freedom. It is to these latter materials that Induction Heating applies.

THE AUTHOR

REX R. GILES ,A.M.I.R.E. (Aust.) Born Sydney 1916: educated Sydney Technical High School, Ultimo. Received initial radio training at Australian Radio College, Sydney. Operated as radio maintenance mechanic until the war; served with Army Signals 1939-1945. Employed by S.T.C. on H.F. Heating 1945 to present time.

The mechanism of Dielectric Heating is by no means a recent discovery since radio engineers have always been wary of the generation of heat in the insulating material placed between the plates of a condenser (known as the *dielectric*) and in fact in all insulating materials subject to high voltages at high frequencies. They also knew that this heating effect became more serious when either the voltage or the frequency was increased or when a poor quality insulating material was employed.

Method of Operation.

Several years ago a French experimenter took the first step towards applying this method of heat generation to an industrial process, when he endeavoured, with considerable success, to use it for curing rubber. However, it was not until the recent war imposed its terrific demands on many industries that large scale use of the method was made.

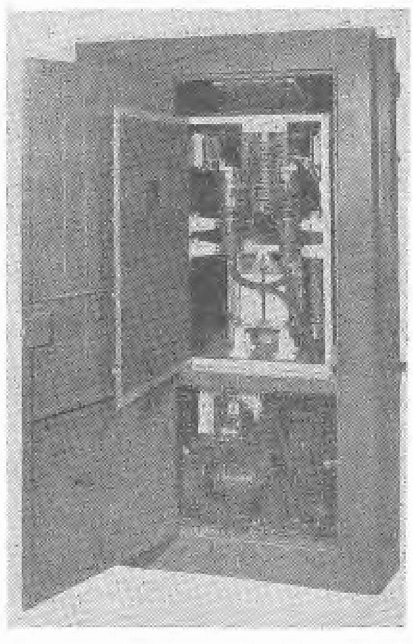
In the usual form of Dielectric Heating equipment two parallel flat plates, which are known as the electrodes, are provided inside a guard screen. To these are connected the output leads from the high frequency generator of the equipment so that the plates are fed with high voltage energy which has its direction reversed at the rate of several millions times per second.

With the space between the electrodes filled only with air, the load on the generator is very low for only the small losses which occur in the circuit of the generator itself have to be met. If, however, a block of wood is placed in this space, not necessarily touching either of the electrodes, a noticeable increase in load occurs.

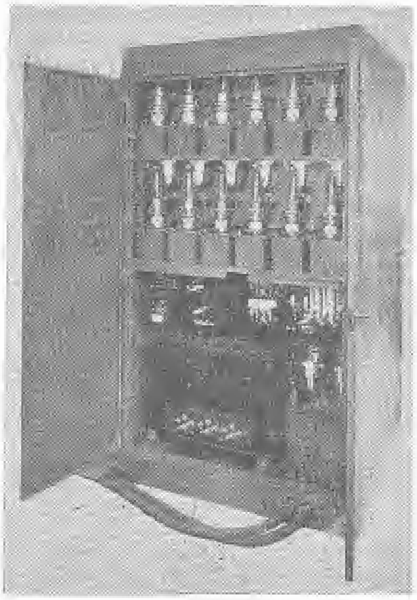
It will also be found that the wood begins to heat, and if this heating is allowed to continue it will not be long before first steam and later smoke will gush out through the crevices and grain of the wood. The most surprising fact is that although some portion of the wood is obviously charring, no change at the surface can be seen. Splitting the block open, however, will reveal that practically the whole core is charred.

This demonstrates the most unique property of Dielectric Heating: the heat is generated within the material and is not merely taken in at the surface and conducted through it at a rate determined by the thermal properties of the material. Thus it is a unique means of heating rapidly and uniformly materials which resist the flow of heat and which are, therefore, difficult and expensive to process.

Asbestos has very outstanding ability to slow up the flow of heat, and so it



Side view of a 20 kw. H.F. Induction Heater, showing water-cooled oscillator valves and main tank coil.



Another view of the 20 kw. unit, showing the twelve mercury vapour rectifier valves high tension transformer and other power control components.

is invaluable for a wide range of insulating problems. It happens though that it is often necessary to treat asbestos based materials at elevated temperatures, so that the very property which makes it useful renders it difficult and expensive to process. Thus it is not unusual to find only thin sections made of the material and not so satisfactory substitutes used where thick sections are essential.

Unique Advantages.

With this type of material, Dielectric Heating is without parallel. The poor thermal properties of the material are of no consequence, and because the high frequency electrical properties of the asbestos are highly suitable, heat can be developed uniformly through it at an amazing rate—irrespective of its thickness.

The heat developed by this method arises from what can be most simply described as a type of friction which occurs in the basic structure of the material when it is subject to a rapidly alternating electric field. An actual flow of current does not occur unless the voltage supplied to the electrodes is made so high as to cause a rupture. This, of course, is to be avoided.

The electric field which exists between the electrodes does not affect all materials to the same extent. It was previously pointed out that when only air was between the electrode no power is drawn from the generator. This is so because air is an excellent insulator: this is described by saying that it has a *low Loss Factor.*

Certain other materials such as special types of plastics and ceramics which have been developed for use as high frequency insulators also have low Loss Factors, and so cannot be heated effectively by Dielectric Heating, but these materials are in the minority. All materials have a different value of Loss Factor and so are affected in varying degrees by the field of a Dielectric Heater.

Typical Application.

The most common application of Dielectric Heating is in regard to the moulding of bakelite materials. Here we have a material which is a very poor conductor of heat and which changes its chemical structure when it is treated at elevated temperatures. Making it more difficult to work is the fact that it must be subject to extremely high moulding pressure while it is hot, thus necessitating expensive hydraulic presses.

This combination of properties was responsible for, until quite recently, only quite thin articles being made from the material despite its suitability for scores of other products. Attempts were made to preheat the raw material in orthodox ovens before feeding it to the presses, as any temperature rise obtained would reduce the pressing time required. However, this was of little avail for the poor thermal conductivity of the material resulted in the core of the batch remaining cold while the surface was at a temperature which set the chemical change in progress, so that when the material was placed in a press it moulded very poorly.

The application of Dielectric Heating to the problem, however, gave it a completely new complexion, and in most moulding shops now it is usual to find this form of heating used at least for mouldings of greater than half inch thickness.

The cold moulding powder is placed between the electrodes of the heater and its temperature is raised to approximately 300 degrees Fahrenheit within a few seconds, so that no serious chemical change can occur. The heated material is then transferred to the press and as it is by then in a putty-like state, it flows with remarkably little pressure to the

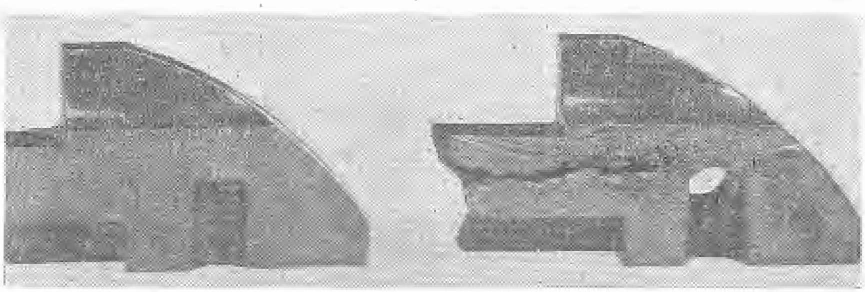
A bakelite preform after it has been heated for approx. 40 seconds. Note the plasticity of the preform and the uniformity of the heating right to the centre of the powder.

required shape, and the complete cycle may be cut to half or even better of its previous duration.

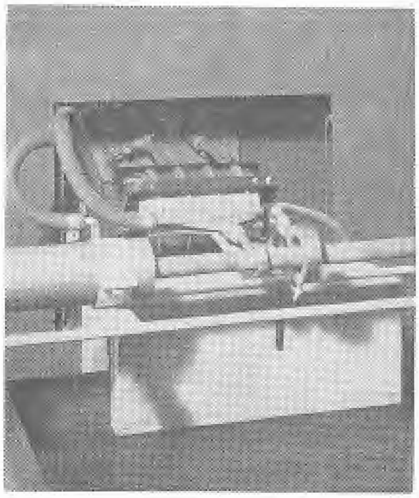
H.F. Induction Heating.

High Frequency Induction Heating employs generators very similar to those used for Dielectric Heating except that it is a coil, which is wound to conform fairly closely to the object to be heated, that is connected to the output of the generator. The coil does not actually touch the article and it is generally wound of copper tube so that water may be passed through to keep it cool.

The generator causes very heavy currents to flow through the coil (known as the *Work Coil*) and these cause currents to flow in the article to be heated in the same manner as currents are caused to flow in the secondary winding of a common transformer. These currents must flow through the resistance of the material and in doing so they generate heat. Naturally, it is easier to develop heat in materials such as steel which have fairly high resistance than it is in materials of low resistance such as copper and silver, but in practice most metals can be handled.



This photograph of bakelite moulding samples with and without H.F. preheat, clearly illustrates the effectiveness of this method of heating.



Experimental arrangements for deep surface hardening of gudgeon pins using 70 kw. H.F. Induction Heater, showing coupling transformers for obtaining high work coil current.

Induction Heating equipment operating at low frequencies have been used for melting large quantities of metals for many years, and in the case of these equipments the currents induced in the load (the object to be heated) are distributed fairly evenly from the surface to the cone of the material, so that heating occurs fairly uniformly throughout the substance. High frequencies, however, have the peculiar property of flowing only on the surface of a conductor and the higher the frequency the more pronounced is this effect. With the frequencies used for High Frequency Induction Heaters, this current penetration is only a few thousandths of an inch, thus the heat is generated only in this skin.

Seeing that heating currents are restricted to thin skin around the load, the heat will be developed only in this region. Of course, if sufficient time is allowed the heat will be conducted throughout the material. However, such intense power concentrations are possible that in many applications of the method, we find that the surface reaches the desired temperature (even though it may be in excess of 1000 degrees centigrade) with practically no temperature rise in regions deeper than a few thousandths of an inch.

Surface Hardening.

This property is of particular advantage in the surface hardening of steel. The orthodox method of obtaining a hard case around a soft cone with steel articles is to start off with a steel having very little carbon (the element which causes hardening) in its composition, and after the piece has been machined to shape, inducing a thin layer of carbon into the surface of the steel by a heat process. When this so-called "carburizing" is completed the article may then be heated to hardening temperature and quenched out in water. This has the effect of hardening only the skin which is rich in carbon and leaving the core unaffected.

This process has several disadvantages, one being that severe distortion occurs during the treatment: another is that the comparatively slow heating of the article allows quite a quantity of carbon to evaporate from the surface of the article, so that this region does not harden properly. These defects make it necessary for the article to be left considerably oversize before heat treatment so that after hardening, the article must be laboriously ground, and sometimes straightened in presses, to correct shape and size.

H.F. Heating Advantages.

When High Frequency Induction Heating is used, however, these disadvantages and several others not mentioned here are effectively by-passed. Instead of commencing with a low carbon, a steel of sufficiently high carbon content is used so that if it were heated and quenched in the usual manner it would harden right through. As it is possible to heat the surface only with high frequency energy, a quench applied immediately after heating in this way will result in a thin skin of the material only being hardened. The depth of hard case can obviously be arranged by varying the amount of time allowed for heating.

So rapid is the treatment and so little of the article is heated that no evaporation of carbon can occur and distortion is practically impossible. This means that in many cases the articles may be machined to final dimensions before hardening and grinding operations are dispensed with.

Some types of articles are not suited for this continuous class of treatment, but they may be treated with the same results by winding a Work Coil to cover the total surface to be hardened. Of course, to get the same power concentrations in this type of arrangement, it is necessary to use equipments of large power output, if the articles are very large.

Equipment Details.

The generators used in Dielectric and Induction types of high frequency equipment are basically alike. Whereas mechanical alternators are used to generate power for low frequency types of Induction equipment, this type of generator is unsuited for generating the frequencies required for Dielectric Heating. Another type of generator is of the spark-gap type and although these will generate frequencies high enough for High Frequency Induction Heating and some forms of Dielectric Heating, they have earned little popularity.

The most usual type of generators now in service are those constructed along the lines of a radio transmitter and incorporating thermionic valves as self excited oscillators.

The most common frequency for Dielectric Heating is 20 Mc/s, but for large articles, such as plywood stacks, frequencies in the vicinity of 12 mc/s are often used, and for very rapid heating of small sections such as occurs in the welding of plastic sheets between rollers, frequencies of approximately 200 mc/s are used. Frequencies considerably higher than this may become popular for special heating problems, especially cooking.

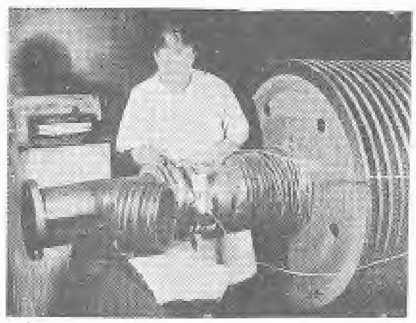
For Induction Heating a frequency of 450 Kc/s is most general, but 1.5 to 2.0 mc/s is also fairly common. When it is required to heat very thin sheets of metal, or articles such as thin needles, it is necessary to use higher frequencies and there have been cases where greater than 100 mc/s was used.

In the case of pre-heating for plastic moulding, a Dielectric Heater of 1 kilowatt power output is adequate for mouldings of approximately 2 lb., and the greatest power used for this type of work would be about 15 kilowatts. For bonding plywood sheets very high power is required and equipments of over 100 kilowatts output are in service. Very small generators are suitable for such application as plastic sheet welding and a rating of 300 watts is adequate in most cases for this type of work.

The equipments are invariably very simple to operate and a comprehensive system of overload and safety circuits are always incorporated to ensure perfectly reliable and safe operation.

Automatic timing facilities are generally included for controlling the duration of heating operations. With large equipments water is generally required for cooling the valves and other components of the generator, but smaller units rely on air cooling by motor driven blowers.

(All photographs supplied by courtesy Standard Telephones and Cables).



Heating large labyrinth sleeves on a turbine shaft to expand them for easy removal.

RADAR AIDS TO NAVIGATION

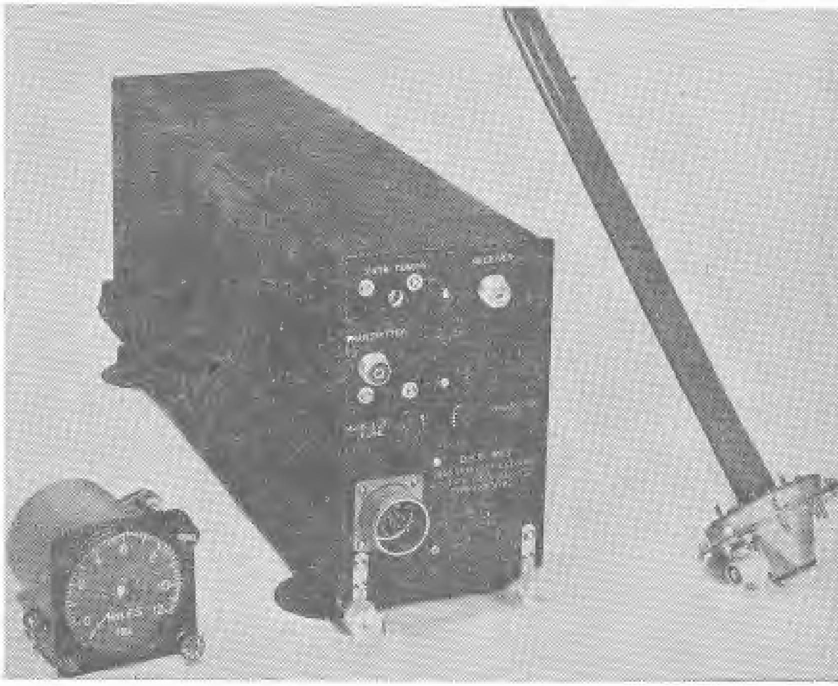
DISTANCE MEASURING EQUIPMENT

By JOHN G. DOWNES, B.Sc., A.M.I.E.E.

In the previous issue, the author described the ground equipment and organisation necessary for use with Distance Measuring Equipment. In this concluding article, full details are given of the airborne apparatus requirements, as well as a description of the airline trials undertaken to prove the suitability of the equipment.

In the preceding part of this article the fundamental principles underlying distance measurement by radar were discussed, and some of the wartime applications of these principles were considered. We then gave some attention to the role which distance measuring equipment can play in the navigation of aircraft along air routes and in providing safe and efficient approach procedures in the vicinity of airports. The distribution and location of the necessary ground beacons was also given brief consideration.

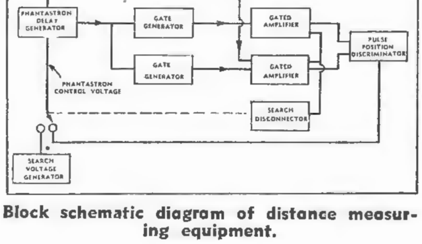
In the present part of the article we shall discuss the requirements to which an airborne distance measuring equipment must conform to be satisfactory for use on civil airlines, and will go on to describe the development in Australia of equipment which meets these requirements. Some consideration will also be given to possible future trends in the development and application of distance measuring equipment.



Engineered prototype model of the Australian Distance Measuring Equipment, showing the main unit, a distance indicator and aerial.

General Requirements of Airborne Equipment.

The general requirements to which airborne radio and radar equipment, and especially equipment for use in passenger-carrying aircraft, must conform, differ markedly from those met with in nearly all other radio and radar applications,



Block schematic diagram of distance measuring equipment.

and therefore merit some special consideration. Consequently, we shall discuss these requirements in some detail and consider how they may best be satisfied.

One of the most important requirements imposed upon an airborne equipment is that its weight shall be the minimum which it is practicable to achieve. The reason for this stipulation is that the most economical operation of commercial aircraft results when the maximum safe payload is being carried; each addition pound weight as radio or radar equipment installed means that correspondingly less revenue-producing payload can be carried.

Concurrently with achieving low weight, it is desirable up to a point to reduce the volume which the equipment occupies. This, however, often follows automatically when the weight is reduced. The requirement of small volume, i.e., compactness, applies with greater force to those parts of an equipment which are necessarily installed in the cockpit of the aircraft; for example, such items as control boxes and indicators. A large number of instruments and controls must of course be fitted in the cockpit, and under the somewhat crowded conditions which exist there in modern aircraft compactness of design is most important.

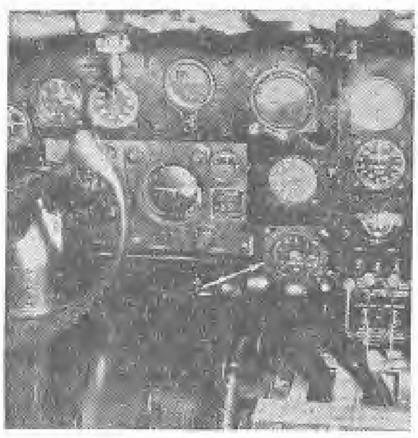
Another requirement of prime importance to be fulfilled by an airborne dis-

Exterior of a Skymaster aircraft—the arrow shows the small aerial of the distance measuring equipment.

tance measuring equipment is that its reliability shall be of a very high order; that is, that it shall function in the correct manner and at all times. It has been found by experience that radio or radar equipment which is not consistently operative when required, often at short notice, is worse than useless. It can in fact represent a hazard, and air crews will rightly cease to make use of or rely on such equipment. Not only must the equipment be consistently operative, but it goes without saying that it must retain its accuracy and be entirely free from false or ambiguous indications of distance.

Reliability Essential

Reliability is achieved by careful attention to the design both of the circuit and of the individual components of the equipment; the behaviour of the latter under a wide range of conditions of temperature, humidity, and pressure must be studied. The effect of ageing of components must also be considered. As a



Instrument panel of Skymaster aircraft; distance indicator can be seen immediately in front of the throttle column.

result of experience obtained over many years of operation of airborne radio equipments it has been possible to draw up specifications for components and equipments which, when met, ensure a high degree of reliability in operation.

The question of prevention of false or ambiguous distance readings is one for the circuit designer, and by suitable design satisfactory performance in this regard can be obtained. It is usual to design the equipment so that, should for any reason a failure occur, the pilot is immediately made aware of the fact by some positive indication. He is thus enabled to act appropriately, as for example by switching over to a spare equipment.

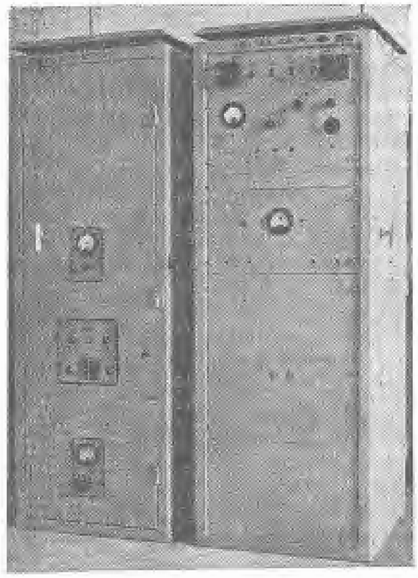
Ease and simplicity of operation of the equipment are other requirements of considerable importance. The chances of incorrect use of an equipment are clearly greater when a large number of controls is used, a difficulty succintly known to Air Force personnel as "finger trouble." The number of "knobs" should therefore be kept as low as possible, and their functions clearly differentiated.

Before leaving the consideration of requirements to be fulfilled, the degree of accuracy which the distance measuring equipment should provide may be mentioned briefly. The precise figure for required accuracy varies with different countries and depends on the intended application of the equipment. No universal agreement has yet been reached but it is thought that in an equipment indicating distance up to 120 miles an accuracy of 1 mile is both obtainable in practice and an acceptable figure from the navigational point of view; where a short-distance scale of 0-12 miles is provided the corresponding accuracy is 1/10 mile.

Australian Developments.

We shall now consider the successive stages in the development of distance measuring equipment and the form which the equipment takes.

The type of distance measuring equipment used in wartime was fairly simple in principle. A cathode ray tube was used as an indicator or "display." Each time an interrogating pulse was sent out, the spot of light on the tube face was made to commence its sweep or scan across the screen, providing a time base. The speed of movement of the spot was known, in inches per millisecond say. The output of the receiver of the equipment was connected to the deflecting plates of the cathode ray tube in such a way that whenever a responding pulse from a beacon was received, the spot of light was deflected at right angles to its direction of sweep, and so traced out a pulse of "blip" on the screen. The position of this pulse relative to the start



Radar beacon at Georges Heights, Sydney. The transmitter is on the left, the receiver and associated units on the right.

of the sweep could be measured, and hence was found the time interval from the transmission of an interrogation to the reception of the response. The distance of the beacon was thus found. The time base could be calibrated directly in miles, and so the distance to beacons read off immediately.

Now this kind of display, using a cathode ray tube, is not particularly suitable for civil aircraft. Firstly, the indication of distance has to be provided directly to the pilot in the cockpit, where the normal intensity of light is such as to make the cathode-ray tube difficult to observe. Furthermore, while in wartime it was common practice to carry a trained radar operator familiar with the adjustment of the cathode-ray tube display and its interpretation, this is not usually the case in civil aircraft, at least in those flying on internal air routes; the type of display used has therefore to be one which the pilot (who is not a radar specialist) can himself readily use and interpret. The logical form of display to provide is that of a pointer moving on a dial marked off directly in miles, and it is towards a satisfactory presentation of distance in this way that peacetime development has been directed. The ideal equipment is one in which the pilot switches on, selects by a knob the beacon to which he requires to know the distance, and is given the answer immediately by the pointer on the dial.

D.M.E. Block Diagram

The way in which the cathode-ray tube presentation has been dispensed with and distance indication by meter provided can be studied by making reference to the block schematic diagram of a distance measuring equipment in Figure 1.

At the same instant as the interrogating pulse is sent out from the aircraft, an impulse is applied to a valve known as the *phantastron.* This valve and its associated circuits, on receipts of such an impulse, generate a definite time delay; that is to say, when a certain time has elapsed from the transmission of the interrogation, the phantastron gives out an impulse. The time by which this impulse is delayed is controlled by the anode voltage on the phantastron.

The delayed output from the phantastron is amplified and shaped to provide a large pulse, known as a *gate,* and this is applied to one grid of a multigrid valve. To another grid is connected the output of the receiver, so that responding pulses from the beacon appear on this second grid. Both grids are normally biased negatively, so that the valve (which is known as a *gated amplifier*) is then non-conducting. However, should a gate pulse and a beacon response pulse be applied to the valve simultaneously, conduction occurs. This happens when the time delay generated by the phantastron equals the time of transmission from the aircraft to the beacon and back.

Voltmeter Scale

Now when the equipment is first switched on the control voltage on the phantastron anode (which, it will be remembered, determines the delay generated) is caused to sweep upward at a slow rate; the delay thus increases steadily, and if a beacon response is being received the delay will eventually reach a value equal to the time of transmission to the beacon and back. When this occurs the gated amplifier conducts, and as a result a relay is energized which causes the control voltage on the phantastron to be held steady at the value it has at that instant. This voltage is read on a voltmeter, and since the phantastron control voltage is proportional to the delay generated, which in turn has been made equal by the above described process to the time of transmission to the beacon and back, the voltmeter can be calibrated directly in miles, and thus provides us with the type of indication we require.

It remains for the equipment to be able to follow a *moving* response such as is received when the aircraft is flying towards or away from the beacon. To achieve this result *two* gate pulses are actually generated, one after the other, and applied to two corresponding gated amplifiers. As the aircraft moves, the received response will tend to coincide more with one particular gate; the corresponding gated amplifier then conducts and its output is caused to adjust the phantastron control voltage, and hence the delay, so that the gates continue to *straddle* the response pulse. The meter at the same time continuously indicates the changing distance.

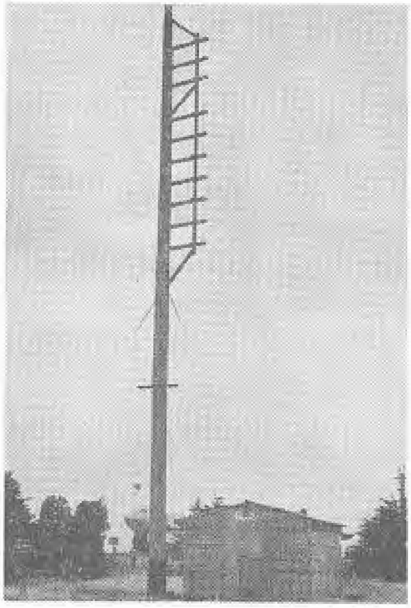
It will be recalled that the sweeping or searching action commences immediately the equipment is switched on. The search moves outward in range, so the nearest beacon is automatically "picked up" first. A push button alongside the distance indicator allows the search to be "released" so that more distant beacons can be picked up if desired.

A neon lamp near the indicator flashes the characteristic code of the beacon being used, thus providing identification. Either of two scales of distance, O-12 and O-120 miles, are available by the turn of a switch.

Equipment Details

The equipment is depicted in Figure 2. The only unit fitted in the cockpit is the distance indicator, with its associated controls. The main unit, comprising transmitter, receiver, and distance-measuring circuits, may be fitted in any convenient position in the aircraft. The aerial is a simple vertical quarter-wave *spike,* fitted to the skin of the aircraft as shown in Figure 3. A single aerial is used for both transmission and reception. The total weight of the installed equipment is about 26 lb.

The development in Australia of distance measuring equipment has been carried out by the Radiophysics Division of the Council for Scientific & Industrial Research as part of its programme to develop radar aids for civil aviation.



View of the beacon hut and aerial at Essendon Airport, Melbourne.

The equipment of which the operation has been described in the preceding paragraphs was naturally not brought immediately to its final form. Successive stages of development occurred, starting with wartime distance measuring equipment as a basis. An experimental model was constructed in which circuits were tested but no particular attention paid to the mechanical layout. Laboratory and flight tests were conducted. A second model was then built using the experience thus gained, more attention now being paid to the form of construction and to achieving reliable operation. Later, six models of an engineered prototype were built and subjected to trials in airline operation. As a result a design suitable for quantity production has emerged.

Airline Trials

A brief description of the manner in which the airline trials were carried out will not be out of place. The objects of the trials were to obtain information on those aspects of the design which only actual operational use could provide, and secondly to provide a test of the reliability of reasonably well engineered models of the equipment. So far as the former object is concerned, the principal aspects are: The general reaction of air crews to the equipment, the way in which its use fits in with existing flying procedures, the suitability of such details as the method of indicating distance, and so on.

The trials were made possible by the co-operation with the Radiophysics Division, C.S.I.R., of two airlines (Trans-Australian Airlines and Australian National Airways) and the Department of Civil Aviation. Two aircraft, a Douglas DC-3 and a DC-4, both carrying out regular scheduled flights, were fitted with prototype models of the distance measuring equipment (and also with equipment providing track guidance by the system known as the Australian Multiple Track Radar Range which will be described in a future article).

The distance indicator was installed on the pilots' instrument panel and was thus available as a navigation instrument. The main unit of the equipment was carried in any convenient position in the aircraft, and the short aerial fitted to the underside of the fuselage. Figure 4 shows the instrument panel of a Skymaster, with the distance indicator installed directly in front of the throttle column. In Figure 3 the small aerial may be seen.

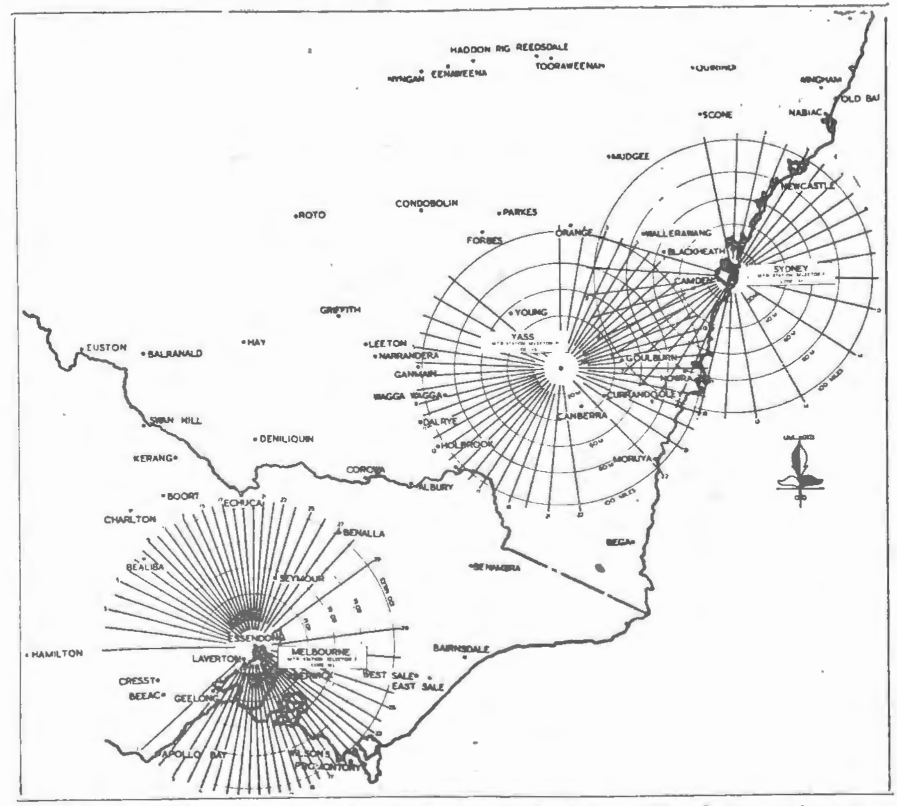
Air Route Used

The Sydney-Melbourne air route was chosen as being the most suitable for the trials. Radar beacons were installed at George's Heights, near Sydney, at Yass, and at Essendon airport, Melbourne. Also, a low power beacon was installed at Mascot Airport, Sydney. The beacons were experimental in form, not being intended as prototype designs, and were constructed largely from former Service radar equipment. Figure 5 shows the beacon at George's Heights. The aerials were usually mounted on wooden poles some 60 feet high; figure 6 shows the beacon hut and aerial at Essendon, Melbourne. The equipments were maintained and operated by technicians of the Department of Civil Aviation or of the Radiophysics Division, C.S.I.R. Figure 7 is a map of the route used; the radial tracks shown in this map are those of the Multiple Track Radar Range system.

During the period of the trials, which extended from January to May, 1947, the air crews logged on as many occasions as possible the maximum range obtained with the equipment at the particular height being flown. These results provided a valuable confirmation in respect of the proper distance at which to space beacons along an air route.

Comments on the suitability of the equipment from the flying angle were obtained; a very favourable reaction was displayed. The trials also provided the airline radio technical staffs with useful experience in the maintenance and operation of the equipment. Some component failures occurred in the equipment, indicating weaknesses to be removed from the production design; the overall reliability of the equipment, assessed as the ratio of successful flights to total flights was 82 per cent., which is regarded as reasonably satisfactory for a first prototype equipment.

(Continued on page 46.)



Map of the Sydney-Melbourne air route, over which airline trials of the equipment were conducted.

RADIO SCIENCE QUIZ

This is the third popular radio quiz to test your general radio knowledge. To obtain your rating take 10 points for each question answered correctly, and 5 points if only half right.

As a guide to your ability, the scores are: Beginner, 50% and under, Experimenters and Servicemen 50 to 75%, Experts 75 to 95%, and over 95% genius.

Q. 1.—To commence with, here is an easy one that should give you full marks. Which of the following abbreviations does not refer to the covering of a wire? Careful, now.

(a) DSC.
(b) SCE.
(c) SSC.
(d) DCC.
(e) SSE.
(f) ESE.

Q.2.—No doubt you have all heard the story how the electrician determined which was the live wire by letting his assistant pick it up. However, it is not generally known that one way of identifying the positive and negative DC leads is to place them in a glass of water. The bubbles will then arise from—

(a) Both leads.
(b) Positive lead.
(c) Negative lead.
(d) Neither lead.

Q.3.—Although the single ended type of valve is assuming greater importance there are still many varieties around having the cap at the top of the valve. The connection to this cap is always the one for—

(a) Internal shield.
(b) Cathode.
(c) There is no general rule.
(d) Plate.
(e) Control grid.
(f) Screen grid.

Q.4.—Most technical articles at some time or another make reference to the use of shielding in receivers. The main purpose of this shielding is to—

(a) Reduce interstage coupling.
(b) Keep the dust out.
(c) Prevent the "know-alls" from tampering with the works.
(d) Keep the oscillator from radiating any interfering signals.

Q.5.—Usually articles dealing with hi-fi radio equipment make mention of the volume expander. The purpose of this is to—

(a) Increase the volume on all stations.
(b) Increase the apparent volume of soft passages in reproducing voice or music.
(c) Make weak stations come in with more volume.
(d) Increase the apparent volume of loud passages in reproducing voice and music.

Q.6—If you were asked to obtain a crystal suitable for use in making a microphone, you would buy—

(a) Carborundum crystal.
(b) Galena crystal.
(c) Quartz crystal.
(d) Rochelle salt crystal.
(e) Silicon crystal.
(f) Piezo-electric crystal.

Q.7.—The term "Ohmic Resistance" applies specifically to—

(a) Resistance to high frequency currents.
(b) Direct current resistance.
(c) Resistance to any form of current.

Q.8.—Even if some of the previous questions have proved a trifle hard, you should at least know that a secondary cell is—

(a) A dry "B" battery.
(b) Any storage battery.
(c) A small battery used to boost up the voltage of a primary cell.
(d) A "C" battery connected to a tap on the transformer secondary.

Q.9.—Ignoring any inherent advantages or disadvantages, which type of contact between a shaft and bearing gives the best electrical connection—

(a) Pigtail.
(b) Sliding.
(c) Wiping.
(d) Rolling.

Q.10.—This one should be a "cinch" to the radio serviceman or experimenter. Simply select the meter scale indicated in the first column that you would use to make the measurements indicated in the second column.

Col. 1.

(a) 0-50 ohms.
(b) 0-50,000 ohms.
(c) 0-10 volts DC.
(d) 0-10 volts AC.
(e) 0-1000 volts DC.
(f) 0-1000 volts AC.
(g) 0-10 ma.
(h) 0-10 amps. AC.

Col. 2.

(A) Rectifier output voltage.
(B) Filament voltage, battery receiver.
(C) Voltage drop across bleeder.
(D) Bleeder resistance.
(E) Filament rheostat, battery receiver.
(F) Voltage secondary power transformer.
(G) Output to speaker voice coil.
(H) Screen grid current in RF section.

Q.11.—Which system of sound recording is likely to have the absolute minimum of surface noise—

(a) Vertical disc recording.
(b) Photo-electric tape recording.
(c) Lateral disc recording.

Q.12.—The usual automatic volume control on your home receiver works by—

(a) Permitting some of the energy to leak from the aerial to the ground.
(b) Controlling the bias on the a-f grids.
(c) Controlling the bias on the r-f and/or i-f grids.
(d) Changing the plate voltage of the detector.

Q.13.—A wave trap is—

(a) A circuit which helps to eliminate unwanted signals.
(b) A part of the circuit which enables messages to be stored whilst the operator is absent.
(c) A super-aerial system which picks up weak radio signals.

Q.14.—Probably you have many times heard all about electron flow in an external circuit, but inside a radio valve the electrons move from—

(a) plate to cathode.
(b) grid to cathode.
(c) grid to plate.
(d) cathode to plate.

Q.15.—In the following list one of the items is out of place. Can you find it and tell why?

(a) Bleeder.
(b) Trimmer.
(c) Oscillation suppressor.
(d) Potentiometer.
(e) Volume control.
(f) Rheostat.

(For Answers, see page 48.)

THE SEARCH FOR URANIUM AND—

Geiger-Müller Counters

BY MAURICE M. LUSBY, B.Sc., B.E.

The presence and identification of radio-active substances such as Uranium can be readily determined by the use of a suitable radiation detector unit. Typical of such equipment is the Geiger-Muller Counter, the operation of which is discussed in this article.

The announced intention of the Commonwealth Government to pay large rewards for the discovery of workable deposits of Uranium Ores does more than merely highlight the importance to the Nation of the Power Metals—Uranium and its neighbours.

Running below these dramatic calls to the people to find Uranium, serious technical people may detect an urgent note calling on them to suspend temporarily, nebulous ideas of so called atomic eras and to get down to the practical business of recognising the substance—The Ore—the beginning of it all.

In the full and complete recognition of Uranium and its ores, at least three branches of Science are involved. The Geologist can go a certain distance, but he can go a lot further and more quickly, with the aid of the Electronics Engineer. The Nuclear Physicist, who has the last say also uses the Electronics Engineer—and in fact cannot work without him.

What we are saying is that, in bringing the Uranium business to its real starting point, the Electronics Engineer plays a most important role, in fact he is indispensible. But he needs to brush up on a bit of geology—to study the funda-
at that time was brought back into use

—THE AUTHOR—

MAURICE M. LUSBY graduated from the Sydney University, B.Sc. 1935 and B.E. 1937 with Honours in Electrical Engineering. Since graduation he has been associated with Westinghouse Rosebery Pty. Ltd., except for four years' leave of absence during the war, when he was attached to the C.S.I.R. Radio-physics Laboratory.

Since the war he has been back with Westinghouse Rosebery heading up special developments in industrial electronics.

mentals of nuclear theory—and then to concentrate on his own specialty—the electronic aids to nuclear engineering.

Much has been written about the fundamentals of the atomic nucleus—even the paper boy, the milkman and the taxi-driver can put a viewpoint on the subject. Geological data, and electronic aids have been apparently lacking in news value—and consequently passed over by the popular press.

It is timely therefore that something be said of these vital factors.

Uranium Ores—two types.

Uranium is rather sparsely distributed in the Earth's crust. It occupies no more than four parts per million although it occurs in over a hundred natural minerals. The important ores are two—*Pitchblende and Carnotite.*

Pitchblende contains the oxide of Uranium $U_3\ O_8$ (uranoso-Uranic Oxide) in yields up to 80 per cent. Pitchblende is brown to black in colour with a pitch-like lustre due to Uraninite. Large deposits exist in Bohemia and Saxony in Europe. It exists also in parts of Northern Canada.

Carnotite, is recognised geologically as a canary-yellow impregnation of sandstone. This ore, which it is suspected may be found in Australia, is scattered over a few of the minerally rich states of U.S.A.—Arizona, Colorado and Utah.

It is interesting to note that Uranium metal was not in any great demand by industry prior to the War. In 1939 U.S.A. produced only 30 tons of commercially refined Uranium. It was used as a colouring agent for glass and pottery and in certain high speed steels where it behaved similarly to Vanadium. Strangely enough it was investigated early in the century as a possible material for lamp filaments but eventually discarded in favour of tungsten. The same plant used during the war to supply Uranium of high purity for atomic research.

Uranium Emanations Assist Search.

In common with the naturally occuring Radio-Active elements, Uranium is unstable: its nucleus is constantly throwing off particles—slowly becoming transmuted into successively lighter elements down the scale of atomic weights. Actu-

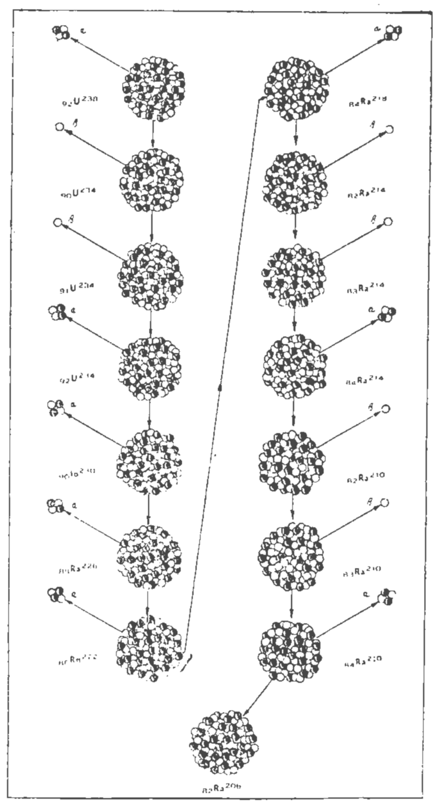


Fig. 1.—Successive emanations of alpha and beta particles transform Uranium into a stable form of radium through fifteen stages.

ally Uranium, starting with an atomic weight of 238 throws off beta and alpha particles to become stable radium 206 in fifteen steps (see figure 1).

The alpha particle consists of two neutrons and two protons and has a positive charge equal to twice the charge on an electron. The beta particle is very tiny and carries a negative charge equal to that of an electron.

In the story of the isolation of Radium by the Curies, it will be remembered that the unexplained silhouette of a key on an unexposed photographic plate led to the discovery of the mysterious radiation from a lump of pitchblende standing by chance on the bench above the key and the wrapped plate. The radioactive particles from the pitchblende reacted on the emulsion just as ordinary light does, but despite the intervening opaque materials.

Sensitive Electronic Detectors Exist.

Whereas a positive action on a photo emulsion would justify the bringing up of more definite and sensitive instruments, it is no doubt true to say that serious prospecting will be done using portable electronic detectors which will be sensitive to weak radiations, quick to indicate and to a certain extent discriminating in their response to various Radio active elements.

Electronic detectors depend for their operation on the fact that when charged nuclear particles fly indiscriminately about in space, they come frequently into collision with gas molecules, separating electrons from the molecules and yielding charged ions whicb are the fundamental agents in electronic phenomena. Thus by observing the ionisation produced with

Fig. 3.—A commercial unit with electronic counter used for detecting emission from a sample of artificially produced radio-active material.

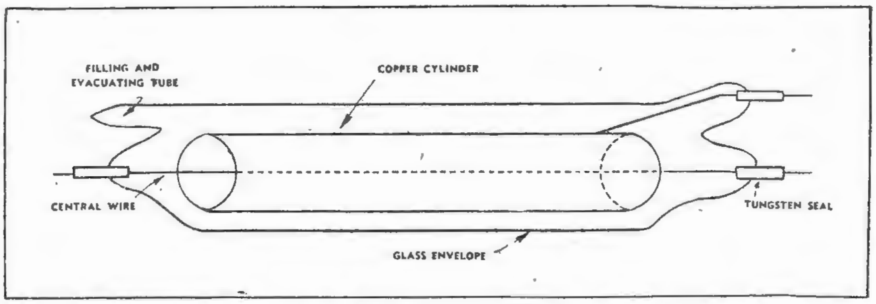


Fig. 2.—The Geiger counter tube as developed by Geiger and Rutherford.

electronic instruments conclusions may be drawn concerning the nuclear particles presumed to have caused that ionisation.

Commonly, ions are produced either by an alpha particle taking electrons from an atom or molecule, leaving it with two surplus positive charges (positive ion) or by a beta particle attaching itself to a neutral atom or molecule and adding its negative charge (negative ion).

Electronically the presence of nuclear particles is detected by enclosing a quantity of gas at low pressure in a glass envelope which also contains metal electrodes with a substantial voltage impressed across them. When this glass enclosure, or tube is placed in the path of the nuclear particles ionisation may be detected by observing the fluctuating current of resulting ions, travelling through the gas to the electrodes. Such instruments are known as ionisation gauges or counters.

Two Useful Ionisation Counters.

Ionisation counters have not altered much, fundamentally, since Sir Ernest Rutherford and H. Geiger published their original paper in Britain, forty years ago. In their first instrument Rutherford and Geiger arranged a cylinder with a central wire running along its axis. A potential was applied between the electrodes so formed and a means was incorporated for measuring the voltage fluctuations (pulses) on the central wire. This counter thus resembles a gas filled diode, see figure 2.

An interesting feature of this counter is that gas amplification is used to give measurable indications. The first ion produced moves towards the central wire and in its passage, comes into collision with other molecules giving rise to more ions at each encounter. Thus an avalanche of ions builds up as the collision front approaches the wire. With this instrument the greater the production of primary ions the more secondary ions are caused to arrive at the wire. For this reason, the counter is called a "proportional counter" and is useful in discriminating between heavy and light nuclear particles.

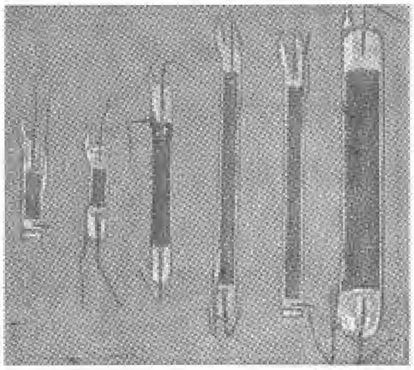
If the voltage between electrodes be increased, a point is reached where the cloud of charged ions approaching near the wire, repels any further ions and so limits the ionisation current to a set value irrespective of the size and charge of the nuclear particle which precipitated the discharge. Such instruments are called Geiger-Muller counters. They are more useful than the proportional counter in many ways because, although not discriminating, they yield pulses of constant amplitude which are more convenient for feeding to the electronic circuits which record the numbers and rates of the detected particles.

Commercial Geiger-Muller counter tubes incorporates some refinements over the original units in that their electrical characteristics conform to limits which can be relied upon. They are frequently fitted with thin mica windows to reduce absorption of nuclear particles entering the tubes, and most important for field use, the construction has become very robust. Glass has been eliminated, except for the seal through which the central wire is energised. The illustration, figure 3, shows a commercial unit, with electronic counter, in use detecting emissions from a sample of artificially produced radio-active material.

Associated Circuits Necessary.

In order to obtain maximum usefulness from a Geiger-Muller detector tube, certain associated circuits are necessary.

In the first place, since a gas discharge is started by the first particle entering the tube, means must be provided for halting the continuing flow of ions so that quiescence can be established in time for



A group of typical Geiger tubes.

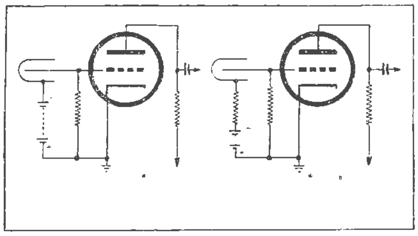


Fig. 4.—Two types of quenching circuits—on the left the Neher-Pickering circuit and on the right the Neher-Harper circuit.

the next particle to be detected, and so on.

Two typical quench circuits are shown in figure 4 (a) and (b). In 4a the normally conducting triode is cut off by the collection of negative charges on the counter tube wire connected to its grid. Quiescence is established when these charges have had time to leak away via the grid leak. In 4(b) the triode is not normally conducting but the gathering negative charges on the wire are connected to the anode of the triode where they reduce the potential to the conducting condition and the triode momentarily short circuits the Geiger-Muller tube thus restoring quiescence.

We have seen how a radio active particle creates ions which collect on the electrode of a Geiger-Muller tube, and how a quench circuit restores the G.M. tube to normal. From the quench tube pulses can be taken for further studies using special circuits.

The simplest terminal circuit would be an audio amplifier and loud speaker. A click would be heard each time a particle enters the G.M. Tube, the rate of clicking indicating the concentration or nearness of the radio active material.

In laboratory work more elaborate counters and rate indicators are used. Counting circuits generally use the well-known multi-vibrator circuit. To cope with very large counts "scaling" is used. Thus a "scale of ten" counter would be one which gives out one pulse for every ten received. This could feed another scale of ten circuit to yield one pulse for every hundred initially produced and so on. The simple multi vibrator circuit could be used as a scale of 2 when arranged to give output for every second ingoing pulse. A scale of ten can be built with ten tubes in a ring. When pulsed, the pulse will flip one tube more around the ring each time, ten pulses being required before the last tube is flipped.

Field Survey Instruments.

Instruments are made for sale commercially for field survey work. Such instruments should be portable and self contained with power supply. A convenient field survey outfit would consist of a Geiger-Muller tube, quench circuit, audio amplifier and speaker with power supply. A block diagram is given in figure 5. The power supply for the G.M. tube would present the greatest problem of portability as at least 1,000 volts is usually required. As the wattage requirement is low, a special vibrator circuit might provide a solution to this problem.

Great Opportunities Exist.

There exist great opportunities in this country for scientifically equipped prospectors searching for Radio active materials. Now that the quest for Uranium has developed into a race between nations and even the polar regions are being over-run by competing interests, the importance of major discoveries on our own home soil should be obvious. It is the responsibility of all who are capable of contributing to this search, to equip themselves technically, for chance eventualities, quite apart from the deliberately programmed surveys which are going on behind the scenes. Electronic engineers and amateurs can help and should be in readiness to do so.

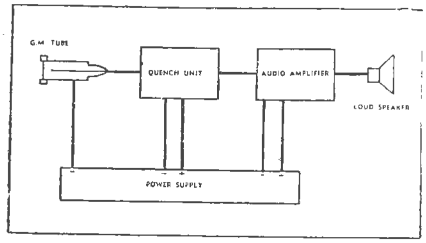


Fig. 5.—The requirements for a field survey ionisation detector are given in this block diagram.

A Technical Survey of Latest Overseas Developments

HEARING AID USES PRINTED CIRCUIT

A new hearing aid recently developed in America is one of the first civilian devices to make use of the wartime printed circuit technique. The whole device is sprayed onto a steatite wafer, measuring 1-1/8 x 2¼ x 3/32 inches, and this takes the place of the previously required 173 separate components.

A feature of the printed circuit is that many of the components are actually manufactured during the process of "wiring up" the equipment. The entire manufacturing process is carried out in four simple steps which may be briefly summarised as follows:

First—silver ink is brushed over a silk screen stencil onto a clean steatite plate or chassis. The resulting pattern on the ceramic is the exact circuit desired, but in place of the usual copper connecting wires, a group of silver lines appears. The ink or paint consists of finely divided silver or silver oxide mixed with a binder to make a paste and then thinned with a solvent such as acetone.

After application of the circuit pattern the plate is heated to a temperature of 1,300-1,500 degrees F. and this process bonds the silver permanently to the ceramic.

Second—the resistors are painted or sprayed through a second stencil designed to make them fall into exactly the right places in the circuit. The resistor paint consists of a conducting material such as powdered graphite and an inert or non conducting material such as mineralite or powdered mica. The plate is then baked in an oven at 300 deg. F. to cure the resistors so their values will not change in use.

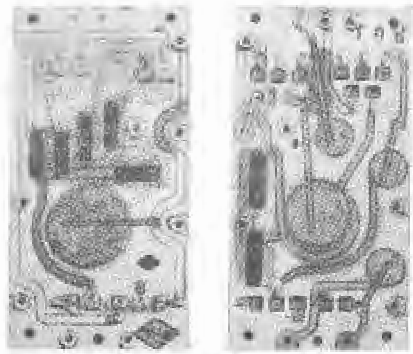
Third—the small, disc-like condensers are then applied directly to the wiring on the plate. The condensers measure from 1/8 to 1/4 inch in diameter and are 0.04 inch thick.

Fourth—the device is assembled by adding the new sub-miniature valves, small transformer, miniature microphone, batteries, 3 position tone control, volume control and an ingenious plug in arrangement which makes possible the use with a single assembly of a choice of three types of receivers—crystal, magnetic air conduction and bone conduction.

A rear view of the completed hearing aid. The B battery is at the left, with the A battery mounted immediately above. The tone and gain controls can be seen projecting from the lower edge of the case.

Three Receiver Types.

The three kinds of receivers are part of an ingenious arrangement which enables the one instrument to be adapted to a wide range of hearing impairments. The crystal earphone is used for persons who require a great proportion of highs —the magnetic unit for those whose hearing is most impaired at the lower registers, and the bone conduction unit is used for cases where the inner ear does not function. In combination with the 3-position tone control, almost any desired frequency response characteristic can be secured.

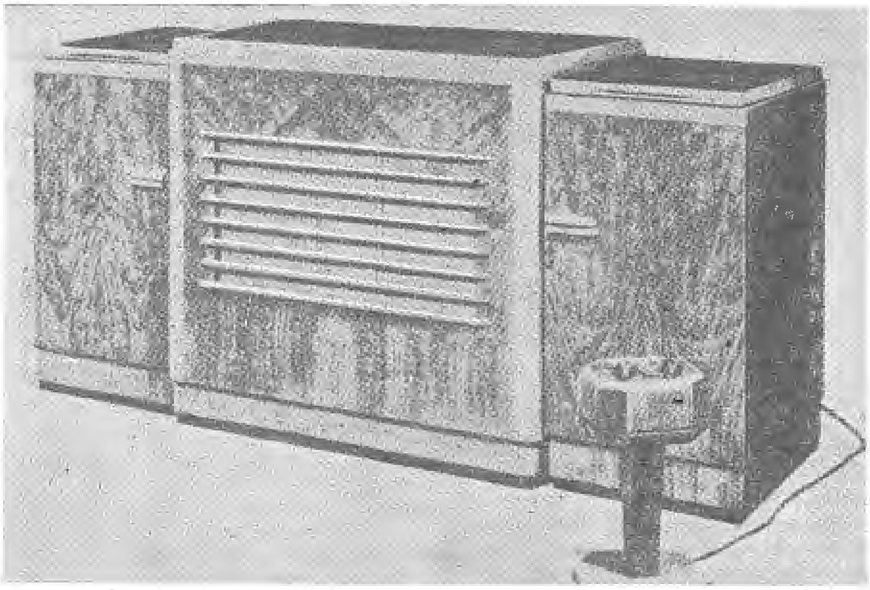


A front and back view of the panel.

In the front and back views of the ceramic "chassis" the rectangular black areas are resistors, covered with a transparent insulating compound. Connections to the outside circuits are made at the eyelets near the edge of the plate and other eyelets are used to carry connections through the chassis from front to back. Connections to the condensers are made of strips of heavy fail or thin metal, silver-soldered to the condensers and to other connectors, or simply to the end of a printer-silver conductor.

Courtesy Radio-Craft

The relative size of the printed section can be seen from this photograph.



The HMV console All Wave receiver and remote tuning pedestal.

SUPER CONSOLE AT RADIOLYMPIA

Probably the largest receiver exhibited at the recent Radiolympia Exhibition held in London was the HMV super console radio phonograph.

This is a 43 valve, all wave radio receiver and record player housed in three large consoles and incorporating a remote control pedestal. One console houses the radio receiver and time switching apparatus, a second console contains the loud speaker assembly, power units, and LF power amplifier, while the third cabinet houses the record playing mechanism, pickup amplifier and storage space for records.

A radio unit provides reception from 10-2,000 metres—the 12 band receiver having three i-f stages and signal frequency amplification on all ranges. A separate FM receiver covers the FM band from 90-94 Mc. Most of the controls are mounted on the control panel under the lid, and some of these are also duplicated on the remote control pedestal.

The loudspeakers consists of two large and one medium high flux permanent magnet elliptical types, and one high frequency ribbon-driven horn speaker. A frequency dividing network distributes the appropriate frequencies to the speakers concerned and the over-all response of the system is remarkably linear over the audio frequency range. The output stage consists of four KT66 tubes operating as triodes in parallel push-pull giving a peak output of 50 watts.

The remote control pedestal which is connected by a length of cable to the radio unit, is put into operation by the local/remote switch. Remote operation of the radio and phonograph unit is then possible.

Crystal Counters.

Radioactivity studies at the National Bureau of Standards, U.S.A., have shown that diamonds are highly sensitive to gamma rays and may be used to detect this radiation in the same way as the more popularly known Geiger-Muller counters.

If a flawless, water clear industrial diamond is clamped betwen two small brass electrodes, maintained at a potential difference of 1000 volts, sharp pulses of current occur across the electrodes when gamma rays impinge upon it. These pulses of current, after amplification may be detected and counted on any suitable device such as an oscilloscope, a current meter or a set of earphones.

In the apparatus used, primary amplification is effected with a minimum loss of original intensity through the use of a triode placed very close to the diamond in the circuit. The output from this tube is then applied to a two stage amplifier from which pulses of sufficient magnitude are obtained to operate the detecting instrument.

The pulse producing property of the diamond is thought to be a result of its highly symmetric crystalline, structure characterised by a very regular arrangement of carbon atoms with relatively large intervening spaces. According to this theory, when a photoelectron is emitted by a diamond atom as a result of absorption of gamma radiation, the freed electron is accelerated through the interatomic space towards the positive electrode. Within a very short distance it acquires such high velocity that other atoms along its path are ionised by collision with the release of additional electrons which in turn are accelerated in the same direction. This multiplication of charges repeats itself in rapid succession, producing a sudden avalanche of electrons equivalent to a small pulse of current.

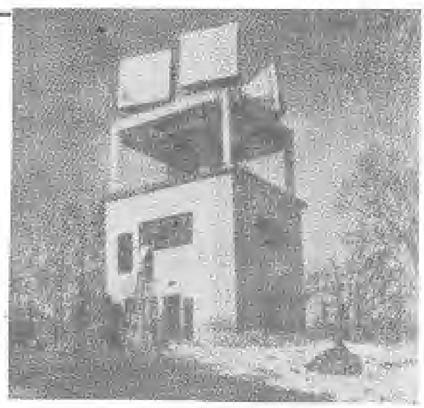
RADIO RELAY SYSTEM

A radio relay system is now in experimental operation between New York and Boston, U.S.A. The radio distance is 220 miles and there are eight jumps ranging in length from eleven to thirty five miles, necessitating seven hill-top relay stations.

Each relay station has four antennas; two are for repeat in one direction and the other two for repeat in the other direction. The antennas are of the metallic lens type which focus the signal into a beam ten thousand times more powerful than unfocussed signals. Each antenna is connected to either a transmitter or a receiver by waveguide. Reflex Klystrons generate carriers in the 4000 Mc region—the power output being only ½ watt.

The receivers (repeaters) are of the radar type and use cartridge crystal detectors. The IF frequency is 65 Mc. These receivers are designed to handle any type of modulation and at present are set up for FM. However, tests are being carried out with amplitude and pulse modulation.

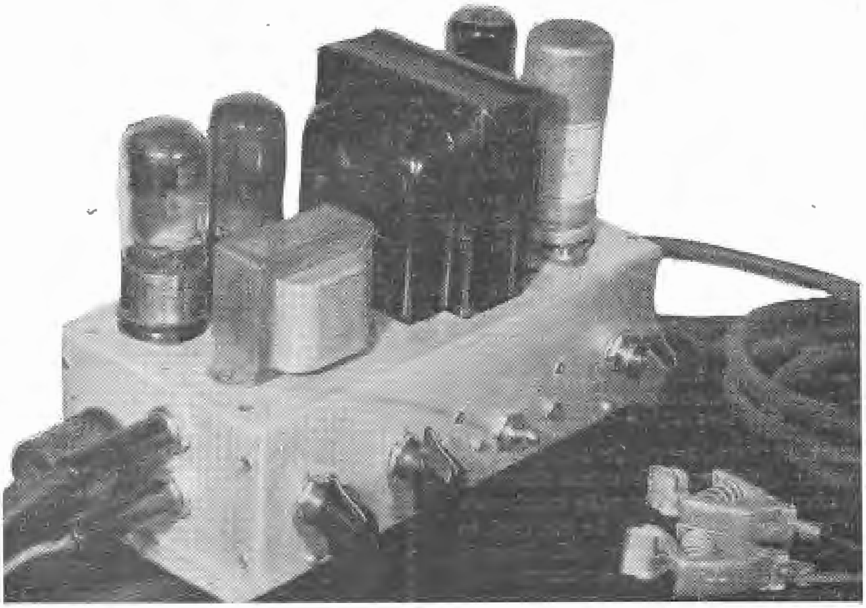
Experimental work has shown that hundreds of telephone circuits and many television channels can operate over the new system. The microwaves (3700-4200 mc.) are not seriously interfered with by rain, snow and most man-made interference.



One of the seven microwave relay stations. A pair of shielded lens antennas provides two way transmission at 4000 Mc.

For A.C. or Battery Operation—

Dual Purpose Amplifier



A general view of the completed amplifier.

Full constructional details for a combined amplifier and power supply unit which should interest both city and country readers. Of a versatile and compact design, special features include:

★Operation from either 240v AC mains or a 6.0v storage battery.

★A small but efficient amplifier section.

★Suitable for indoor or outdoor installations where only moderate power output is required.

One of the most surprising features of recent letters has been the steady demand for the description of another small amplifier, similar to the low cost unit described in the first issue, except featuring a single 6V6-GT in place of the push-pull output stage. These requests have come in from both city and country readers, the latter asking for details of vibrator operation, and consequently we have decided to feature such a unit in this issue.

In order that the amplifier will be completely versatile and be suitable for operation in both city and country areas, it has been designed for operation from either the 240-volt AC mains, or at the flick of a switch, from a 6.0-volt storage battery. Such a feature is particularly valuable as it makes the small unit suitable for use in small halls, etc., where the mains voltage is available, or, if necessary, for operation outdoors from a single car battery.

Despite its somewhat compact-looking size, it will be found that results on both sources of input power are exceptionally good, making it admirably suitable for those small jobs requiring only a moderate power output.

The Circuit

As the complete unit basically consists of two separate sections mounted on the one chassis — that is an amplifier and a separate power supply, each of these units will be described in turn.

Referring to the amplifier circuit, it will be seen that this is quite straightforward and should present little difficulty. The 6SJ7-GT is operated as a pentode audio amplifier, having a .25 meg plate load resistor, a 1.5 meg screen resistor, and a 1,000 ohm bias resistor. A 1.0 meg potentiometer in the grid circuit acts as the volume control.

This stage is then resistance coupled to the 6V6-GT power amplifier, via the .1 coupling condenser and .5 meg grid resistor. This valve is wired up in the conventional manner, with the output transformer being mounted on top of the of the chassis immediately in front of the two valves. One voice coil lead is earthed, and the other taken to a PMG type of output jack.

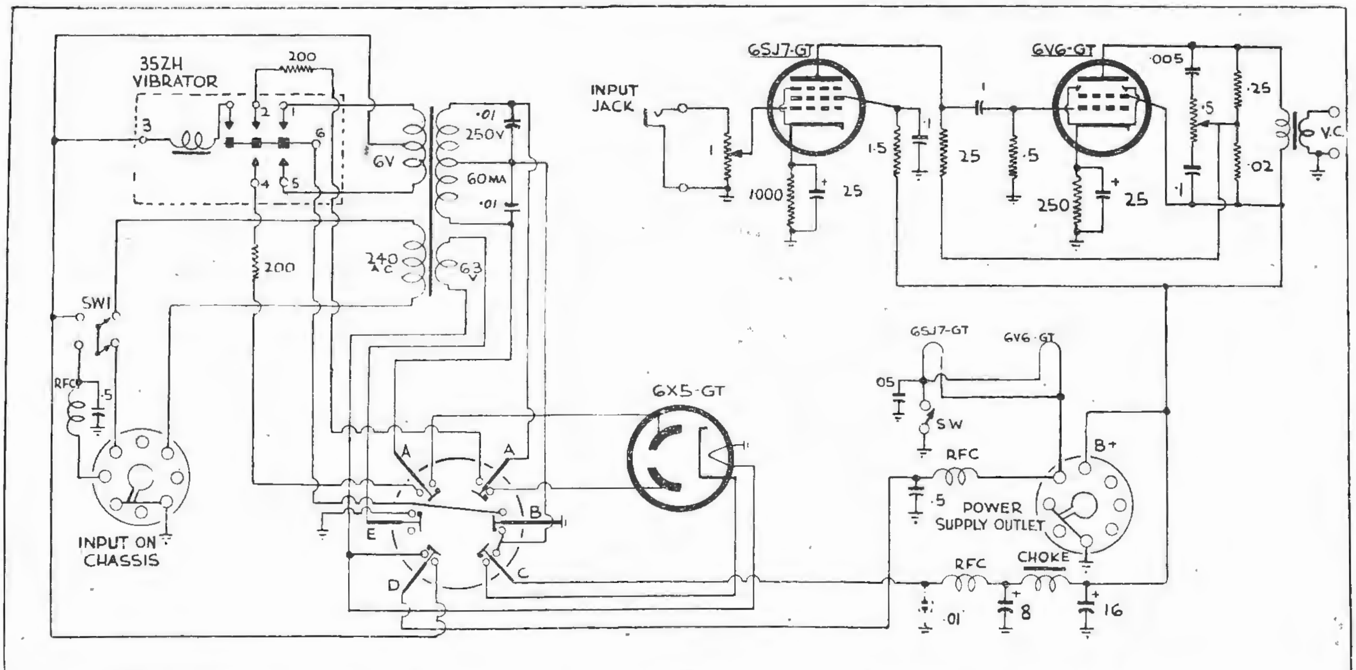
Probably the only section of the amplifier circuit warranting any further explanation is the tone control and negative feedback network. The arrangement shown is quite standard, and will operate over the entire tonal range quite smoothly and effectively.

The negative feedback circuit consists of the .25 meg and .02 meg resistors wired in series across the speaker output transformer. A lead from the junction of these two resistors is then taken to the .25 meg 6SJ7-GT plate load resistor.

Tone Control Operation.

The tone control network consists of the .005 mfd condenser, .5 meg potentiometer, and the .1 mfd condenser all connected in series across the feedback network. The centre moving arm of the potentiometer is then connected to the junction of the two feedback resistors.

In operation this control provides an effective control over the treble response of the amplifier. Its action may be briefly stated as follows: When the moving arm is rotated to one extreme position, the .005 mfd condenser is in effect shorted out of the circuit, leaving the .1 mfd condenser connected in parallel across the .02 meg feedback resistor. This has the effect of reducing the feedback at high notes —



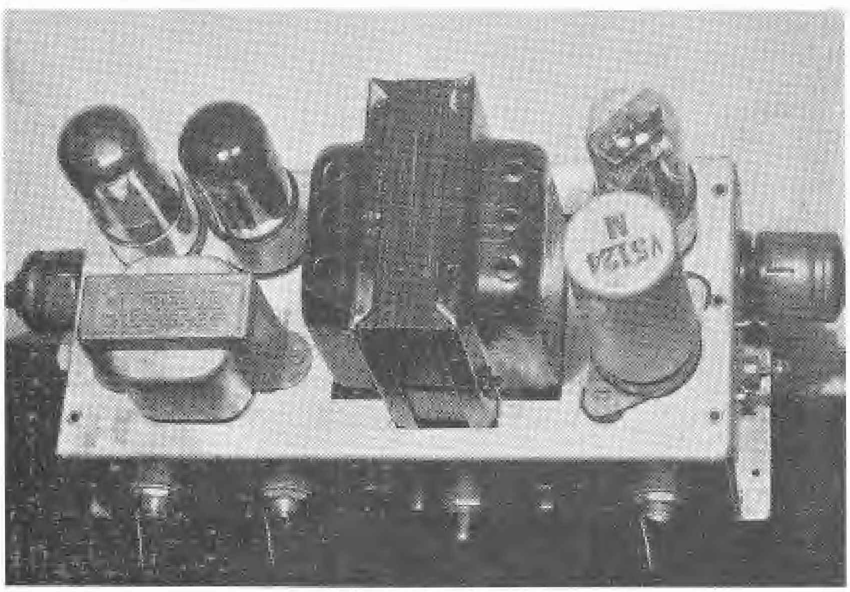
This is the circuit for mains or vibrator operation. Although the switch connections may appear complicated, they are simple enough if traced out in a logical order.

that is, it provides a means of treble note boost.

Similarly when the control is turned in the opposite extreme position, the .1 mfd condenser is in effect cut out of the circuit and in this position the .005 mfd condenser is shunted across the upper feedback resistor. This means that the feedback at high frequencies is now increased, or, in other words, the treble response will be attenuated.

Varying degrees of tone response between these two extremes are possible by intermediate settings of the .5 meg potentiometer. Although the values shown in the circuit should be generally satisfactory for most needs, they can be changed to suit the needs of the individual. Since it is the capacitance of the condensers used that determines the tone control range, it will only be necessary to experiment with these components until you obtain the response you require.

One point to bear in mind with regard to the potentiometer is the effect of the "taper". If the control is wired up in-



A top view showing the chassis layout. The vibrator and rectifier are mounted on the right, and the amplifier section at the left.

PARTS LIST—DUAL PURPOSE AMPLIFIER

1 special chassis 8½ x 4 x 2½.
1 Power transformer 6v/240v. primary, 250v CT high tension, 6.3v. secondaries (Ferguson).
1 35ZH Vibrator cartridge and wafer socket.
1 6-60 filter choke.
1 6 x 2 Rotary wafer switch.

RESISTORS.
1 1.5 meg 1 watt.
1 .5 meg ½ watt.
2 .25 meg 1 watt.
1 .02 meg ½ watt.
1 1000 ohms 1 watt.
1 200 ohm wire wound 3 watt.
2 200 ohm ½ watt.
1 1 meg potentiometer.
1 .5 meg potentiometer.

CONDENSERS.
2 25 mfd electrolytic.
1 16 mfd electrolytic.
1 8 mfd electrolytic.
2 .5 mfd tubular.
2 .1 mfd tubular.
1 .05 mfd tubular.
3 .01 mfd tubular.
1 .005 mfd mica.

VALVES.
1—6SJ7-GT, 1-6V6-GT, 1—6X5-GT.
3 R.F. chokes (two heavy duty filament types).
4 Octal sockets, 1 octal plug (male), 2 octal plugs (female)

SUNDRIES.
3 pointer knobs, 2 switches, 1 input jack, heavy cabtyre flex, 2 battery clips, 1 AC plug, hook up wire, nuts and bolts, etc.

correctly, then the control will not be smooth in operation over the entire movement, and, in this case, the remedy is to reverse the two outer leads.

So much then for the amplifier section.

Power Unit.

Since the amplifier was designed for operation from either the 240-volt AC mains or from a 6.0-volt storage battery, one of the main problems associated with the power unit was the arrangement of a suitable switch which would enable either source of power to be used as desired.

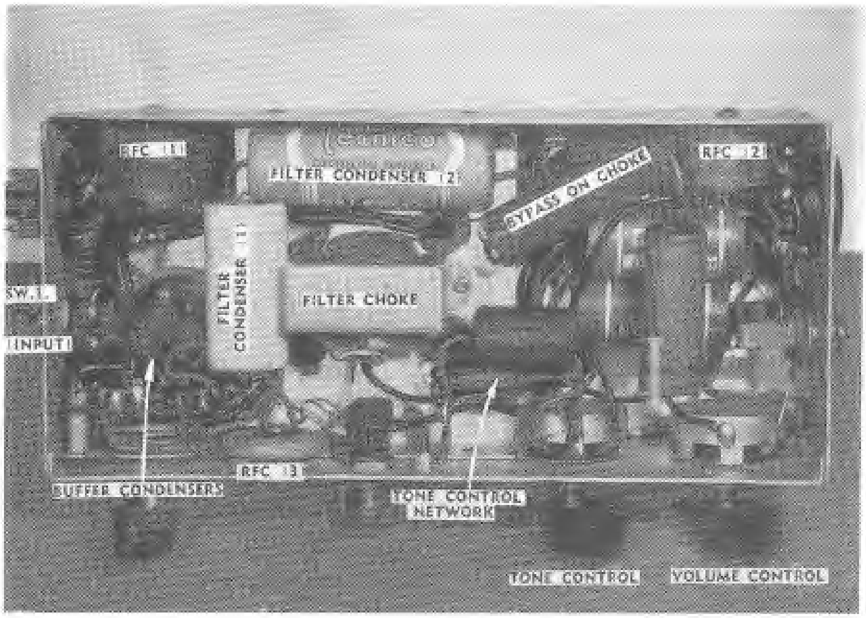
The power transformer used is a special Ferguson type (6V/240V) designed to operate from either a 6-volt storage battery or the 240-volt mains. When operating under either condition, the output voltage is 250 volts Max. with a current drain of 60 m.a.

The transformer is quite a bulky unit, since it has two input windings — one for the 240-volt mains and the other a centre-tapped 6.0-volt winding, a HT secondary winding which is common to both input sources, and a 6.3-volt heater winding.

The vibrator used in the circuit is of the synchronous type, which means it is capable of rectifying the output without the need for a separate rectifier valve. Under these conditions an alternating voltage is developed in each half of the secondary winding of such a nature that the centre tap becomes the high tension positive voltage source. Under AC operating conditions, of course a rectifier is necessary, and for this reason the 6X5-GT is included in the circuit. The ouput voltage in this case is then taken from the rectifier cathode in the normal manner with the HT secondary centre tap becoming the negative return line.

Switch Connections.

To enable all these changes to be brought about, a suitable switch has been incorporated in the circuit. Although the connections to this switch may, at first glance, appear to be complicated, they are really quite simple if traced out in a logical order. Starting from the input side of the power transformer, these connections will now be explained in some detail, since the correct functioning of the unit depends in no small measure on this switch.



This underchassis photograph shows how most components were fitted in. This layout keeps all leads to a minimum, thus reducing one potential source of interference.

The 240-volt AC mains are connected to their respective pins on the octal input socket, and as can be seen a switch, SW1, has been included in one lead. This provides a ready means of changing the input voltage from mains to 6.0 volts, and, at the same time, constitutes an effective ON-OFF switch for either voltage source.

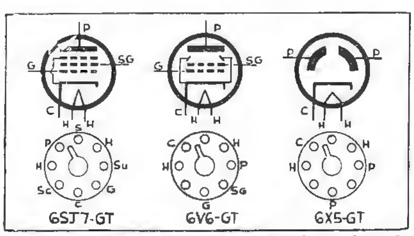
The 6.0-volt lead is taken through an RF choke, bypassed with a .5 mfd condenser and mounted very close to the input socket pin, to the centre tap of the 6-volt primary winding. This 6.0-volt lead also connects to one lug of the D section on the wafer switch, as well as to pin 3 on the vibrator. The outer leads of this primary winding are connected to pins 1 and 5 of the vibrator socket.

The HT secondary leads are wired direct to the two moving arms marked A on the switch. The plates of the 6X5-GT are taken to one lug of each section — the other two lugs being connected to the high tension output pins — 2 and 4 on the vibrator. The centre tap of the secondary is connected to one pin of the B and C sections, as shown, with the B moving arm being earthed.

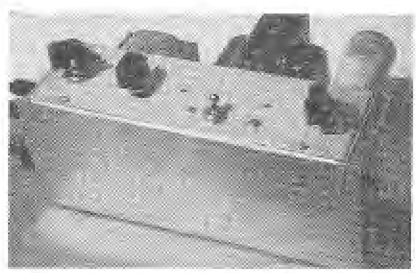
In the AC position it can now be seen that the secondary leads are connected direct to the 6X5-GT plates, with the HT centre tap being earthed. On moving the switch to the vibrator position, these plates are automatically cut out of the circuit and the two vibrator leads now connect to the high tension secondary. At the same time the moving arm C connects to the HT centre tap, making it the positive high tension output for the vibrator, thus bypassing the 6X5-GT. To complete the circuit the moving arm B earths the vibrator reed, thus enabling the vibrator to operate.

Next comes the heater circuit. The 6.3-volt filament winding connects to the moving arm of the E section as well as to one lug on the D section. In the AC position, it can be seen that one side of this heater is effectively earthed, with the other lead going direct to the 6X5-GT heater, and to the other two valves, via the moving arm D. Changing the switch to the vibrator position — the 6.3-volt winding is open circuited, to all valves, and at the same time the 6.0-volt lead connected to one lug of the D section is now connected through the moving arm D into the circuit.

The high tension output in both cases is taken from the moving arm C, since this switches to either the 6X5-GT cathode or to the centre tap of the HT winding.



This diagram shows the connections for the three valves. The socket is viewed from the underneath.



The base plate was fitted to give a finished appearance to the unit.

The output is filtered in the normal manner by means of the filter choke and associated filter condensers.

Special Care Necessary.

It should be realised that a vibrator power supply unit is much more critical in design than the AC counterpart, and for this reason, special care should be taken with the wiring up. At this stage we would say that if you have not had previous experience with this type of equipment, then make sure you have a technical adviser on hand to assist you where possible.

Due to the nature of the vibrator unit, transient voltages and currents are generated by the rapid make and break type of circuit, and these can be easily picked up by any long leads or other wiring, amplified through the circuit, manifesting themselves in the form of interference commonly referred to as "hash".

Although in this circuit most precautions have been taken to eliminate this form of trouble, it should be realised that this interference problem will vary with each unit built up, and consequently no set of rules can be formulated for its removal. In circumstances such as these we can only reiterate previous statements of keeping all leads to a minimum, mounting the various components as close as possible to the associate circuits.

Layout Considerations.

The general layout of the various components can be seen from the accompanying photographs. The power transformer is mounted in the centre of the chassis, the actual placing of this being optional. In the original model, an effort was made to keep the overall dimensions to a minimum, without any overcrowding of the components.

To achieve this result the transformer was mounted below the level of the chassis on a metal plate riveted in position. However, for those who may not wish to go to this extra trouble, then it is quite satisfactory to bolt the transformer direct to the chassis. In either case make sure that rubber grommets are fitted to the holes carrying the various leads, so as to prevent any fraying and possible short circuits.

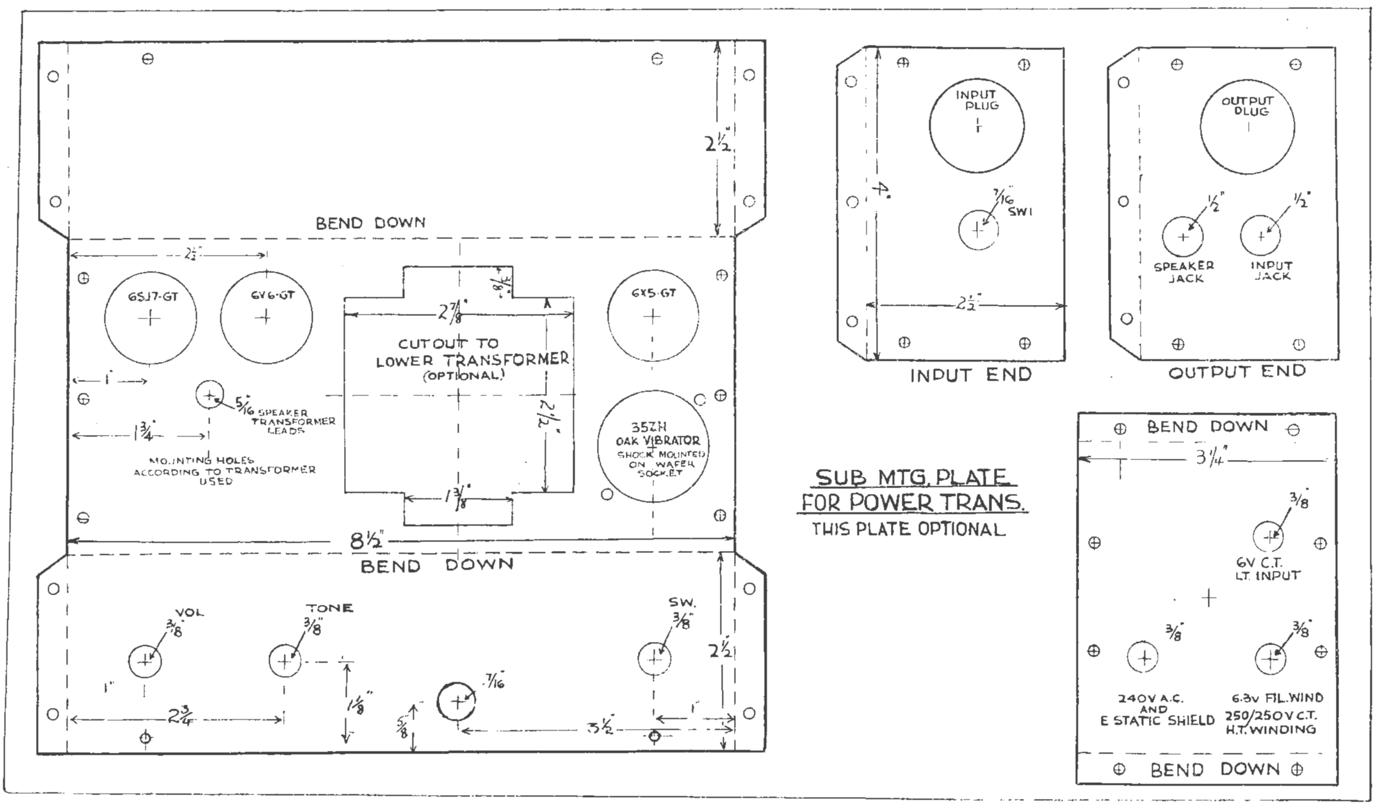
The vibrator cartridge and 6X5-GT are immediately on the right of the transformer. One word of caution here — make sure a wafer type socket is used for the vibrator, so as to prevent the outer casing being earthed to the chassis. This is a very necessary precaution, since, in some types of vibrator cartridges, this outer case may become "alive"— not very dangerous, but still enough to give you a sharp jolt. So make sure of this point, and, if in doubt, cut a small cardboard ring and slip it between the cartridge and socket. Also ensure this socket is shock mounted on rubber grommets.

The 6SJ7-GT and 6V6-GT are mounted along the back edge of the chassis, with the output transformer immediately in front. Underneath the chassis the filter choke is mounted on the power transformer submount panel, with the two filter condensers close by. For clearness some of the other components are marked in on the underneath chassis photograph, and this should be referred to for the actual location of parts.

Wiring Up.

The wiring up of this unit is not particularly difficult and reference to the photographs will clearly show the location of most components. The various precautions to reduce the interference problems usually associated with vibrators can be seen in the circuit diagram.

As the heater circuit is frequently a radiator of high frequency "hash", the input hot lead is passed through an RF choke right at the point of its entry into the chassis. This choke is also bypassed to earth with a .5 mfd condenser. It should be noted that the choke in this circuit should be wound of a heavy gauge wire (14 to 16 gauge) so as to keep the d-c

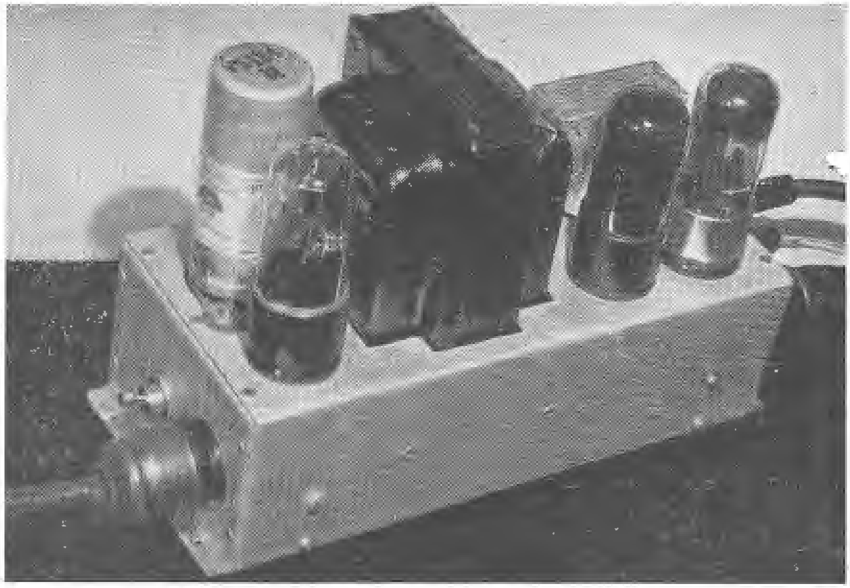


The necessary chassis dimensions are given in this drawing. Note the optional mounting for the power transformer.

resistance in the filament circuit to a minimum.

On the high tension lead an RF choke has been inserted in series with the lead and is bypassed by a small condenser. This precaution may not be necessary, but at the same time represents a typical measure frequently necessary in an amplifier of this type.

The buffer condensers connected across the HT secondary are used to correct the waveform, and should preferably be mica types, although 600 volt tubular will give good results. These two condensers are connected right at the appropriate lugs on the change over switch, as this keeps the leads short and direct.



A rear view of the completed unit.

Check Output Polarity.

When making the connections to the vibrator socket, ensure that either primary or secondary leads are left long enough to enable them to be changed over should the output polarity be incorrect. The unit should be connected to a 6.0 volt storage battery in the correct manner and the d-c output checked with a meter. If the high tension voltage is found to be negative with respect to the chassis, it will be necessary to reverse either the primary or secondary leads,—but not both, to give a positive output. Unless this is done the filter condensers will act as a direct short circuit resulting in possible detrimental results to the vibrator.

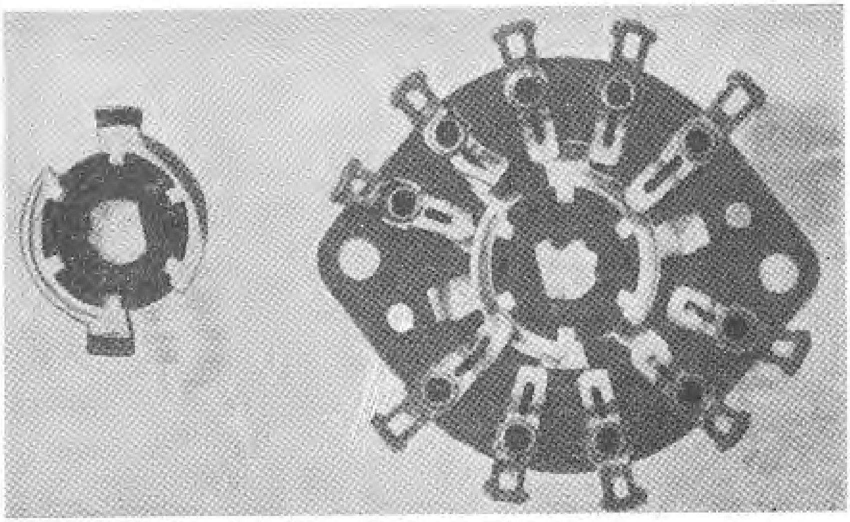
The input leads should be made up from rubber covered flex, one terminating in the standard three pin AC plug, and the other with battery clips. The battery lead should be as heavy as possible to reduce any voltage drop to a minimum. Both leads are fitted with an octal plug, and it should be noted that the male portion is mounted ON the chassis. Unless this is done there is the danger of 240 volts being accidentally touched when the AC lead is connected to the mains.

CLEANING SWITCH CONTACTS

This authorative article deals with some of the detrimental effects on switch contacts, etc. caused by the continued use of Carbon Tetrachloride as a cleaning agent.

Carbon tetrachloride is generally accepted as a useful agent for removing the cause of defective or noisy switch contacts and it is widely believed that it functions by removing surface films of grease.

The opinion that grease is often the cause of faulty contact is inaccurate, as will be seen later; it can have little or no direct effect on electrical contact. It will in fact be shown that a thin layer of grease is an important feature in the operation of a switch, or any form of moving contact. The real cause of noisy contact is thought to be due to particles of solid matter with insulating characteristics which mechanically lift the surfaces of the contacts apart, and are held up by the thin layer of grease.

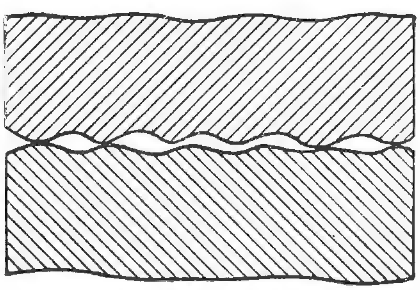


Photograph of a typical wafer switch, subjected to mechanical life test after cleaning with carbon tetrachloride.

Surfaces Not Smooth.

In order to study the process involved let us consider a switch of the wiping contact type. The two mating surfaces appear smooth, but in fact consist of a series of microscopic undulations. Only the high spots of these two surfaces can be in electrical contact, as shown in the figure. It would appear possible from this figure that the high spots of one contact could enter the valleys of the other. There is little chance of such an occurrence, as it is extremely unlikely that all the scratches will be exactly parallel. Thus high spots only will be in contact.

Consider now a layer of grease applied to these surfaces, of thickness less than the depth of the scratches and the switch operated a few times. Due to the viscous nature of the grease, the contact pressure will force the high spots through this layer. Thus they will still make electrical contact, and the valleys will now be filled with grease. As it is the high spots which are again in contact the presence of the grease has in no way affected the area of contact, and hence the resistance.



Sketch of contact surfaces of the switch.

Noisy Operation.

When this layer has collected sufficient foreign matter to pile and separate the contacts, the switch will become noisy and erratic in operation. This is due to the random building up and collapsing of the piles of foreign matter during the movement of the switch. When the majority of them are forced into the valleys, electrical contact between the high spots is again possible. This random effect will, therefore, result in large changes of contact resistance, even causing a series of complete makes and breaks. accompanied by the usual symptoms known as noise.

Let us now proceed to cure this fault by applying a quantity of carbon tetrachloride to the contact. As this is a solvent for the grease, the grease will go into solution. Hence the foreign matter is no longer held to the contact faces and will be washed off together with the grease. As the cause of the faulty contact has now been removed, our switch has now returned to its original noise-free action.

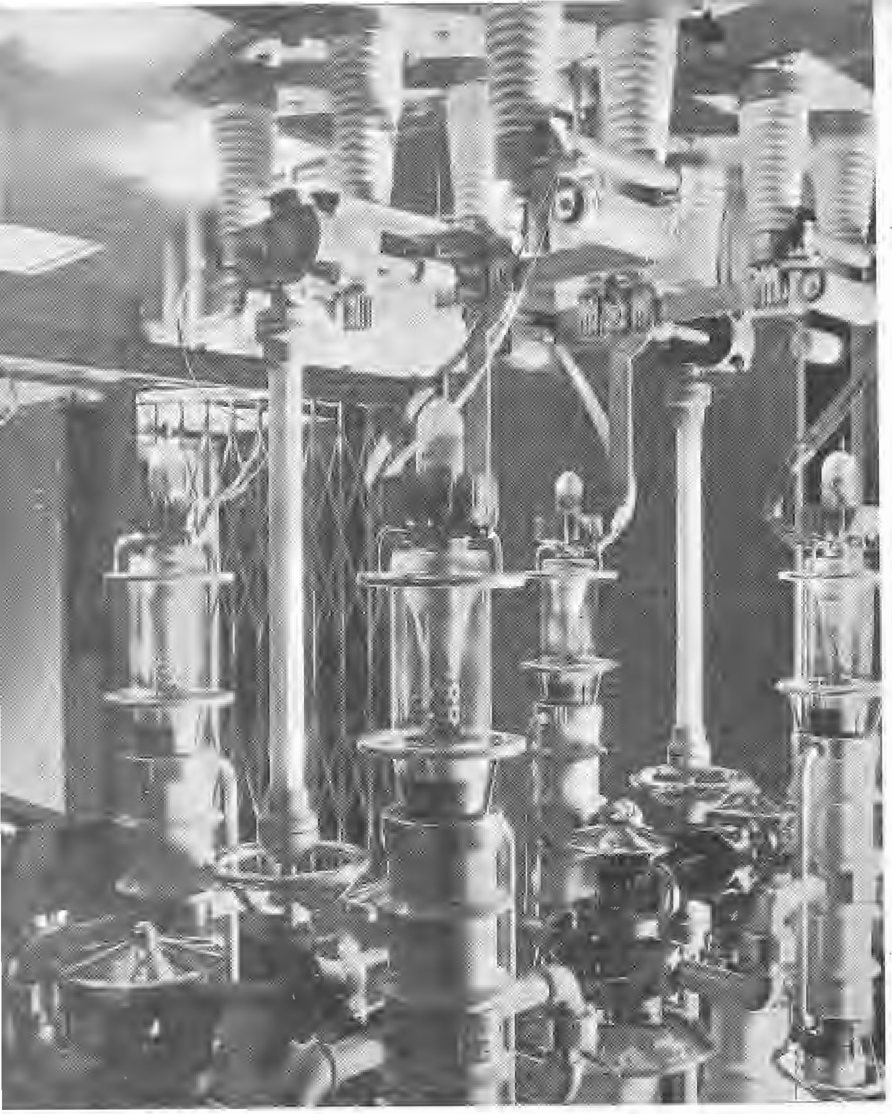
But we are not yet out of the wood. In curing the faulty switch we have removed the film of grease. As in any mechanical device, the result will be increased friction, and eventually, excessive wear, even though a switch is not normally operated at high speed.

A series of mechanical life tests were conducted by the author on a batch of new wafer-type switches. Half of this batch were treated with carbon tetrachloride. In every case the untreated switches showed no serious effects, while excessive wear took place in those treated This in some cases led to the severing of the tongue on the moving contact, and in others the fixed contacts were dragged from their normal position until the moving contact jammed against their edges.

Effect of Wear.

The dark patches on the tongue of the switch rotor illustrated in the accompanying photograph, represent the area denuded of plating thereby exposing the base metal which has suffered severely from the effects of wear. One of the

(Continued on page 46.)



A 15,000 volt DC rectifier unit for use with the 100 kw. transmitter showing mercury vapour rectifier valves.

A view of the transmitter hall, showing the two 100 kw. transmitters in the foreground and the 50 kw. unit at the rear.

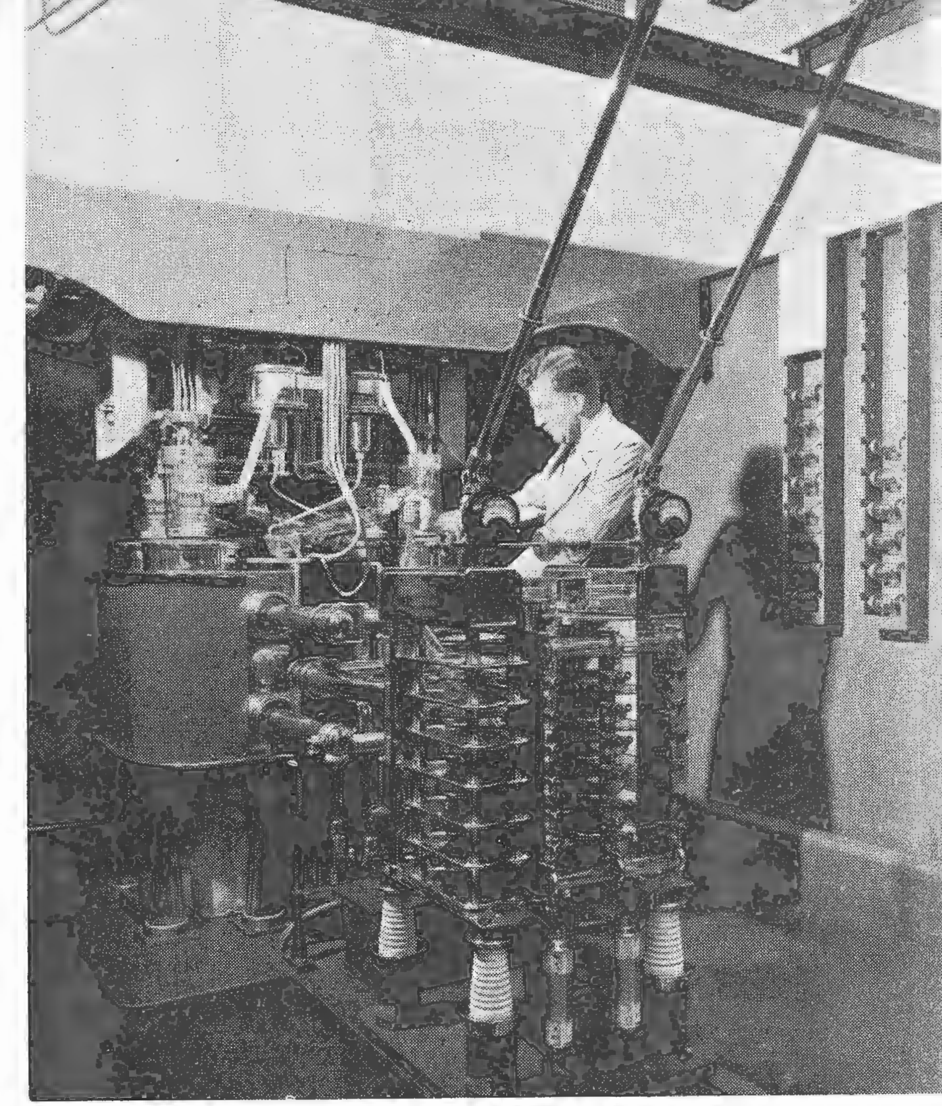
"RADIO AUSTRALIA CALLING"

Controlled and operated by the Postmaster General's Department, RADIO AUSTRALIA uses four high frequency transmitters. All transmitters are located in Victoria—three at Shepparton (120 miles from Melbourne) and one at Lyndhurst (30 miles from Melbourne).

Two of the Shepparton transmitters—VLA and VLB are each 140 kw. maximum power, VLC is 50 kw., whilst the Lyndhurst transmitter VLG is of 10 kw.

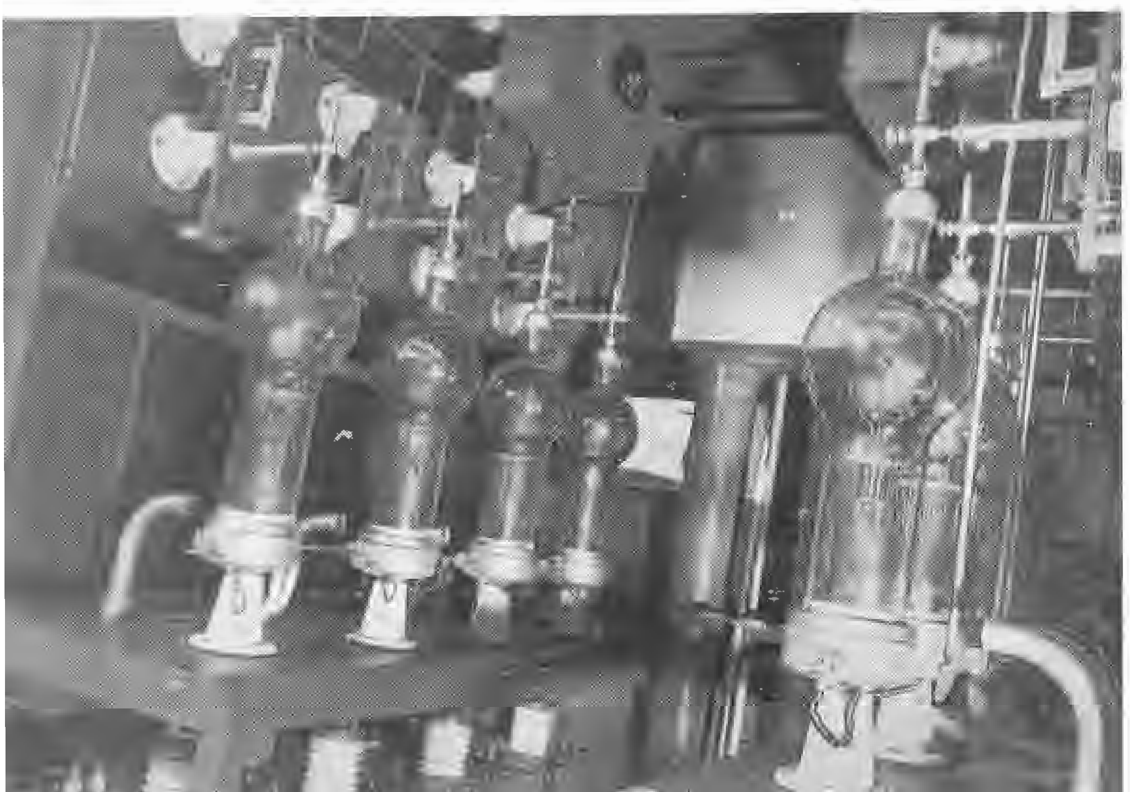
To meet the requirements of adequate transmissions to any part of the world at any time of the day, 19 directional arrays have been erected. These enable transmissions to be carried out on a number of channels in the frequency band from 6 to 22 Mc/s. (13-50 metres). The supporting structures for the aerial system are 14 guyed lattice steel masts, each 210 feet in height, and arranged in a semi-circular arc over a mile in length.

Australian Official Photographs—supplied by courtesy of the Department of Information.

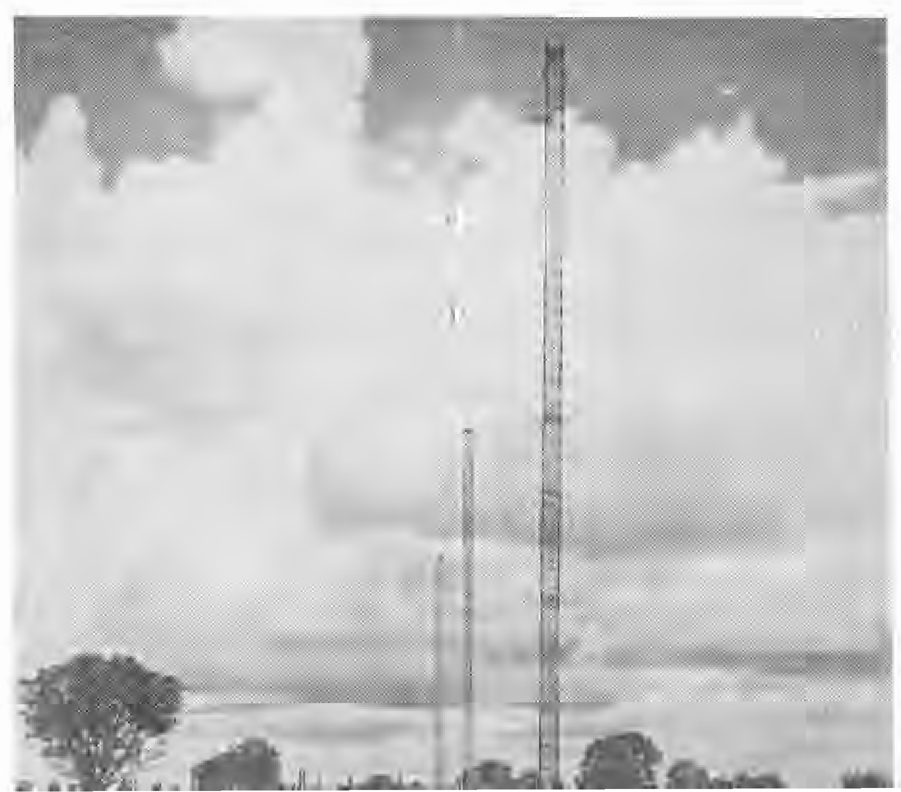


The Australian designed 100 kw. r-f power amplifier installed at Shepparton.

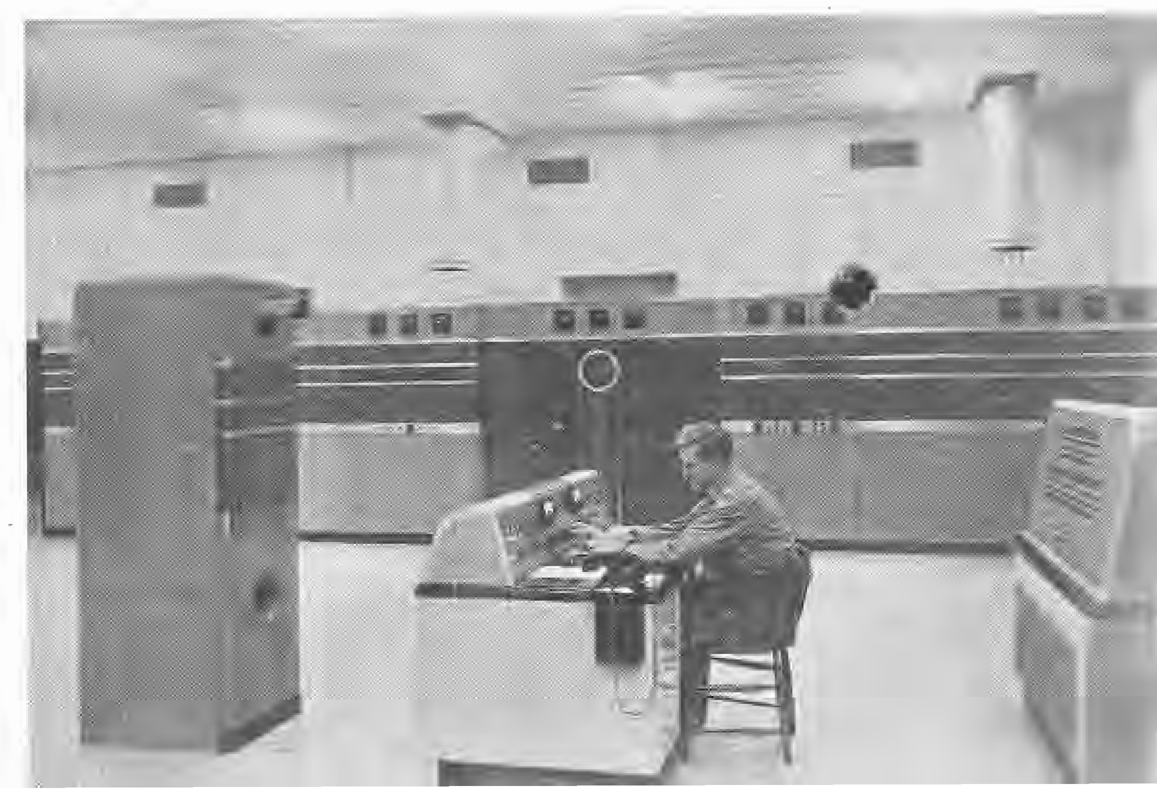
Close up of the modulator unit for use with 100 kilowatt r-f power amplifier.



The North American and South African group of aerials at Shepparton is typical of the aerial systems used.



The 50 kw. high frequency transmitter at Shepparton operating on frequencies 6-22 Mc/s, and consisting of two r-f channels and modulation and power equipment.



For The Serviceman—

A VERSATILE SIGNAL TRACER

The signal tracer is a valuable servicing aid to the successful serviceman. This description of a small portable unit, now available in kit form from the FN Radio and Electronic Co., should be of interest to many such servicemen.

Nowadays with the accent on speedy radio servicing the usual point-by-point method of static voltage and current measurements carried out by the average serviceman is hardly in keeping with modern ideas on the subject.

Whilst this method of servicing may have some merits in that it provides a ready means of checking a stage for correct operating potentials, etc., it is still a very slow process usually necessitating the removal of the chassis from the cabinet. In addition, the system of voltage and current measurement is not completely dependable, since it is possible for any number of defects to exist in a particular circuit without in any way altering the operating potentials, currents or d-c resistance values.

Because of these inherent disadvantages, it is now generally conceded by progressive and successful radio servicemen that the simplest and most logical approach to the problem of diagnosing radio receiver defects is by the principle of signal tracing. The reason for this attitude is not difficult to understand; for here we have the means of readily following the input signal through the receiver, stage by stage under operating conditions, thus enabling the defect to be quickly localised and identified.

Since one of the major objections to signal tracing has centred around the amount of equipment a serviceman can conveniently carry, the general trend has been to simplify the design and construction of such units. As a result the average signal tracer used for radio servicing has now become a small, compact instrument performing one or more functions, so as to simplify as much as possible the tracing of the signal through every section of the receiver.

Main Requirements.

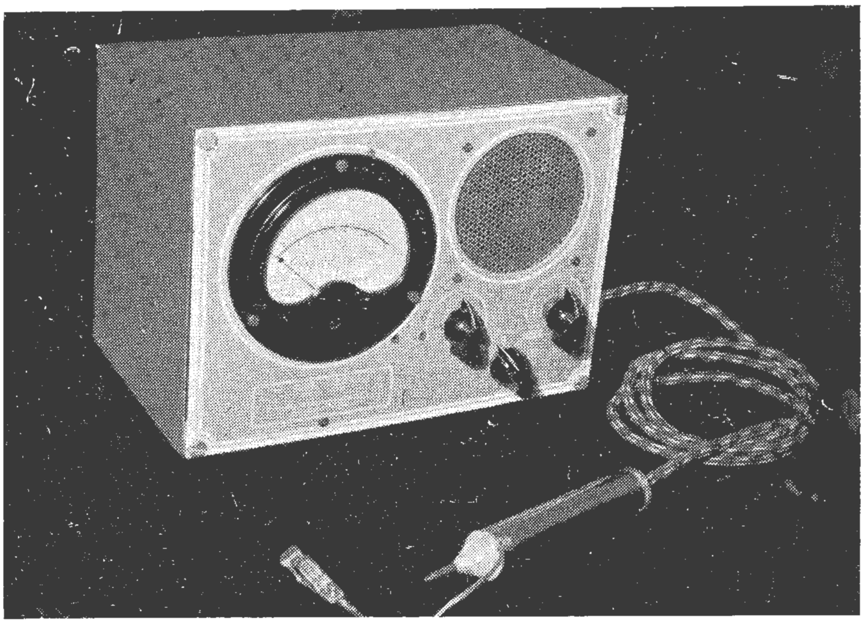
The main requirements of a signal tracer may be briefly summarised as follows: First and foremost it must be able to indicate the presence (or absence) of a signal in every successive stage of the receiver circuit. It must be sensitive enough to give a usefully loud response of signals from the aerial terminal to the voice coil, as well as indicate conclusively the presence, absence and magnitude of the superhet, oscillator voltage, AVC voltage, etc.

In addition it should not load the receiver circuit under test so heavily as to upset performance and perhaps mask out the trouble being sought. To be completely versatile it should give both visual and aural indication, and therefore contain a rectifier to convert the r-f signal into an audible a-f output. It should not require any tuning in operation and to sum up—must function with the essential simplicity and speed of an ordinary DC voltmeter.

In view of the foregoing remarks the signal tracer described in this article embodies most of the requirements listed by providing an r-f, i-f and a-f vacuum tube voltmeter and at the same offering an audible check on the signal quality by means of the loudspeaker, thus permitting maximum flexibility with increased sensitivity. Although no provision has been made for the measurement of voltages, since in any case most servicemen already own some form of multitester, the meter does provide a suitable relative strength indicator, which is particularly valuable when checking stage gains.

The Circuit.

The circuit utilised is particularly simple and consists essentially of a grid leak VTVM and a single stage of a-f amplification. The detector section consists of the 1T4 miniature 1.4 volt valve, connected as a triode, with a .0002 mfd



The completed instrument is fitted in an attractive crackle grey metal case.

PARTS LIST—SIGNAL TRACER

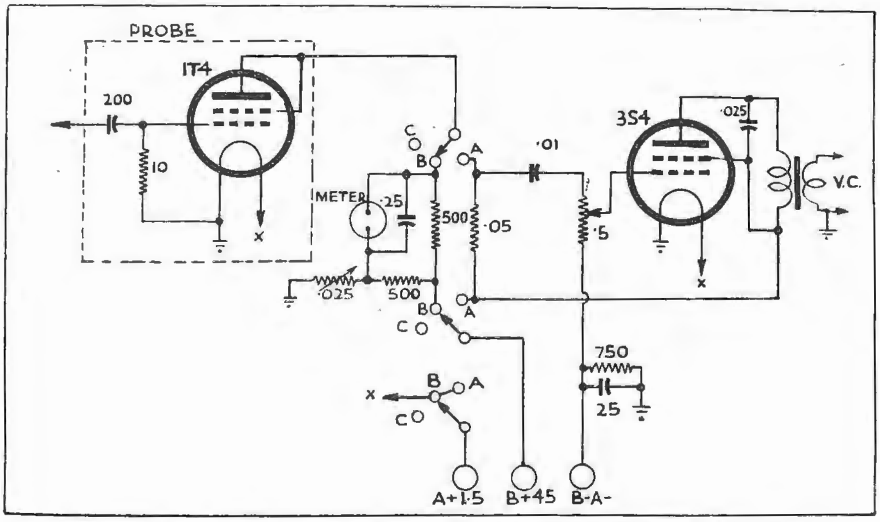
1 Metal case complete with front panel.
1 Meter.
1 3-inch speaker to match 3S4.
1 3 x 3 Rotary wafer switch.
1 probe.

RESISTORS.
1 10 meg ¼ watt.
1 .05 meg ½ watt.
1 750 ohm ½ watt.
2 500 ohm ½ watt.
1 .5 meg potentiometer.
1 .025 meg potentiometer.

CONDENSERS.
1 25 mfd. Electrolytic.
1 .25 mfd tubular.
1 .025 mfd tubular.
1 .01 mfd tubular.
1 .0002 mfd midget mica.

VALVES.
1T4, 3S4.

SUNDRIES.
2 miniature sockets, 3 pointer knobs, hook up wire, shielded wire, nuts and bolts, solder lugs, etc.



Although only requiring two valves, the unit is capable of very good results.

coupling condenser and 10 meg grid resistance, all mounted in the probe shield. The condenser acts as a blocking condenser isolating any DC voltages from the input circuit, whilst the 10 meg resistor acts as a grid return and bias resistor. This high value also means that the input impedance of the grid circuit is kept high, thus reducing any loading effect on the circuit under test to a low value.

One of the characteristics of the VTVM circuit used is large idling current due to the lack of bias. The operation of this circuit may be briefly described as follows:, Under no signal conditions, plate current will flow since there is no bias on the valve. When a signal is received, rectification takes place and the grid current flowing through the grid resistor biasses the valve causing the plate current to drop.

Reverse Meter Leads.

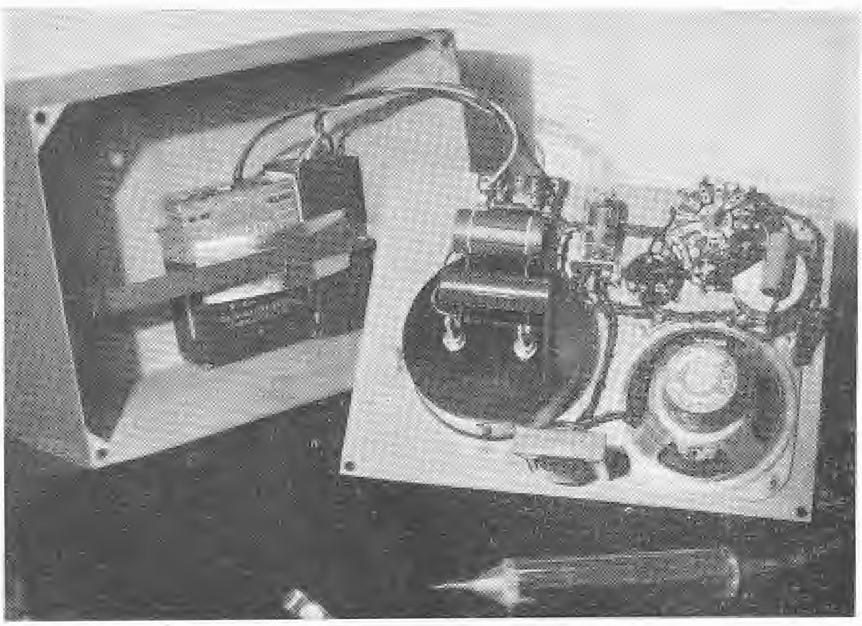
The net effect of this on a meter connected in the circuit would be to make it read backwards. To overcome this difficulty and enable the meter to indicate positive current readings for decreases in valve plate current, the meter is connected in reverse—that is positive to the plate and negative to B plus.

In order that the meter will indicate "zero" under no input signal conditions, a "bucking" voltage is applied across the meter. This is carried out by using the balancing potentiometer provided in the circuit, and consequently once adjusted will allow the meter to indicate across the scale in the conventional manner when an input signal is received. It should be noted that the calibration of this meter is not in volts, but simply in relative signal strength units.

A three position switch has been incorporated in the circuit, and this allows either VTVM or "speaker' to be selected at will. The third position is simply the ON-OFF position and it will be noticed this breaks both the filament circuit as well as the high tension lead.

With the switch in position A, the output from the 1T4 is now taken to the grid of the output valve via the .05 meg load resistor and .01 mfd coupling condenser. This enables the received signal to be heard on the speaker instead of being indicated on the meter—a valuable asset when checking for distortion. The volume is controlled by means of the .5 meg control in the 3S4 grid circuit.

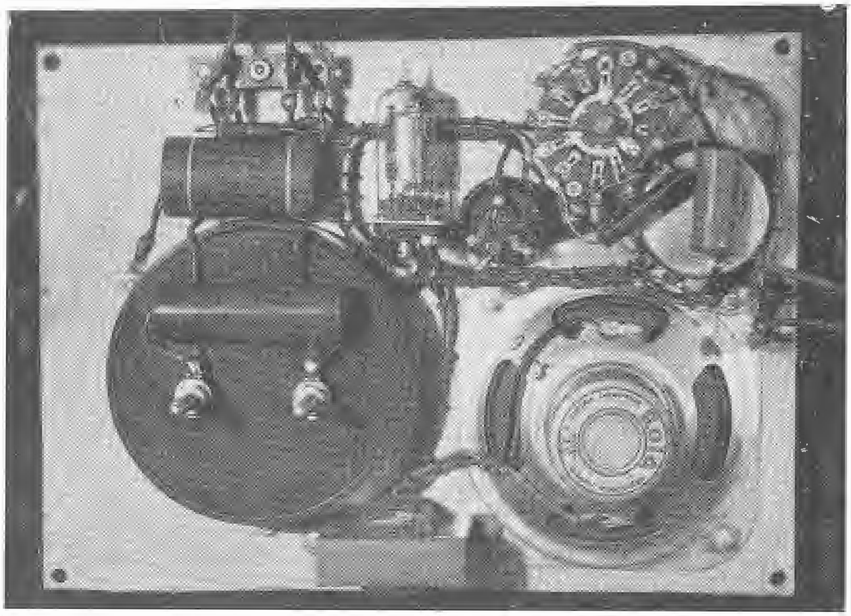
The necessary bias for the valve is provided by the 750 ohm resistor connected as shown between the grid return lead and earth.


A general view of the components inside the case. Note the small metal plate holding the batteries securely in position.

Construction.

The actual construction of the unit is not difficult and the location of most components can be clearly seen from the various photographs.

The meter, speaker, amplifier attenuator control, meter zero setting control and combined ON-OFF, meter and speaker switch are all mounted on the



A close-up of the completed wiring. The various leads are tied together for neatness, and are made as short and direct as possible.

front panel in the positions shown. The speaker transformer is placed near the top of the panel between the speaker and meter, and uses one of the speaker mounting bolts as a support.

The 3S4 is mounted on a small aluminium right angle bracket, rivetted to the front panel and placed adjacent to the meter balancing potentiometer.

The remainder of the condensers and resistors are placed as close as possible to their circuit, and for neatness all leads should be bundled and tied together as shown in the photographs.

The 1T4, with the .0002 mfd condenser and 10 meg grid leak are mounted in the detector probe. To do this it is necessary to remove the small metal mounting lug fitted to the miniature socket. By using thin rubber covered wire for plate and filament voltage leads it will be found that the whole assembly will just fit snugly into the metal probe. However it should be remembered that the toleranses here are rather fine, and any thicker type of hookup wire will not be suitable. The .0002 mfd condenser is soldered direct from the valve socket to the probe point, whilst the small (¼ watt) 10 meg resistor is earthed into the small metal shield in the centre of the socket.

Some Uses.

With the unit completed, the following notes on general signal tracer usage will be particularly helpful, especially to the beginner who previously may not have used this type of instrument.

Turn the signal tracer ON, set the control to "speaker" and attach the grid return to the receiver chassis under test. For the purpose of the discussion assume this to be a superhet.

First of all place the probe on the antenna, when it should be possible to hear some station or stations weakly. Move it on to the grid of the mixer valve (assuming no RF stage)—rotate the tuning condenser, when stations should be heard separately and in signal tracer speaker. Lack of signal at this point indicates a faulty aerial coil.

If signals are satisfactory, place probe on the mixer plate, when it should be possible to hear stations at a much greater volume. No signals might indicate—no plate voltage, defective valve, shorted screen condenser, etc.

Next pass on to the I.F. amplifier grid —here the signals should be heard again similar to the plate of the mixer valve.

With the probe on the I.F. amplifier plate — very strong signals and possibly necessary to turn down attenuator. Lack of signals here possibly due to defective valve, no plate voltage, screen grid trouble, open cathode circuit.

Test the diode plates—signal again should be heard and this can be followed to the high side of the diode load resistor (usually the volume control) where only the audio voltage should be present.

Apply probe to the high end of the volume control—if satisfactory, clear strong signal should be heard, as the tracer automatically biasses itself for r-f or audio signals.

Grid of the first audio—volume approximately the same as at the diode.

Plate first audio—much louder signal. Any defect will readily show up. Weak signals may be due to weak tube; improper bias will cause distorition; whilst lack of signal is probably due to an open plate resistor.

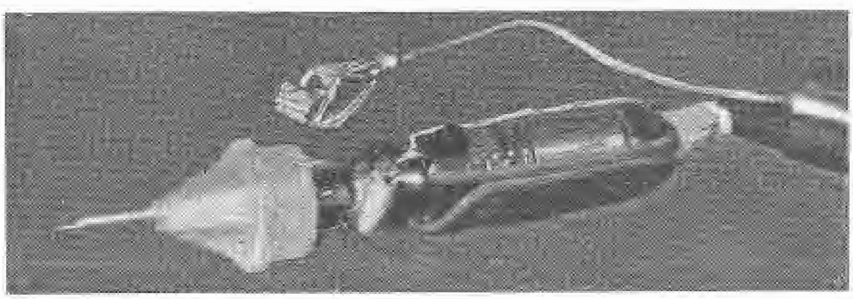
Grid and plate of the output valve—increase in volume of the signal. A distorted signal may be caused by a leaky coupling condenser, shorted cathode condenser, open grid resistor, etc. The final test is then to place the probe on the voice coil leads. If in this case the tracer responded to signals but the receiver was dead, then an open voice coil lead would be indicated.

Versatile Unit.

Although it has been only possible to briefly outline the use of this instrument, it should be realised even from this that a receiver can be checked through very rapidly. By its intelligent use, the instrument can be used to test for open, noisy, shorted resistors, coils, condensers and transformer windings, whilst bad or weak valves can all be tested under actual operating conditions.

In addition, hum can be traced to its originating source by placing the probe on the B plus leads. In this case the percentage of ripple is amplified by the tracer. Fading circuits are also isolated by noting the circuit where the signal remains constant and where fading originates.

With the use of this signal tracer, a volt-ohm-milliameter and a spare set of good valves, the faults in any receiver can be completely and rapidly diagnosed. without the use of any additional equipment.



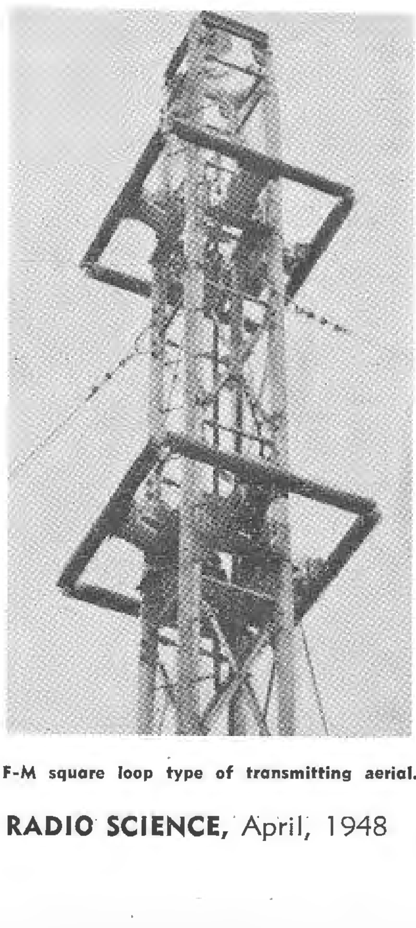
The probe assembly details are shown in this enlarged photograph.

F. M. ANTENNAS

A discussion of the Design, Operation and Installation of Antennas which can be used for F-M reception. Factors consided include Height, Polarization, Reflection,, Transmission Lines and Impedance Matching.

The advent of highly-efficient loop type antennas and high gain input circuits in AM receivers outmoded outdoor installations in many instances. Today with the coming of FM receivers we find that the outdoor antenna is once more an essential factor. For in many areas, an outdoor antenna is required to provide sufficient pickup to properly operate the FM limiter and provide noise-and-distortion-free signals.

Since the FM carrier is at a much higher frequency than that for AM transmissions, it will be necessary to use an antenna that will be efficient at these higher frequencies. Experience has shown that an outside antenna of the dipole type, correctly installed will give the best results.



F-M square loop type of transmitting aerial.

Half Wave Antenna.

The simplest antenna for FM reception is the half wave dipole and consists of two quarter wave rods spaced about 1 inch apart at the centre. This antenna provides a radiation resistance of about 72 ohms at resonance. A dipole resonates when its length is approximately equal to one half wave length of the frequency that it is to be used on.

The overall length of the half wave dipole for any desired frequency can be computed from the equation:—

$$L \text{ (in feet)} = \frac{492 \times 0.94}{\text{Frequency (Mc)}}$$

Each rod of the dipole will then be one-half the overall length. The factor 0.94 compensates for the end effect at high frequencies and consequently the actual length of a half wave antenna will not be exactly equal to one-half wavelength of the frequency it is to be operated on, but will be about 5 per cent. less.

In actual practice the length of the antenna depends on a number of factors. If the antenna is to pick up signals from only one station, then the overall length should be calculated from the middle of the frequency band for that particular station. However, in most cases it is desired to be able to pick up signals from a number of different stations in the band and, therefore, some compromise must be made in the exact length of the antenna.

The usual procedure is to cut the antenna so that it will be $\frac{1}{2}$ wave length long at the centre of the range it is desired to cover. For the range of frequencies from say 88-108 Mc. the antenna should be cut so that it will be a half wave length long at the frequency of 93 Mc. Substituting this value in the foregoing equation, we find that the overall length of the antenna would be:—

$$L \text{ (feet)} = \frac{492 \times 0.94}{98}$$

$= 4.72$ feet, that is approx. 4ft. 8in.

Consequently the length of each half of the dipole would be 2ft. 4in. approximately.

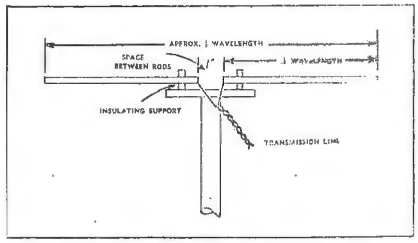


Fig. 1.—A half-wave dipole antenna used for F-M reception.

Range of F-M Signals.

For all practical purposes the frequencies assigned to F-M are too high to be refracted back to earth by the ionosphere, as is the case for frequencies somewhat lower. The critical frequency above which refraction in the ionosphere fails to return signals back to earth depends upon the electron density of the ionized region which has daily, seasonal and yearly variations, dependent upon the sun's radiation. For this reason F-M must depend upon waves travelling directly from transmitter to receiver through the space above the ground. However, due to the curvature of the earth the range of the signals is limited to moderate distances.

Signals received over a greater distance than the straightline path are unreliable because of such factors as refraction. Refraction of ultra-high frequencies by the earth's atmosphere comes about because the variation of atmospheric temperature, pressure and moisture content with height, cause the refractive index of the atmosphere to decrease with elevation and tends to bend the waves back towards the earth.

The amount of curvature that results varies with atmospheric conditions but, on the average, it is equivalent to assuming that the earth's diameter is increased by 25 to 35 per cent. However, due to the continually varying conditions upon which this refraction depends, it is obvious that a signal travelling along this path will not be reliable and, consequently, we must depend upon the

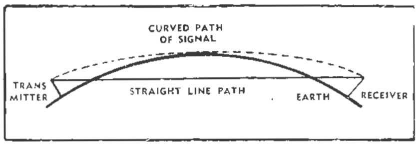


Fig. 2.—This diagram shows the refraction path of an F-M signal.

straight-line path or the line-of-sight path for dependable F-M reception.

The range of a station, considering only the straight-line path depends upon the heights, Ht and Hr of the transmitting and receiving antennas respectively.

According to the formula: Maximum distance for straight-line path = 1.23 ($\sqrt{Ht} + \sqrt{Hr}$), where the antenna heights are in feet and the distance is in miles.

If atmospheric refraction is considered, the distance is increased by a factor of 1.25 to 1.35, depending upon the atmosphere's refractive index, K. In Fig. 3 there are several curves showing the effect of antenna heights and atmospheric refractions upon the direct line-of-sight transmission. With the exception of the path, all curves are calculated on the basis of the effective range being increased by a factor 1.3 because of refraction in the earth's atmosphere.

In Table I appears a chart giving the range for several transmitting antennas in excess of 1,000 ft. It is of interest to note that when one antenna is high (usually the transmitting antenna) and the other relatively low, a given number of feet increase in either antenna is much more effective in increasing the range if it is applied to the lower antenna. This may not at first be apparent until we reconsider the fact that the line-of-sight range is directly proportional to the square root of the height of either antenna.

For example, if one antenna is 10 ft. high and the other 1,000 ft. high, the straight-line path in miles will equal:

$D = 1.23\ (\sqrt{10} + \sqrt{1000})$

$= 1.23\ (3.16 + 31.6) = 42.75$ miles.

Now suppose we increase the height of the lower antenna by 90 ft., the straight-line path will now be:

$D = 1.23\ (\sqrt{100} + \sqrt{1000})$

$= 1.23\ (10 + 31.6) = 51.8$ miles.

Now suppose that instead of increasing the lower antenna by 90 ft. we had increased the higher antenna by 90 ft., the straight-line path would have then been:

$D = 1.23\ (\sqrt{10} + \sqrt{1090})$

$= 1.23\ (3.16 + 33) = 44.5$ miles.

From the foregoing example, it is obvious that since receiving antennas are relatively low and transmitting antennas relatively high, that increasing the height of the receiving antenna is much more effective than increasing the height of the transmitting antenna an equal amount. Therefore, the importance of placing the receiving antenna as high as possible when the receiver is located a considerable distance from the transmitter, can now be realised.

Polarization of Antenna.

Since a radio wave consists of magnetic and electrostatic fields at right angles to each other, the polarization of a radio wave simply means the relationship of the electrostatic field with respect to the earth, as the radio wave travels into space. If the electrostatic field is vertical with respect to the earth, the radio wave is said to be vertically polarized. If the electrostatic field is horizontal with respect to the earth, the radio wave is said to be horizontally polarized. If the arms of a dipole transmitting antenna are vertical with respect to earth, then the antenna is said to be polarized vertically and for maximum induced voltage the receiving antenna should also be verticaly polarized, i.e., the arms of the receiving dipole must be vertical with respect to earth.

If the arms of the transmitter dipole are horizontal with respect to the earth, then it will send out a horizontally polarized wave and, therefore, for maximum signal pickup the receiving antenna should also be horizontally polarized.

It has been found that a horizontally polarized receiving antenna is less susceptible to ignition noise and other electrical interference and, consequently most F-M transmitting antennas send out a horizontally polarized wave.

Response Characteristics of the Dipole Antenna.

The solid curve of Fig 4 illustrates the horizontal directivity of a horizontal dipole antenna. As shown, the signal pickup is greatest when the signal arrives in a direction that is at right angles to the broad side of the antenna. In other words, for maximum signal pickup, the broadside of the antenna should be pointed in the direction in which the signals are arriving from, i.e., toward the transmitting antenna.

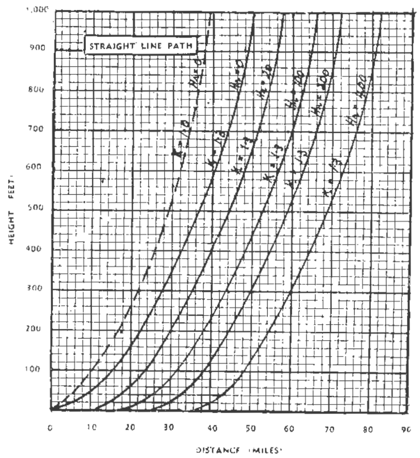


Fig. 3.—These curves show the effect of antenna heights and atmospheric refractions upon the line-of-sight transmission.

An inspection of the plot shows that in the direction along the axis of the antenna the signal pickup is practically zero. Use can be made of this fact in locations having a high-noise level by rotating the antenna so that its axis points in the direction from which the noise signal is arriving. Such an orientation may decrease the signal pickup somewhat since the broadside of the antenna may not be pointing exactly in the direction of the arriving F-M signal, but will be very beneficial because of the very great reduction in noise signal pickup.

As shown by the plot, the horizontal dipole responds equally well to signals arriving in either direction that are at right angles to the broadside of the antenna, and under certain conditions this is undesirable.

Noise Source.

For instance, if there is a noise source near the antenna such that the noise signal from it arrives in a direction that is just the opposite from that of the arriving F-M signal, as shown in Fig. 5, it will greatly reduce the signal-to-noise ratio which may result in poor reception. This undesired condition can be greatly reduced by making use of a reflector.

Table 1. This chart gives the range of several antenas in excess of 1000 feet. Hr is the height of the receiving antena.

Height	Straight Line Path	With Atmospheric Refraction, K—1.3	Hr 20′	Hr 40′	Hr 100′	Hr 200′	Hr 401′
1,250	44	57	64	67	73	79	89
1,500	48	62	69	72	78	85	94
2,000	55	72	79	82	88	94	104
3,000	68	88	95	98	104	111	120
4,000	78	101	108	111	117	124	133
6,000	95	123	130	133	139	146	155
10,000	123	160	167	170	176	183	192

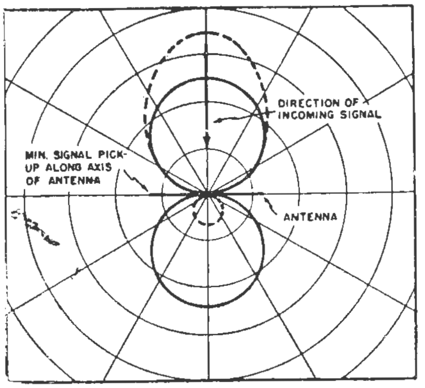


Fig. 4.—Horizontal radiation pattern of a dipole.

A reflector is simply another rod which is placed parallel to and in back of the receiving dipole. The reflector element is usually about 5 per cent. longer than the receiving dipole and is placed about ¼ wavelength in back of the receiving dipole with a resulting gain in signal pickup of about 3 db in the direction in which the broadside of the receiving dipole is pointed; a half-wave dipole with a reflector is shown in Fig. 6.

The directional characteristics are illustrated by the dashed curved in Fig. 4, and, as shown results in strengthening the desired signal and also in greatly reducing any interfering signal that comes from a direction which is directly in back of the receiving dipole.

When a reflector is added to the regular dipole it increases the antenna directivity considerably, so that the orientation of the antenna array with respect to the direction of the incoming signal is a rather critical adjustment for optimum results. When installing antennas of this type it is usually advisable to check the results of rotating the antenna by listening to the receiver. This normally requires two men to make the installation, one on the roof at the antenna and the other at the receiver, with an intercom. system to relay two-way messages.

Transmission Lines.

A transmission line is used to transfer power with a minimum of loss from its source to the device in which the power is to be usefully expended. At r-f where every wire carrying r-f current tends to radiate energy in the form of electromagnetic waves, special design is necessary to minimise radiation and thus permit as much as possible of the input power to be delivered to the receiving end of the line.

There are various types of transmission lines in use, namely, the open-wire line which consists of two parallel wires maintained at a fixed spacing of a few inches by insulating spacers; the twisted-pair line which consists of two rubber-insulated wires twisted together to form a flexible line; the coaxial or concentric line which uses a wire conductor centred inside of a metal tube which is used as the outer conductor; the flexible coaxial line which uses solid insulation between the inner and outer conductors, instead of spacers or beads, with the outer conductor being made of copper braid rather than solid tubing so that the line will be flexible; the shielded pair balanced to ground which consists of two parallel wires maintained at a fixed spacing by solid insulating around which is an outer shield of copper braid.

Twisted and Parallel Lines.

The open-wire line has a fairly low attenuation loss per wavelength, but due to its rather high surge impedance it is more difficult to balance out extraneous signal pickup. The most usual method of transferring the signal from the antenna to the receiver is by means of a low-impedance twisted or parallel pair transmission line, which has a surge impedance of about 100 to 300 ohms. An ordinary twisted pair line is not satisfactory for this purpose since it probably will not have the correct surge impedance and will also probably have a high attenuation loss.

A special type of twisted or parallel pair line is made for this purpose, having the correct surge impedance and the proper kind of insulating material to keep the attenuation losses as low as possible, even after being exposed to the elements. However, even the best line has a fairly high attenuation loss, about 3 db per 50 ft. of length at 100 mc. A twisted or parallel pair transmission line is usually satisfactory for distances up to about 100 ft., but for distances beyond this it is advisable to use one of the low-loss transmission lines, such as the coaxial line or the shielded pair balanced to ground.

Impedance Matching.

In the foregoing paragraph, mention was made of the surge impedance of a transmission line. The characteristic or surge impedance of a line is not determined by the ohmic resistance of the conductors, but by the construction of the line and is equal to the square root of the ratio of inductance to capacity per unit length of line; thus $Zo = \sqrt{L/C}$.

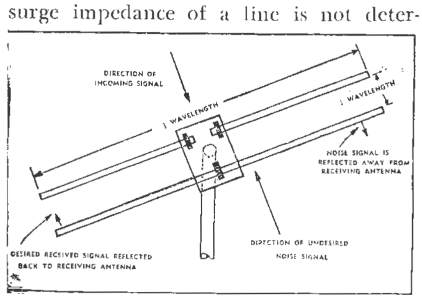


Fig. 6.—A half-wave dipole fitted with reflector to improve signal to noise ratio.

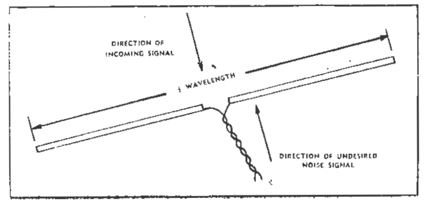


Fig. 5.—Signal response of a half-wave dipole.

Therefore, every transmission line has a characteristic or surge impedance, which acts as a pure resistance, the value of which depends on the construction of the line.

If a transmission line is terminated in its characteristic or surge impedance it is equivalent to an infinitely long line and there will be no standing waves or reflections along the line and the line is said to be non-resonant. The input end of a transmission line that is terminated in a resistance equal to its surge impedance will appear as a pure resistance having a value equal to the characteristic or surge impedance of the line.

However, if the transmission line is not terminated in a load that equals the surge impedance of the line, then there will be standing waves produced along the line which may result in a serious loss of signal between the antenna and the receiver, depending upon the amount of mismatch between the load impedance and the surge impedance of the transmission line.

For maximum transfer of power from the source to the load, it is necessary that the load impedance be equal to the source impedance. When the average resistance at the centre of a half-way dipole varies from about 72 to 100 ohms the antenna input circuit of the receiver is designed for an impedance of about 100 ohms, so that there will be a maximum transfer of energy from antenna to receiver.

The transmission line is usually balanced to ground by means of a centre tap on the primary of the antenna transformer so that any noise signal picked up by the line will cancel out.

From the foregoing it is evident that for the maximum transfer of signal from the antenna to the receiver it is necessary that the surge impedance of the transmission line match the input impedance of the receiver at least fairly closely, and also that the input impedance of the transmission line match the impedance at the centre of the dipole.

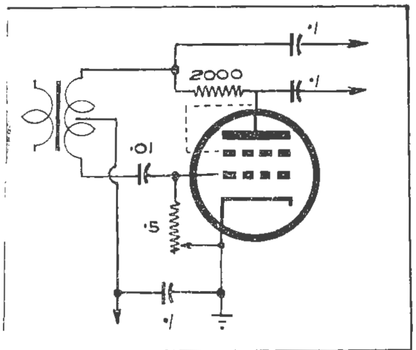
(Continued on page 46.)

FOR THE EXPERIMENTER

By A. H. NICHOLLS, VK2NI

Audio Oscillator.

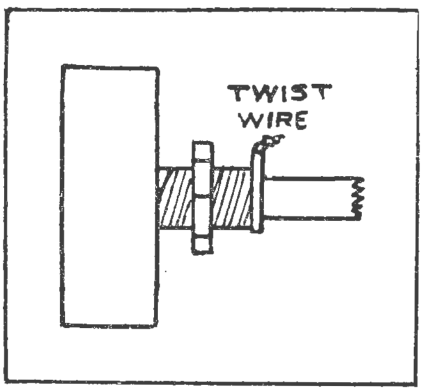
This circuit may be used as an audio signal generator or code oscillator. Any centre tapped speaker transformer may be used for the inductance, whilst any triode or pentode (connected as a triode) is suitable for the valve. The frequency is adjusted by the use of the .5 meg. potentiometer in the grid circuit.



The audio oscillator circuit. Any triode or pentode connected as a triode will operate satisfactorily.

Repairs to Volume Controls.

Sometimes volume controls that are noisy when rotated can be repaired by "pulling" the shaft outwards. This holds the wiper tightly against the element. A permanent cure may be affected by twisting a piece of wire of about No. 22 gauge around the shaft at the neck of the bearing as shown in the drawing.

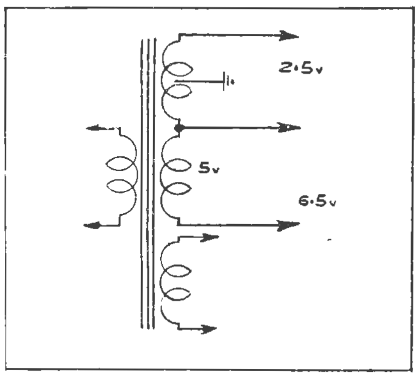


Twisting a piece of wire around the volume control shaft will often cure a "noisy" control.

Dip Soldering.

For anyone using a solder pot for repitition sweating of cable ends, lead tips, etc., here is an idea to prevent "scum" forming on the surface of the molten solder. The accumulation of this film can be reduced by floating a layer of powdered charcoal on top of the molten metal.

A ¼-inch layer will suffice for most purposes and this will allow the work to be dipped without any charcoal adhering to it. The charcoal will not tarnish the work, but make sure only wood charcoal is used as the bone variety usually contains impurities.



This is the method of connecting the 5.0 and 2.5 volt windings to obtain 6.3 volt output.

2.5 Volt Heaters.

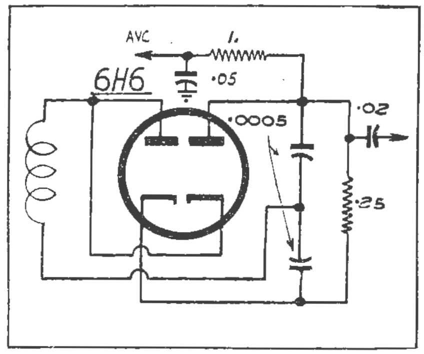
Many good sets in use nowadays are a headache to the average radio serviceman because of the irreplaceable 2.5 volt valves used in the circuit.

Whilst similar types are available in the 6.3 volt counterpart, most old sets using the 2.5 volt series have no 6.3 volt winding on the power transformer.

The simplest way out of this difficulty is as follows: Replace the 80 with a 6X5-GT. This then frees the 5.0 volt winding which is connected in series with *one half* of the 2.5 volt winding. This gives an output voltage of approx. 6.4-6.5 volts which is quite suitable for the 6.3 volt valves as well as the 6X5-GT rectifier.

Voltage Doubler Detector.

This voltage doubler circuit gives greater AVC control voltage and as well as an increase in signal voltage. Consequently it is an advantage in some cases over the usual diode detector circuit.

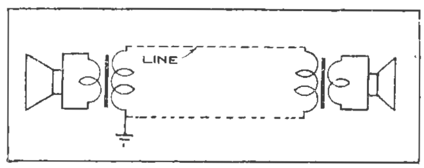


This voltage doubler detector circuit give increased signal and AVC voltages.

Simple Intercommunication System.

A good intercommunication unit can be made up using two 3 inch speakers. The speakers of modern design have exceptionally good magnets and will work with quite usable volume for distances up to 100 feet.

Each unit may be mounted in a discarded clock case which makes an attractive unit for the desk.



A simple intercom, system can be wired up using two modern permag. speakers.

U.H.F. Techniques

By
HARRY N. EDWARDES, B.Sc., B.E.

In this second article of the series, the ever important subject of oscillator operation and requirements from an U.H.F. point of view are discussed in some detail.

Any U.H.F. system, whether it be a communication link or radar, consists essentially of a transmitter, transmission line (comprising feeders, aerial and the ether) and a receiver. The transmitter is a source of U.H.F. energy, usually at a high level, and it may be either a single power oscillator stage, an oscillator driving a "straight" power amplifier or an oscillator followed by frequency multiplier stages and a power amplifier. Invariably some form of modulation is applied to the carrier produced by the U.H.F. generator. For example, square pulses are used in Radar while video signals are applied to the carrier in Television.

The particular arangement employed in a transmitter depends upon the power output necessary for the system, the tubes available for the frequency, the desired frequency "stability," and the type of modulation to be used. Where high stability is required in order to facilitate the tuning of the receiver, or in order to keep within an allotted band, a low frequency crystal master oscillator followed by multiplier and power amplifier stages is employed.

THE AUTHOR

HARRY N. EDWARDES, was born at St. Mary's, N.S.W. in August, 1920. From North Sydney Boys' High School, he proceeded to Sydney University where he graduated as B.Sc. in 1940 and as B.E. (Hon. 2 Elec.) in 1942. Since September, 1941 he has been engaged as a radio research officer at the Council of Scientific and Industrial Research, Radiophysics Laboratory, Sydney on radar development work.

Oscillator Applications

Since superheterodyne receivers are invariably used in U.H.F. applications a U.H.F. local oscillator is necessary. This is a low power source, and generally consists of only one stage. Crystal controlled local oscillators are often used, whilst in most centimetre radars, automatic frequency control of the local oscillator (invariably a klystron) is a standard feature. A smooth and convenient tuning control and good stability are requirements for local oscillators.

Other applications of U.H.F. oscillators are in signal generators for receiver and other testing, and in test oscillators for aerial pattern measurements and impedance measuring equipment, such as Q-meters and standing wave indicators. The powers involved in these applications are very low (of the order of a few hundred millawatts) and the stress is on frequency stability and constancy of frequency calibration, precautions being taken against the effects of temperature changes and radiation leakage.

Although the requirements of U.H.F. amplifier tubes and circuits are very similar to these of oscillators, it is proposed to deal mainly with the latter in this article.

The most important part of any U.H.F. source is the vacuum tube or valve, and in this respect progress has been along two main lines: Firstly, the improvement of the triode feedback oscillator tube as well as other tubes suitable for power amplifiers, and, secondly, the development of special tubes such as the klystron and magnetron. These latter will be the subject of a future article. The factors affecting the design of other tubes for U.H.F. will be discussed here; various tubes will be described and the circuit and associated techniques dealt with.

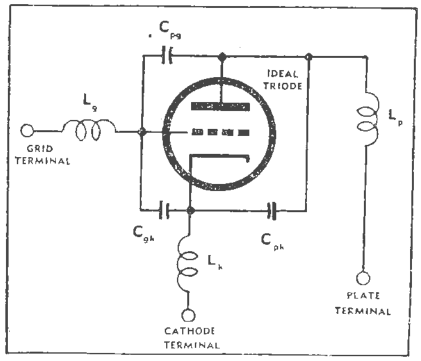


Fig. 1.—Equivalent circuit of a triode at U.H.F.

Design Factors of U.H.F. Tubes.

A radio frequency oscillator is a device for producing steady periodic oscillations. The essential components of any oscillator is an amplifier, the output of which passes into a network which controls the frequency, as well as supplying a component of suitable phase which is fed back to the input of the amplifier. Thus an oscillator is an amplifier supplying its own input RF power. Energy is extracted from the DC supply and transformed into RF energy in the output

A conventional triode will oscillate satisfactorily up to about 10 Mc/s. At higher frequencies operation is conditioned by various factors:—

(1) **The capacity and inductance of the tube elements.**

(2) **Power losses due to the dielectric material of the tube base, skin effect in the conductors and radiation from the circuits.**

(3) **Transit time of electrons from grid to plate.**

The interelectrode capacities and inductance of the leads which are connected to the tuned circuit add to the reactance of that circuit and hence set an upper limit to frequency corresponding to the tube capacity and inductance alone. Large capacities in the tank circuit will allow heavy circulating currents

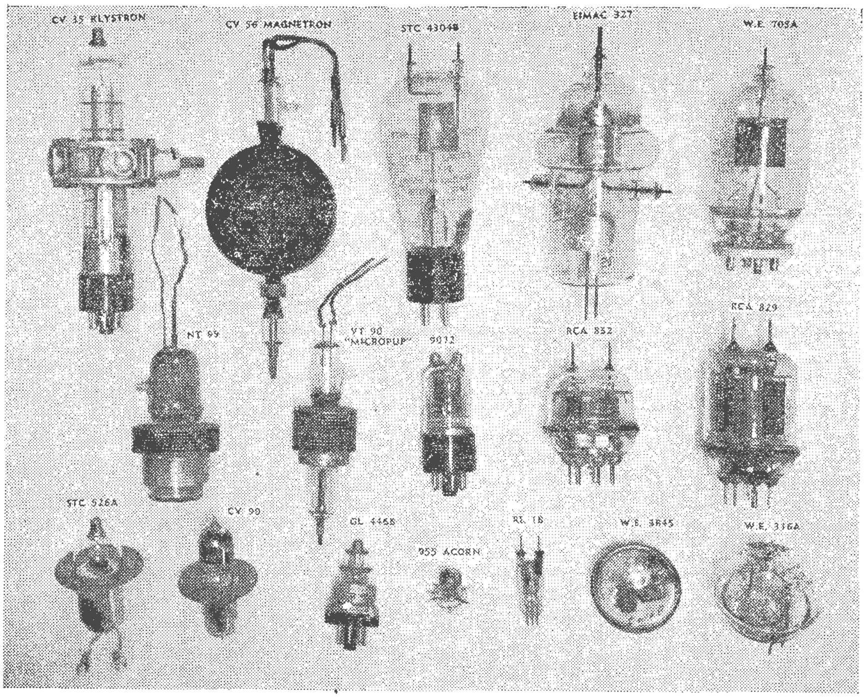


Fig. 2.—A representative group of valves used in U.H.F. equipment.

causing power to be lost in the circuit resistance. For example, every 1 uuF of capacity in the tank circuit of an oscillator with 1,000 volts R.F. across the tank circuit gives rise to a circulating current of 2 amps. For this reason alone interelectrode capacity should be small. Also this interelectrode capacity is known to vary with voltage so that in the interests of frequency stability it must be kept to a minimum.

Interelectrode capacities are diminished by reducing the sizes of the elements, whilst maintaining a reasonable spacing, although increased spacing increases electron transit time. Special grid structures are also employed.

Reducing Lead Inductance

Although inductance in the leads of a tube can limit the frequency, there is no accompanying loss as in the case of interelectrode capacity. The method of reducing lead inductance is to eliminate the normal base and to bring the connections through the glass envelope as close to the elements as possible. Multiple parallel connections are often employed, whilst in some tubes large pieces of metal, to which the glass is sealed, form the elements.

To facilitate the analysis of U.H.F. circuits an equivalent circuit for a tube at R.F. as shown in Fig. 1 is employed. This takes into account capacity and inductance in the tube itself. By eliminating the base, dielectric losses are also minimised. The conductors are brought through the glass envelope at points where the R.F. voltage is low (i.e., potential nodes in the oscillating circuit). The use of low resistance conductors of large surface area reduces skin effect losses to a very low value.

Electron Transit Time

Electron transit time is probably more serious than any of the above factors in reducing tube performance at U.H.F. The electrons take a finite time to travel from cathode plate, so that there is a certain amount of inertia connected with the control the grid voltage exercises over plate current. The electrons do not arrive at the plate in the correct "phase" to maintain oscillations and their energy is dissipated in heat.

Ferris & North have shown, however, that the real limit to frequency due to transit time is a result of a reduction in grid input resistance, which is normally very high, so that energy is fed into the grid and is dissipated as heat. This effect is called grid loading. The relation between grid input conductance and transit time is:—

$$G = KSkf^2T^2$$

where G is grid input conductance, K is a constant depending on tube geometry.

Sk is cathode slope, i.e., change of cathode current with grid potential,

f is frequency,

T is transit time (seconds).

Transit time may be reduced by using small electrode spacings (unfortunately accompanied by higher capacities) and higher anode voltages. In low power oscillators the former is employed while for high power oscillators, where interelectrode insulation is to be considered, increased accelerating voltages are used. In pulsed circuits such as Radar transmitters, it is possible to employ much higher voltages than in CW operation. Voltages employed in high power oscillators are of the order of tens of kilovolts so that considerable separation between the tube leads is necessary as well as proper precaution regarding corona discharge which may take place from sharp corners and edges.

Heat Dissipation

Because of the small structures demanded by the methods of reducing interelectrode capacities and transit time, dissipation of heat becomes more difficult with increasing frequency. Since all of the energy supplied from the DC anode is not converted into RF energy as a result of inefficiency, the surplus must be dissipated or conducted away from the tube. This dissipation, together with the efficiency of the tube determines the maximum power output available. In high power oscillators tantalum plates operating at red heat for improved dissipation are common. Conducting fins are fixed to the anodes of some tubes while air blast cooling and water cooling are resorted to in many instances.

Heating of the grid due to the proximity of the filament is also considerable in U.H.F. tubes. Good filament emission is necessary to provide the heavy circulating currents in the interelectrode capacitances of high power tubes. For pulsed operation particularly, the cathode is called upon to supply heavy currents

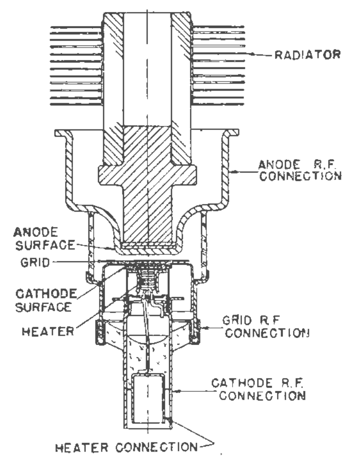


Fig. 3.—A sectional drawing of the 2C39.

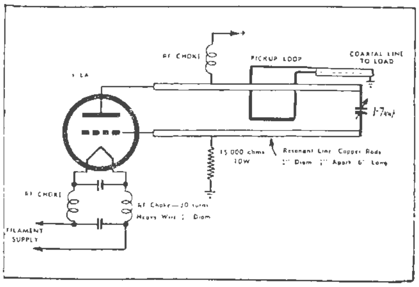


Fig. 4.—The ultra-audion oscillator circuit.

for a short time. High power tubes usually have tungsten bright emitter filaments although coated cathodes are used in smaller tubes.

Some U.H.F. Tubes.

During the pioneering days of U.H.F. in the absence of special tubes, experimenters used such expedients as removing the bases from conventional tubes (e.g. the 201A).

Of the special U.H.F. tubes the Western Electric 316A *doorknob* (Fig. 2) was probably among the earliest developed. The name is taken from the shape of the glass envelope through which the short, well spaced leads project. The electrode structure is small, transit time setting the upper limit to frequency. This tube is capable of producing an output of about 5 watts at 300 Mc/s. A later development in doorknobs, the Western Electric 368A has a frequency limit of about 1,700 Mc/s. In this tube the grid and place supporting wires pass right through the envelope so that the tube may be inserted in the centre of a half wave line, the plate-grid capacity being divided between the two halves of the line.

The beam power twin tetrodes RCA 829B and 832-A are developments from the previous types usually being employed as straight power amplifiers or as frequency multiplier amplifiers, the 829B giving 45 watts at 200 Mc/s when grid-modulated.

For low power applications such as receiver local oscillators the "acorn" triodes RCA 955 and the English counterpart, the Osram HA1 are available. These employ very small electrode structures and fit into special sockets.

WE 304B, RCA 834 and Eimac 100 TH are capable of powers in the region of 50 watts with the frequency limited to about 100 Mc/s.

Probably the best triodes for high power at U.H.F. are the RCA 5588 and 8025A, the former giving 50 watts at 1,000 Mc/s while the latter is capable of 30 watts at 500 Mc/s. If higher powers are required, two valve push-pull circuits and ring circuits using four valves may be employed.

Specially developed for pulsed operation in 200 Mc/s radars the VT 90 *Micropup* and NT 99 were used extensively during the war. The anodes of these tubes are fitted with cooling fins and forced draught is required. Anode voltages of 8 KV served to reduce transit time while the anode structure, and in the NT 99, the grid structure results in reduced inductances.

Disc Seal Triodes

The disc seal triodes CV 90, 2C40 (or GL-446) and 2C43 are suitable for use in low power applications up to 3,000 Mc/s and lend themselves to co-axial line and cavity tuned circuits; the CV90 will give 0.8 watt at 1,200 Mc/s. These tubes operate at low anode voltages (about 250V) the transit time being reduced by extremely small spacing between the electrodes which are in the form of flat discs supported from larger metal discs between which pieces of gears form the tube envelope. The lead inductances are thus practically eliminated. The only undesirable feature of these tubes is their relative weakness mechanically, the "lighthouse" tubes such as the GL-446 being worst in this respect. In addition to the 2C40 and 2CA3, the G.E. company has developed the 2C39 which is capable of higher powers, particularly at slightly lower frequencies (2.5 watts at 500 Mc/s). The construction of this tube may be seen from Fig. 3; cooling fins have been provided on the end of the anode while the heater has provision for co-axial line feed.

Circuits and Techniques

Tuned circuits made up of coil inductances and condensers may be employed up to a frequency of 200 Mc/s. It is necessary for the inductances to be low resistance conductors while the condensers should be low loss types preferably with air dielectric and polystryrene or ceramic insulators where necessary. In order to attain small reactances, higher Q, and better mechanical stability resonant lines are used.

$$Q = 2\pi fL/R.$$

where f is the frequency,
l is the inductance,
R is equivalent series resistance.

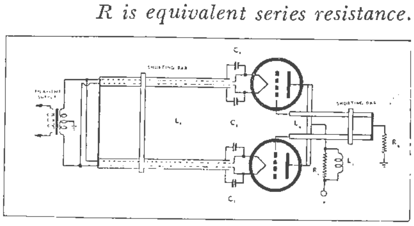


Fig. 5.—The tuned-grid tuned-cathode push pull oscillator.

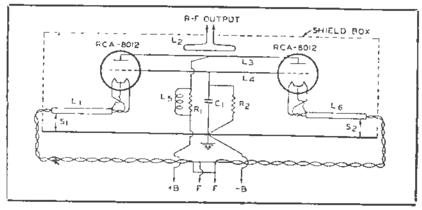


Fig. 6.—A parallel-plate oscillator using two 8012's.
—Courtesy R.C.A.

Above 200 Mc/s resonant lines are essential. These lines may take the form of parallel wire lines, parallel plate lines or co-axial lines. An extreme form of the resonant line used at very high frequencies is the resonant cavity, which is suited for use with disc seal triodes such as GL-446.

Resonant lines are usually short circuited and adjusted to be less than a quarter-wave in length so as to have an inductive input reactance. If an open circuit is desired at the input a quarter wave line is used. Between this and a half wave length the reactance is capactive while a short circuited half wave line presents an open circuit at the input.

The input reactance of a short circuited line may be calculated from the formula—

$$X = Zo \tan B$$

whese X is input reactance in ohms,
Zo is characteristic impedance of the line in ohms.
B is electrical length of the line (360 deg. for a full wave length).

Zo is between 250 and 500 ohms for parallel wire lines and between 25 and 100 ohms for co-axial lines. Thus co-axial lines are used for frequencies above 1,600 Mc/s. Resistance losses are reduced by using relatively large diameter conductors of low resistance material—silver plated copper is ideal.

Parallel wire lines are often shielded to prevent radiation by enclosing them in a metal case. This also has the effect of reducing the input reactance of the line. Co-axial lines and cavities are automatically shielded. In these circuits, however, difficulties arise with heat dissipation and for this reason high power triode oscillators are not used above about 1,200 Mc/s; at higher frequencies magnetrons hold the high power field. Balanced or symmetrical circuits, as in the case of push-pull oscillators are a means of reducing radiation.

Parasitic Oscillations

In order to prevent oscillations in the wrong mode parasitic suppressors must be used. Another mode may be possible due to alternative tuned circuits being

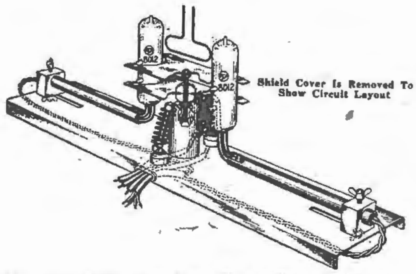


Fig. 7.—This drawing illustrates the layout of components used in the circuit shown in Fig. 6.
—Courtesy R.C.A.

available. These parasitic oscillations are prevented by resistors of from 10 to 100 ohms in value, placed at maximum current points for the wrong mode so that they absorb the energy of this oscillation and are usually in the grid and plate supply leads.

Some U.H.F. tubes have directly heated cathodes while in others indirect heating is employed. In the latter case the cathode is usually connected to the filament (unless cathode bias is employed). Cathodes may be either grounded or isolated from ground as far as RF is concerned.

In order to isolate the filaments from ground for U.H.F. radio frequency chokes are inserted in the filament leads, together with by-pass condensers as shown in Fig. 4.

In high power oscillators shielded filament leads are employed. Since it is difficult to provide an effective "ground" for r-f right at the cathode, the leads are extended and by-passed at a point which is electrically half a wavelength from the filament and therefore at the same R.F. potential. A shield is necessary to prevent radiation which becomes considerable above 300 Mc/s.

Circuit Components

Stranded wires are not desirable as conductors in U.H.F. circuits. U.H.F. currents flow in a very thin layer on the surface of a conductor so that with a stranded conductor current may flow from one strand to another and unless the wires are perfectly clean, resistance losses may result.

Supports for tuning lines, pick-up loops and other components should be of low loss dielectric material such as polystyrene, trolitul or ceramic. Dielectric insulators may be eliminated in many cases, particularly in high power applications and in co-axial lines by the use of *metal insulators,* i.e., short circuited quarter wave length shunt stubs which have a high input impedance and have negligible shunting effect on the line.

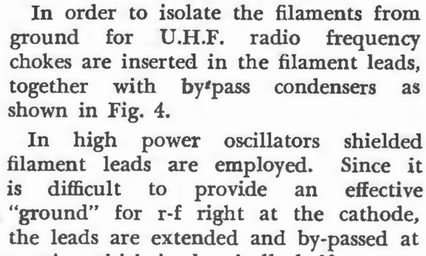


Fig. 8.—A cross-section layout of the 2C39 co-axial line oscillator.

Since one of the methods of reducing transit time in the oscillator tube is to increase the anode voltage, U.H.F. oscillators require high voltage power supplies. Voltage doubler circuits are often resorted to, and high voltage rectifiers are required. The Western Electric 705A is commonly used. The Australian AV11 is another high voltage rectifier.

Grid bias in U.H.F. oscillators is usually by grid leak although in grounded grid circuits cathode bias is more suitable.

In all triode feedback oscillators some means of feeding energy from the plate circuit to the grid circuit in the correct phase to maintain oscillations is essential.

U.H.F. Oscillators

All U.H.F. oscillator circuits are developments of the well-known Hartley and Colpitts circuits. Interelectrode capacitances play an important part in determining the properties of the circuit.

One of the simplest U.H.F. oscillators is the ultra-audion illustrated in Fig. 4. The tube could be a type 316A doorknob, while the tuned circuit is a two wire line slightly longer than half a wave length. The small condenser across the end of the line is for tuning purposes. The cathode is isolated by two RF chokes, while DC plate and grid connections are made at a point of low RF voltage, i.e., the electrical midpoint of the line. Grid leak bias is used.

From the equivalent circuit of the triode (Fig. 1) it may be deduced that the ultra-audion is basically a Colpitts oscillator with the R.F. voltage developed across the plate cathode capacity being in phase with that across the grid cathode capacity.

Employing only one tube, the ultra-audion is not suitable for high power applications, the one described above being capable of about 5 watts at 400 Mc/s. The ultra-audion was used in radar receivers and IFF transponders.

A typical high power U.H.F. triode oscillator circuit is the tuned grid—tuned cathode type as depicted in Fig. 6. This employs two tubes in push-pull with quarter wave line tuning and shielded filament leads. The anodes of the two tubes are short circuited. The equivalent circuit of this oscillator also is the Colpitts. The grid line adjustment controls the tank circuit inductance and hence the frequency.

The feedback voltage is adjusted by variation in the length of the cathode line which acts as a reactance shunter across the plate cathode capacity. Making the length of this line slightly greater than a quarter wave length increases the capacity and hence also the feedback voltage, with very little effect on frequency.

Other Circuits

Other oscillator circuits are the tuned-plate and tuned-grid and tuned-cathode and tuned-plate tuned-grid arrangements. The former reduces to an equivalent Hartley circuit. The plate circuit is tuned to a lower frequency than that of the grid circuit whilst the oscillator frequency is below both plates and grid resonant frequencies; the grid circuit tuning mainly affecting the feedback voltage. In the tuned-cathode, tuned-grid, tuned-plate oscillator the frequency depends on the lengths of plate and grid lines whilst the cathode line is used to vary the feedback. Since there are

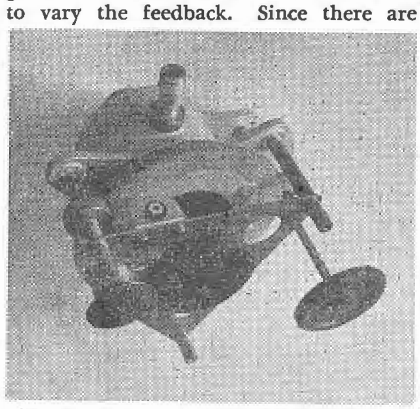


Fig. 9.—A typical cavity tuned oscillator for 1200 Mc/s operation using a GL-446B lighthouse triode.

three variables it is possible to obtain optimum adjustment with many combinations.

Of the three last mentioned types the tuned-grid tuned-cathode has most advantages; the tuning is simpler, the anodes are grounded for R.F., and the output may be easily taken from the cathode line by tapping, since the cathode is earthed for DC.

Ring Circuit

For the generation of still higher power at U.H.F. several tubes may be employed in a ring circuit. It is not practicable to use tubes in parallel at U.H.F. because the inter-electrode capacitances add together, thus reducing the maximum frequency.

In a ring circuit an even number of tubes (usually four) are arranged so that

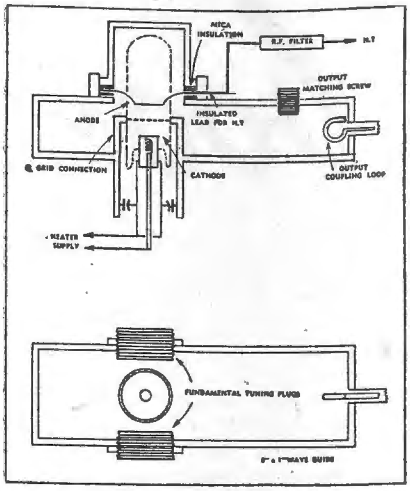


Fig. 10.—The circuit arrangement for a 3000 Mc/s harmonic oscillator using a CV 90.

adjacent tubes oscillate in opposite phases and the upper frequency is the same as for one tube. The four tube ring circuit is effectively two push-pull circuits linked together.

As mentioned previously parallel plates may be employed as circuit elements. An interesting application of this technique is shown in Fig. 6, in which two RCA 8012's are arranged in a symmetrical version of the ultra-audion circuit with the addition of half wave tuned lines, the length of which is used to vary the feedback to the grid by controlling the grid cathode reactance. The slots in the plates provide minor tuning adjustments. The power output of this very simple oscillator is 25 watts at 600 Mc/s.

Circuits employing co-axial lines and cavities with disc seal tubes are coming into use more today with the upward trend in frequencies. Fig. 8 is a diagrammatic section of a co-axial line oscillator using the 2C39 tube, shown in Fig. 3, suitable for the 300 to 1,000 Mc/s range with a power output of 25 watts up to 500 Mc/s.

A tuned-plate tuned-grid arrangement is used with capacitive feedback from plate to grid. A circuit of this type demands a high degree of mechanical accuracy; the valve manufacturers provide design data for the contacts which must be carefully made and fitted.

Cavity Type Oscillator

Fig. 9 is a photograph of a cavity type oscillator using a GL-446-B tube suitable for use as a receiver local oscillator. The frequency is about 1,200 Mc/s, the power output being 0.4 watt for an input of 4 watts. Tuned-plate tuned-grid cavities are employed, with the tuning control on the plate cavity in the form of an adjustable end plate operated by the hand wheel. Plugs screwed into the sides of the cavity furnish fine controls.

Feedback is provided by means of a probe from the plate to the grid cavity. A special shielded socket is used with built-in by-pass condensers, while the anode is earthed for r.f. by a special disc condenser with mical dielectric.

Power is extracted from the plate cavity by means of a coupling loop.

Use can be made of the frequency multiplier principle to produce higher frequencies from disc seal tubes. An example of this is a 3,000 Mc/s oscillator using a CV90 tube. With a fundamental frequency of 1,000 Mc/s a resonant wave guide is used to select the third harmonic.

It has been possible to obtain .1 watt output at 3,000 Mc/s with an arrangement as depicted in Fig. 10. The large screwed plugs serve to tune the fundamental together with the cathode line while the 3,000 Mc/s output is optimised by the small matching screws in the wave guide which does not propagate 1,000 to 2,000 Mc/s.

Positive Grid Oscillator

Of historical significance rather than practical value is the positive grid or retarding field oscillator first discovered by two German engineers, Barkhausen & Kurz, during tests on transmitting tubes in 1920. With a circuit as shown in Fig. 11 it was found that very high frequency oscillations could be maintained when the grid voltage was relatively large and positive. Their conclusion was that the frequency depended only upon the transit time of the electrons. The results of the work of Gill and Morrell published in England two years later indicated that the frequency did depend upon the external circuit constants and was independent of transit time. More recent theory has indicated that these two forms of oscillation are due to the same cause. A physical explanation of B. and K. oscillations is as follows:—

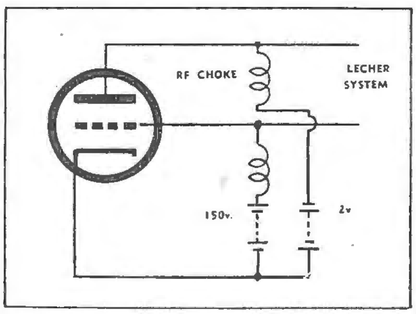


Fig. 11.—The Barkhausen and Kurz positive grid oscillator circuit.

Electrons are accelerated by the grid, attaining their maximum velocity at the grid. Due to the retarding field (the plate being at zero or a slight negative potential) the electrons turn back and pass through the grid again coming to rest between cathode and grid.

Thus large numbers of electrons attain a to-and-fro motion which causes energy to be transferred through the capacity of the tube to the external circuit. The wavelength is given by the formula:

$$\text{wavelength} = \frac{1000\,d}{\sqrt{Eg}}$$

where

d is diameter of plate (cm),
Eg is voltage on grid (volts),
for a tube with cylindrical electrodes.

It is possible to attain a wavelength of 10 centimetres with some tubes.

These oscillations are always considered to be present if the tube is operated under these voltage conditions, the external circuit merely serves to extract power.

Due to bombardment of the grid with fast moving electrons B & K oscillators are valve "wreckers" and are not of any great practical value.

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TYPE	ANODE VOLTAGE	ANODE DISSIPATION WATTS	MAXIMUM FREQUENCY	REMARKS
304B	1250	50	100	Triode 4 pin base.
4304B	EQUIVALENT TO THE 304B			
4316A 316A	450	30	300	Doorknob Triode.
955	180	1	600	Acorn.
826	1000	55	250	
834	1000	35	100	
829B	750	30	200	Twin beam tetrode.
832A	750	15	200	Twin beam tetrode.
8012A	800	27	500	
8025A	800	27	500	
5588	800	130	1200	
VT90	13,500	400	300	"Micropup" for pulse operation.
8014A	EQUIVALENT TO VT90			

For your note book

A page of radio servicing hints and notes of practical value to the radio serviceman and technician.

UNUSUAL SERVICING PROBLEM

Substitution of components is the last desperate resource of the experienced serviceman and usually the only hope of the novice when trying to trace an obscure fault. It is also the obvious method of verifying a suspicion. When the suspected fault is an open circuit, a temporary substitute can be connected in parallel without removing the suspected component.

Open Circuit Check.

The most convenient way to check for open-circuited condensers, for example is with a condenser of suitable value connected to a pair of crocodile clips. This method is generally advocated in service manuals and handbooks and may be seen in practice when visiting many radio service departments.

However faith in this well established practice recently had a severe setback. Motorboating had developed in a well known radio-phonograph and it was quickly isolated to the duo-diode triode circuit. All the decoupling condensers with the exception of the electrolytic cathode by pass condenser were eliminated by the established method. using a 1 mfd condenser and crocodile clips.

Grid bias was normal. Therefore if the cathode condenser was defective it must be open-circuited and not short-circuited. A suitable electrolytic condenser was selected and its short leads were connected direct to the clamping screws of a pair of crocodile clips (which incidentally were comparatively new and of clean appearance).

The new condenser was clipped in place across the suspect and made no apparent difference in either the volume or frequency or motorboating. This caused some surprise, and a new reading was taken across the bias resistance. It again showed correct bias voltage (while taking this reading the motorboating was stopped temporarily by shorting the triode grid to chassis). Wrong diagnosis was assumed and time was wasted endeavouring to trace the fault elsewhere.

The electrolytic condenser still seemed to be the source of trouble, and, though it was obviously not short-circuited, it was removed and the new one (still connected to its crocodile clips) clipped into place. New points of attachment were selected since the previous ones — the leads of the old condenser — had been removed. The motorboating, however, persisted with unchanged vigor.

The original condenser being 8 years old and still regarded with half-suspicion the substitute condenser was removed from the clips and soldered in position, whereupon the motorboating immediately ceased. This was so surprising that it was decided to recheck. The condenser was accordingly removed, a similar one fixed to the crocodile clips, which were clipped into position, and the motorboating reappeared. The new substitute condenser was then soldered to the crocodile clips, which were again clipped into position, but the motorboating persisted. The ends of the crocodile clips were cleaned with carbon tetrachloride, but the motorboating persisted with unabated violence; the serrated edges were then filed bright, the clips again put into position, and the motorboating ceased.

Check Clips.

This unusual experience is told as a warning that substitution is not 100 per cent. substitution unless a proper soldered connection is made. Ninety-nine times out of 100, or even 999 times out of 1,000 a clip connection is good enough but it is necessary to be on the alert for the odd case. The above experience also shows that the conclusions of systematic diagnosis should not be thrown aside lightly until proved incorrect.

Experiments with the coating elsewhere on the clips showed that the skin was an excellent DC conductor, but acted as a rectifier to radio frequencies, presumably because of oxidization of the metal with which the devices were plated or coated. This rectification could be stopped by cleaning the surface thoroughly with a light abrasive, but rectification properties returned within 24 hours and reached a maximum in 72 hours. Unfortunately, means were not available to measure the impedance of surface contact at radio frequencies.

RADIO SERVICEMEN!!

Contributions, preferably of a practical nature, will be accepted for this page. Payment will be made for all items published.

Cleaning Midget Condensers.

Midget tuning condensers are now coming into greater use and it will be found that the condenser plates are so closely spaced that the old stand-by (a pipe cleaner) is no longer suitable for cleaning between them.

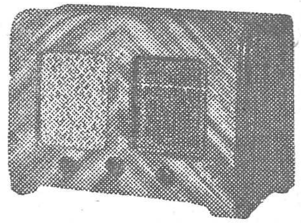
In this case wash between the plates with carbon tetra-chloride using a soft bristle brush. A good absorbent blotting paper is then cut into strips about ½ inch wide and drawn between each of the condenser plates. This absorbs any unevaporated solution along with any dirt which may be present.

Check These Condensers.

In any thorough repair, there are four condensers that should be replaced. These are the second audio coupling condenser, the tone control condenser from output plate to ground, RF bypass from B plus line to B minus, Screen Grid bypass from i-f screen grid to B minus. All can be replaced in a very short time and yet from the owners' viewpoint will help to build up goodwill.

SERVICE DATA SHEET

MODEL 204



CIRCUIT. Four valve dual wave battery superheterodyne, using converter, one stage I.F. amplification, detector, audio stage, power output stage, A.V.C., inverse feedback, tone switch.

TUNING RANGE.
Broadcast 540—1620 Kc/s.
Short Wave 5.9—18.2 Mc/s.

VALVES:
V1 Converter 1C7G.
V2 I.F. Amplifier 1M5G.
V3 2nd Det., A.V.C. Audio amp. 1K7G.
V4 Power output 1L5G.

MEASUREMENT SPECIFICATIONS.
I.F/s. from V1 grid 150 microvolts.
„ „ V2 „ 15 millivolts.
Broadcast 30 microvolts.
Short wave 16 to 9 Mc/s—50 microvolts.
„ „ 9 to 16 Mc/s—150 microvolts.

ALIGNMENT FREQUENCIES.
1400 and 600 Kc/s Broadcast.
16 and 6 Mc/s Short Wave.
455 Kc/s. Intermediate Frequency

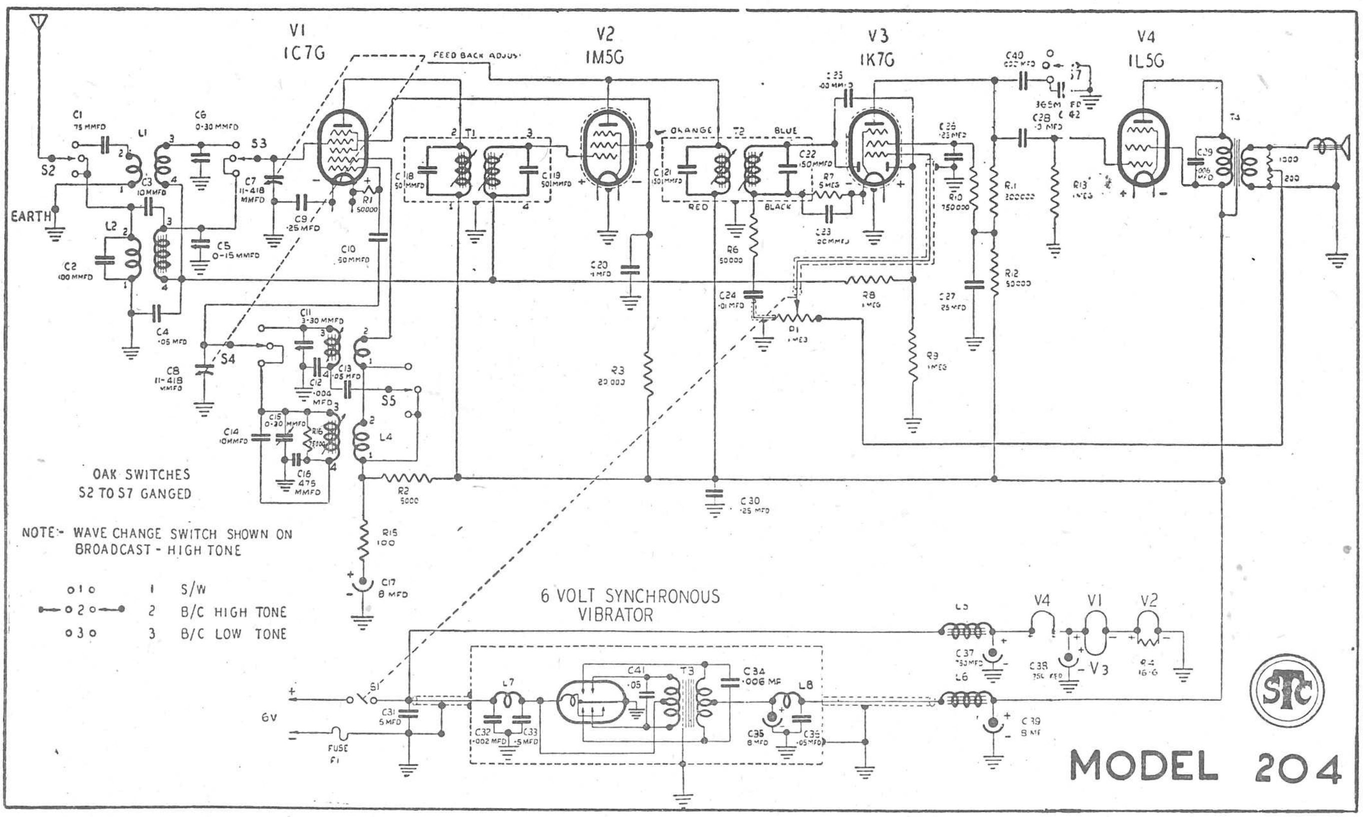
POWER SUPPLY.
6 volts 1 amp—6v. Accumulator.
Power consumption 6 watts.

LOUD SPEAKER.
Permag 6" cone. 15,000 ohms input.

CHECK POINTS.
1000 Kc/s Broadcast.
10 Mc/s Short Wave.

CIRCUIT VOLTAGES.

	Plate	Osc. Plate	Screen	Fil.
V1	135	100	67	2
V2	135	—	67	2
V3	50	—	40	2
V4	130	—	135	2



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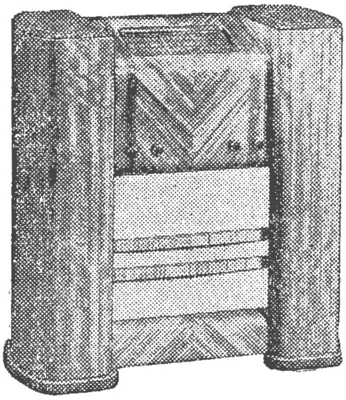


STC MODEL 253

MEASUREMENT SPECIFICATIONS.
I.F/s from V1 grid 15 microvolts.
" " V2 " 750 microvolts.
" " V3 " 33 millivolts.
Broadcast 5 microvolts.
Short Wave 15-20 microvolts.

ALIGNMENT FREQUENCIES.
1400 and 600 Kc/s Broadcast.
16 and 6 Mc/s Short Wave.

CHECK POINTS.
1000 Kc/s Broadcast.
10 Mc/s Short Wave.

CIRCUIT VOLTAGES.

	Plate	Osc. Plate	Screen	Fil.
V1	170	100	65	2
V2	180	—	65	2
V3	180	—	65	2
V4	75	—	45	2
V5	176	—	180	2

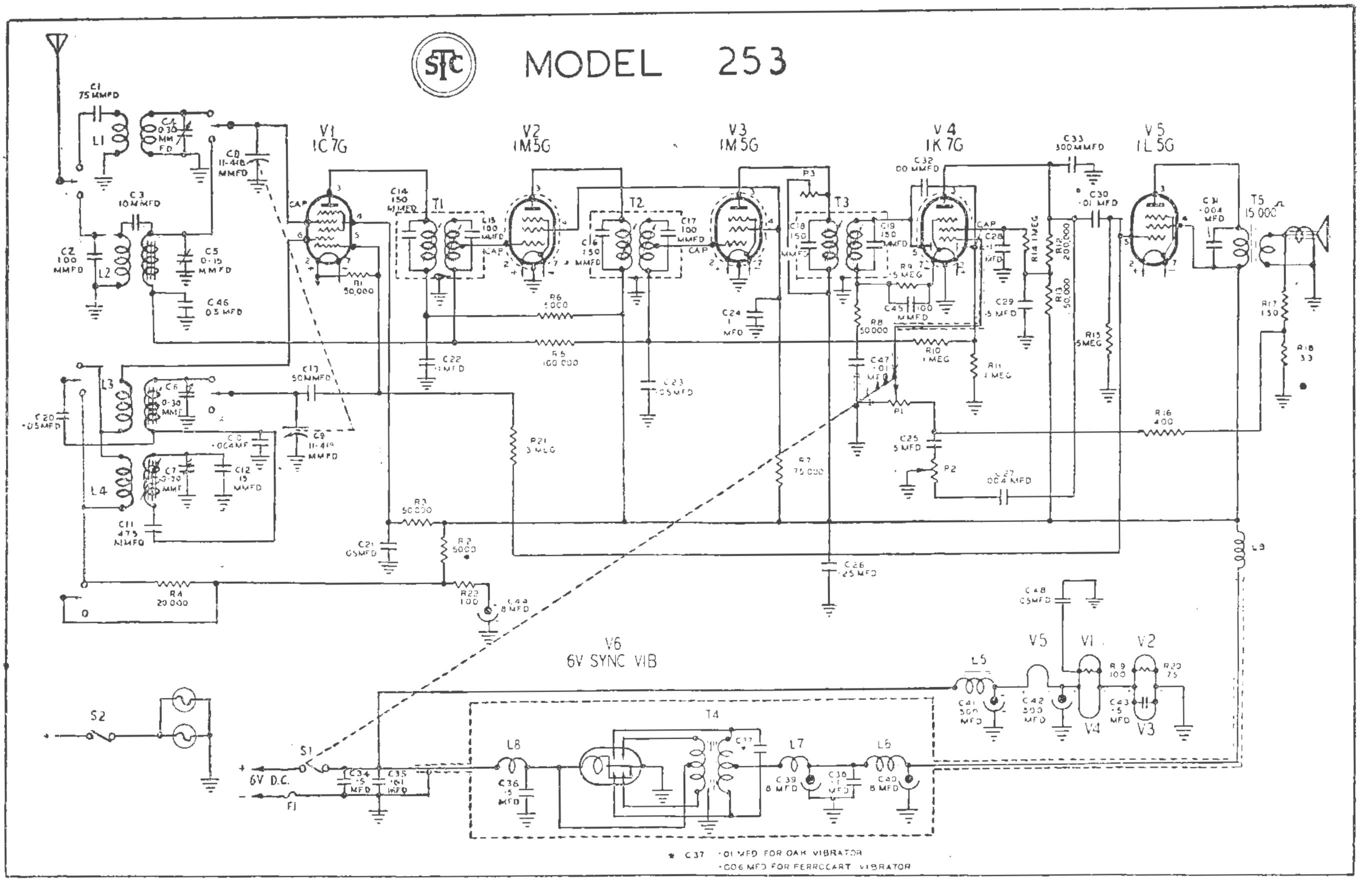
CIRCUIT. Five valve dual wave battery superheterodyne, using converter, one stage I.F. amplification, detector, audio stage, power output stage, A.V.C., inverse feedback,

TUNING RANGE.
Broadcast 540—1620 Kc/s.
Short Wave 5.9—18.2 Mc/s.

VALVES:
V1 Converter 1C7G.
V2 I.F. Amplifier 1M5G.
V3 I.F. Amplifier 1M5G.
V4 Detector, Audio 1K7G.
V5 Power Output 1L5G.

POWER SUPPLY.
6 volt Accumulator. Consumption 9 watts.

LOUD SPEAKER.
Permag 8" cone. 15,000 ohms Input Transformer.



ON THE BROADCAST BAND

NEW ZEALAND STATIONS

At first glance broadcasting in New Zealand appears to operate in the same manner as we know it in Australia—that is stations operating without advertisements and those devoting their time on the air to sponsored programmes. The difference, however, is that all stations in New Zealand are controlled by the Government and whilst privately owned stations may operate, their revenue must not be derived from the sale of advertising time.

The main and auxiliary national stations may be readily identified, as the former are usually assigned the letter Y following the numeral indicating the district in which the station is located (2YA, 3YL, etc.), whilst those operated by the National Commercial Broadcasting Service replace the Y with the letter Z (1ZB, 4ZB, etc.).

Stations in the far north of the country are assigned the numeral 1, those nearer the south end of the North Island the numeral 2, the north end of the South Island, numeral 3 whilst those further south numeral 4. Some big changes in equipment are being planned and plans for the installation of new transmitters at several already operating stations is well under way which should result in improved reception.

At the present time it should be possible to hear several New Zealand stations in their early morning programme around 6 to 7 a.m. N.Z. time, or 4-5 a.m. A.E.S.T. At this time Australian stations do not crowd them out.

2YA—Wellington, 570 kc. With its 60 *kw* is good from around 4 a.m. for approx. 2 hours. Also excellent at night after 9 p.m.

1YA—Auckland, 650 kc. One of the 10 *kw* group. Also good in mornings, but unreadable at night with 4KQ on same channel.

4YZ—Invercargill, 680 kc. Another good morning signal—often in relay with 2YA as are other N.Z. stations during the morning.

3YA—Christchurch, 720 kc. Try also in the mornings.

By
ROY HALLETT

2YH—Napier, 750 kc. Mornings and night.

4YA—Dunedin, 790 kc. Mornings only.

2YC—Wellington, 840 kc. Clear at night around 8 o'clock, but not on in mornings.

3ZR—Greymouth, 940 kc. Opens 5 a.m. Jammed by 4QR at night.

1ZB—Auckland, 1070 kc. Opens as other ZB's at 4 a.m.

This is not a complete list of N.Z. stations, but merely a guide to those likely to be heard during the next few weeks.

READERS' REPORTS

A letter from R. Rooke, Manly, contained some interesting DX news, for which we thank our correspondent. A schedule of some of the All India Radio stations was enclosed, and this is printed for the benefit of other readers.

VUD—Delhi, 886 kc. Daily until 3.30 a.m. A.E.S.T. using 10 KW.

VUB—Bombay, 1231 kc. (1.5 KW) may also be heard till 3.30 a.m.

VUC—Calcutta, 810 kc (1.5 KW) leaves the air 3.0 a.m.

VUM—Madras, 1420 kc. (500 watts) leaves the air 3.00 a.m.

VUW—Lucknow, 1022 kc. (5 KW) leaves the air 3.00 a.m.

VUT—Trichinopoly, 758 kc (5 KW) another heard, closing 3.00 a.m.

Generally Indian type programmes are heard from these transmitters; news bulletins, talks, etc., in English, however, may be heard at regular periods, plus occasional programmes of European type music.

Are you interested in Broadcast DXing? If so, you are invited to send in reports of your latest logging, equipment being used, as well as any suggestions regarding the information you would like included in this page. All letters should be posted direct to Mr. Roy Hallett, 36 Baker Street, Enfield, N.S.W.

Mr. Rooke has been hearing fair signals from some midnight Americans and Hawaiians—KULA, 690 kc. and KPOA, 630 kc. in the early hours of the morning, both operating from Honolulu. Station KGMB, 590 kc., and KGU, 760 kc., should also be heard around 2 a.m., beginning their early morning session for the previous morning, Hawaii being 18 hours behind A.E.S.T.

Mr. D. Harding, Lakemba, tells of an interesting signal he is hearing around 4 a.m. on a channel just actually off the high frequency of the broadcast band. The transmitter appears to be in use in the European Service of the BBC, an interval signal is heard at 4 a.m., followed by news in English. The signal is received just above 1700 kc., and could possibly be one of the numerous Armed Forces stations still operating from Europe.

NEW TRANSMITTER AERIALS

The practice of installing transmitting aerials on top of buildings in which the broadcasting station's studios are situated, has been more widespread in Melbourne than here in Sydney; in fact until late last year 3AK was the only commercial station in Melbourne to install an aerial outside the city. In November, however, 3AW installed a new 2 *kw* transmitter and aerial system at Alphington, (a suburb of Melbourne) in an attempt to improve reception of their transmitter.

Here in Sydney, after erecting a new mast above their Market Street studios, 2UW has not found it as effective as anticipated, and is now finishing off yet another aerial mast in the flat area near Homebush Bay, on the Parramatta River. This appears to be a particularly good area for radio transmission, as stations 2GB and 2UE have already erected aerials in that district. In addition, station 2KY is in the process of constructing a new transmitter there in place of their present set up in use at French's Forest, whilst 2SM recently installed a new transmitter (2 *kw*) near Pennant Hills.

Consequently after 2UW's move, 2CH will be the only remaining station in Sydney to employ an aerial from the top of their city studios, although it is understood that 2UW may still retain their city mast for use during the midnight to dawn period of transmission.

SHORT WAVE LISTENER

Conducted by Ted Whiting

NEW OVERSEAS STATIONS

From the pages of "Radio News" we glean some interesting information on a station which we feel sure will interest many readers.

The projected station will be located at Fernando Po, an island in the Bay of Biafra, off the west coast of Africa. Once a penal settlement, Fernando Po is to be the site of the world's largest Commercial Short Wave Station, and is to operate with a power of 200 watts in the aerial.

"Radio Atlantic" the call which will be used is expected to be completed in about 12 months, and will be operated by the Sociedad de Radiodifusion Intercontinental, a Spanish organisation. The transmissions will be conducted in Spanish, English, German, Portuguese, Italian and French, and aerials will be erected to give coverage in Spain, U.S.A., Europe, Africa and South America. No frequencies have yet been allotted, but we do know that the station is to operate at least on the 21 M/c and 17 M/c bands.

Reports on Radio Atlantic will be received with interest here when tests commence.

Gold Coast.

ZOY, Accra, Gold Coast, is heard fairly frequently in various localities on the 4910 kc channel closing its transmission at 5 a.m.

Experiments have been conducted using a frequency of 15340 kc but the station announces that these will not precede a regular service on this frequency as the transmissions from ZOY are only intended for reception within the Colony which necessitates the use of the lower frequencies.

Those readers receiving the former transmission may send their reports to Broadcasting Department, P.O. Box 250, Accra, Gold Coast Colony.

New Zealand.

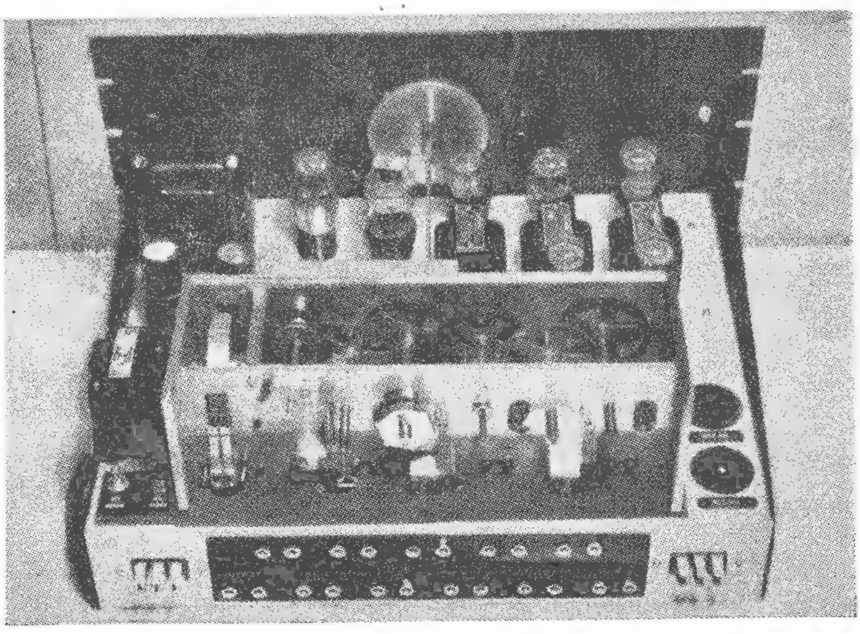
The frequencies of the new stations of the New Zealand Broadcasting Corporation have been announced and are as follows: ZL1, 6080 kc; ZL2, 9540 kc; ZL3, 11780 kc; ZL4, 15280 kc; ZL5, 17770 kc; ZL6, 25800 kc.

The power in use will be 7.5 Kilowatts but no details of schedules and date of opening are to hand.

Radio Waiouro is the call of a station broadcasting programmes direct to Japan from a location in New Zealand on a frequency of 6800 kc. ZLO has not been heard on any regular schedule, but has been heard at about 7 p.m. at night. Noumea is still heard on 6160 kc at quite good level although the transmission is nowhere as good as in the past. Periodically the quality of this station appears to suffer for some obscure reason, only to be cleared up for a fairly long period. The schedule appears to be 9 a.m.-10 a.m. and 6.30 p.m.-8 p.m. Radio Noumea, Noumea, Caledonia, will suffice for reports.

READERS' REPORTS

Readers desirous of submitting Short Wave reports for inclusion in these notes, should ensure they reach our Short Wave Correspondent not later than the 1st of each month. Address all letters to:—Mr. Ted Whiting, 16 Louden Street, Five Dock, N.S.W.



The Seconds Pulse Generator and time interval selector used in the time control equipment at station WWV. The one second contact is made by a cam on the flywheel immediately at the right of the electric motor.

RARE STATIONS

The following list of stations, which we print in its entirety has been forwarded to us by Mr. Cushen on behalf of the DX Bulletin, N.Z.

YV5RY, 4725 KC, "Radio Continente," Apartado 866, Caracas, Venezuela. Has moved to this frequency from the 86 meter band. Opens with march at 9 p.m., news in Spanish follows.

YDD2, RADIO BATAVIA, Koningsplein Z17, Batavia, Java, verifies by Air Mail. The S.W. Broadcasts from this centre are to be greatly extended in the future. Frequencies at present in use are 15145, 10360, 9550, 4865, 3024, 19340 and 17630 kc.

HS8PD, 5990 KC, Publicity Dept., Overseas Broadcasting Station, Bangkok, Siam. On a power of 500 watts this one is heard at 8 p.m.-9.30 p.m. on 5990 kc, 10 p.m.-12.30 a.m. on 6120 kc and at 8 p.m.-9.45 p.m. on 4754 kc and 7025 kc.

HHYM, 6000 KC, Port-au-Prince, Haiti, a new station—not yet heard here as close of transmission at noon.

RADIO CONGOLIA, 6010 kc, Leopoldville, Belgian Congo. Operates on 6010 kc and 15325 kc at 3 a.m.-4.30 a.m. Reports to P.O. Box 63 Leopoldville, Belgian Congo.

RADIO FRANCE, 6045 kc, Hanoi, Indo China. Now heard in the clear as Kuala Lumpur has moved to 6050 kc. Very good one at 11 p.m.

VU7MC, The Akash-Vani Broadcasting Station, Mysore, India, has three daily services, 11.30 a.m.-1.40 p.m., 6.30 p.m.-7.40 p.m., 10 p.m.- 2.40 a.m. on this frequency and on the broadcast outlet on 968 kc. At present the power used is only 300 watts, but it is hoped to increase this to 5 Kw in the near future.

KZBU, 6100 KC, Philippines Broadcasting Corporation, Cebu, uses 250 watts and is heard 7 p.m.-2 a.m. News at 9 p.m. despite interference from WLKS.

RADIO PARIS, 6120 kc, France. New frequency heard from 10 p.m.-11.15 p.m.

RADIO ESPANIA, Indepencia, Russia. "Freedom" broadcasts heard hourly in the early morning.

RADIO TASHKENT, 6825 kc, U.S.S.R. Transmission beamed to India at 3 a.m.-3.30 a.m., with English used throughout.

RADIO CLUBE DE BENGUELA, Benguela, Angola, CR6RB on 9165 kc and CR6RF on 7054 kc at 3 a.m.-5 a.m. daily

RADIO SOMALI,. Hargeisha, British Somaliland. Being heard in N.Z., but no times quoted. Suggest 6 a.m. as being the likely time. Frequency is 7350 kc.

XLKA, KOREAN Broadcasting System, 1 Chung Dong Jung, Seoul, Korea. Heard on 7390 kc and 2510 kc from 6 p.m.-11.34 p.m. daily.

RADIO DOUALA, 7950 kc, Douala, French Cameroons. News in French at 4.30 a.m., operates from 3 a.m.-5 a.m.

RADIO MACASSAR, 9375 kc, Celebes. This one is now operating on this channel used in the past.

COCH, 9437 KC, Paseo de Marti 107, Havana. Now using the slogan "Union Radio" and heard 10 p.m.-4 p.m.

CR6RA, 9470 KC, Radio Club de Angola, Luanda, Angola. Schedule 9.15 p.m.-10.45 p.m., 4.30 a.m.-7 a.m.; Sunday 6 p.m.-7.30 p.m., 9.15 p.m.-10.45 p.m., 12.30 p.m.-3.30 a.m.

"SENDERGRUPPE ROT-WEIT-ROT," 9575 kc, Linz, Austria, is on the air using 1 Kw on this frequency at 3.57 p.m.-8.30 a.m.

HED6, 9665 KC, Swiss Broadcasting Corporation, Berne, Switzerland. Good signal in Nth. American transmission till close at 1.30 p.m.

HJAP, 9950 KC, "Radio Colonial," Cartagena, Colombia. A new frequency for this station which was operating on 4930 kc. Closes at 1.30 p.m.

DAMASCUS, 12000 KC, Republique Syrienne, Director Generale des Postes, Telegraphes et Telephones, Damascus, Syria. Verifies by letter from above address.

XDA, 14525 KC, Mexico. Verifies by letter, address reports to Secretaria de Relaciones Exteriores, Dept. de Informacion Para El Estranjero, Mexico City.

EPB, 15100 KC, Teheran, fine signal with news at 10.15 p.m., this in N.Z.

OIX4, 15190 KC, Helsinki, Finland. Relays a religious service at 6 p.m. Sunday, also on OIX2 on 9500 kc.

RADIO BRAZZAVILLE, 21002 kc, Brazzaville, French Equatorial Africa. Schedule on this frequency is 8 p.m.-10.45 p.m. with News in English at 10.15 p.m. Also with 17845, 11970, 9984, 7000 and 6024 kc at 2 a.m.-3.35 a.m. The latter stations continue till 7.30 a.m.

READERS' REPORTS

New Chinese Station.

Mr. A. T. Cushen, DX Bulletin, N.Z., Invercargill, N.Z., another old friend in this hobby sends us a very interesting log. Among the many stations mentioned is XMPA, 12200 kc, whose verification he has received. This station has been recently moved from the previous location at Chungking and is now operating from Nanking using a power of 1,000 watts. The schedule at present is 9 a.m.-10 a.m., 2 p.m.-4 p.m. and 7.30 p.m.-12.30 a.m. XMPA is well heard here and a good report will bring a verification in due course. The address, XMPA, Chinese Army Radio Service, 10, Snake Mountain, Hanchungman, Nanking, China.

XGOY, 15170 kc, is also heard asking for reports from the Australian continent while transmitting a programme at 8 p.m. These reports should be sent to Fung Chien, C/o XGOY, Chungking, China.

Algeria.

Mr. R. Rooke, Manly, N.S.W., comes along with news of Radio Algeria, logged on 11880 kc until closing at 6 p.m. As Mr. Rooke states, interference is quite bad on this frequency, but the programme can be followed quite well at times. French and Eastern type programmes are radiated.

TAP, Ankara, is another from the same reader, Radio Ankara is heard on 9465 kc till the end of transmission at 7.45 a.m. The "Mail Bag" session on Monday at 7.30 a.m. is the one heard by Mr. Rooke. Try this station for a verification.

Radio SEAC, Colombo, is good listening at from 9 p.m. on 17730 kc in English transmission and from 10.10 p.m. on 15120 kc. It is of interest that the BBC has given Radio SEAC the use of their 17730 kc frequency allocated to GVQ owing to the interference on 17770 kc by other stations. No doubt SEAC will be interested to learn the success of this move.

Indonesia.

Capt. L. V. Solomon, Bellevue Hill, N.S.W., writes of the fine reception of the "Voice of Free Indonesia" on 11 megacycles. English is used from 8 p.m.-10 p.m. with the usual news and candid comment we have become so accustomed to hearing from this station. The signal is, however, excellent. We have no knowledge of any verifications being received from this station, possibly they are working under cover.

Capt. Solomon uses a very fine receiver. It is an American RCA Communications Receiver, using 10 tubes with a coverage from 500 kc—32 M/c. We hope you manage to get the calibration right.

LISTEN FOR THESE STATIONS

Warsaw

Following a change of frequency, Radio Polskie, Warsaw, is now heard clearly in an English transmission at 6.50 a.m.-7.10 a.m. daily. On the former frequency of 6100kc interference was rife, but the move to 6215kc has worked wonders. Any changes such as this should be noted, we will always be pleased to hear of them.

Another European, AFN, Munich, Germany, is a good signal on 6080kc at 3 a.m. These AFN stations are operated as an Armed Forces Network by the American Army for the entertainment and education of their forces throughout the world, and are doing a grand job.

Also located at Munich is a *"Voice of the United States of America"* outlet, which is also heard at good level in the morning. This one is the station interfering with Warsaw recently and is heard closing at 5 a.m. on 6170kc to return to the air on 6100kc at 5.15 a.m. As is usual with these stations the *"Star Spangled Banner"* is played at the conclusion of transmission.

BBC Services

Changes are noticed in the Services of the BBC as affect Australia, the Pacific service has been discontinued as such, and has been replaced by the Pacific Regional service which runs from 4 p.m. till 5.45 p.m. This transmission is carried simultaneously by GRD 15450kc, GSN 11820kc, GSD 11750kc, GRX 9690kc and GVZ 9640kc. All outlets are heard at good level.

That part of the General Overseas Service beamed on this continent is heard by tuning to the following station: GST 21550kc 4 p.m.-8 p.m.; GSH 21470kc, GSV 17810kc, GRA 17715kc 8 p.m.-10 p.m.; GSN 11820kc 9 p.m.-10 p.m. Fine entertainment is available on this service, many local stars are now in England being frequently heard.

In our next issue we hope to give details of the other services of the BBC as these stations provide excellent points of reference in the bands in which they are located.

Jaffa

The stations formerly announced as "Sharq Al Adna" have now been alloted call signs and the latest list as given in *"Universalite"* is ZMJ3 9645kc, ZMJ4 6135kc, ZMJ5 6170, ZMJ6 6790 and finally ZMJ7 11720kc. The possibility of hearing these stations will keep us out of bed in the early morning, and suggest that 5 a.m. would be the time to listen.

Also gleaned from *"Universalite"* is a very imposing list of frequencies now in use by the Emissora Nacional at Lisbon, Portugal. This is given in its entirety, one of the stations is heard regularly, CS2ML 11040kc, at 6 a.m., we believe they conclude transmission at 7 a.m.

CS2MA	6374kc	CS2MK	11027kc
CS2MB	7260kc	CS2ML	11040kc
CS2MC	9635kc	CS2MM	11840kc
CS2MD	9670kc	CS2MO	11995kc
CS2ME	9680kc	CS2MP	12749kc
		CS2MQ	15100kc
CS2MF	9727kc	CS2MR	15110kc
CS2MH	9740kc	CS2MS	15120kc
CS2MI	9940kc	CS2MT	15320kc

Canadians

Many of those who received hospitality from the Canadians during the war years will be pleased to hear the news of the day, even if the previous day, direct from the capitals of the states of Canada. A very fine network of stations is to be heard, operated by the Canadian Broadcasting Corporation, to whom all reports should be addressed at Montreal. CKLO 9630kc, Sackville, is a good one at 6.30 a.m. and later, at the mentioned times, News in French is heard followed by a musical service.

CHOL, 11720kc, from the same location is also heard at around 7 a.m., often a better signal here. CKCX, 15190kc yet another good outlet to listen to later in the forenoon, especially when interference is off.

Others from this country are CBLX 15090kc with news, etc., and the usual programme at 10.30 p.m., located at Montreal; and CFRX Toronto, 6070kc heard from 9 p.m. in some districts, but possibly better at 11 p.m. in most locations. These last two stations are privately owned and reports should be addressed direct to the station.

Returning to the CBC stations, the latest schedule in their International Service and directed to Australia and New Zealand appears to be as follows:

CHOL 11720kc, 6.45p.m.-8.5 p.m.
CHLS 9610kc, 6.45 p.m.-8.5 p.m.

Eastern Schedules

Located at Nanking, China, XGOA operates a comprehensive schedule of transmissions beamed on the undermentioned frequencies.

To N. America — 11835kc and 9730kc, 11.30 a.m.-2 p.m.

To Philippine Is. and Australia — 11835kc, 7 p.m.-9 p.m.

To Mongolia, Tibet and Sth. Sea Chinese — 11835kc, 9 p.m.-10 p.m.

To Japan and Siberia — 11835kc, 10 p.m.-11.30 p.m.

To India, S. Africa and Eastern Europe — 11835kc, 11.30p.m.-1.15 a.m.

A musical broadcast titled *"Musical Hours"* is radiated on 11835kc and 9730kc between 6 p.m. and 7 p.m.

News in English from the Chinese angle is broadcast at 1.30 p.m., 8 p.m. and midnight. The Chinese International Broadcast station, XGOY, Chungking, of which we wrote last month has four distinct transmissions.

1. Australia and East Asia — 11913kc, 8.5 p.m.-9.30 p.m.
2. East Asia and the South Seas — 9658kc and 7153kc, 9.35 p.m.-11.35 p.m.
3. N. America and Europe — 9658kc and 7153kc, 11.45 p.m.-2 a.m.
4. Europe, America, China and the South Seas—9658kc and 7153kc, 2 a.m.-2.45 a.m.

English News is read from this network at 10 p.m., Midnight and 2 a.m.

Further reports now list the 6142kc outlet of XGOY as operative in the third transmission between 11.45 p.m. and 2 a.m., English solely used from 12.30 a.m.

Holland.

News in English is now broadcast from "Radio Nederland," Hilversum, Holland, as per the following schedule: 8.30 p.m.-8.45 p.m. directed to the Pacific on PGD, 6020 kc, PCJ, 15220 kc, PHI 17770 kc. 4 a.m.-4.15 a.m. directed to the British Isles and South Africa on PGD 6020 kc, PCJ, 9590 kc, PHI 17770 kc. 12.30 p.m.-12.45 p.m. directed to U.S.A. and Canada using the same frequencies as the transmission at 4 a.m.

Africans.

A fine DX session is heard via "Radio Australia" on Sunday at 3.25 p.m., conducted by Graham Hutchings, some interesting detail of stations is frequently heard. From this source we glean news of ZRB, Pretoria.

This station is normally operated on 7445 kc, but is now used on 9110 kc, presumably in the early hours of the morning. Reports are required on this frequency in particular and should be addressed to ZRB, Air Force Station, Odonata, Pretoria, South Africa. The station is primarily operated as a Telecommunication and Weather Information Base, but we are led to believe that other transmissions may be heard at times.

Club Notes and News

AMATEUR BANDS

Activity on 50 M/c is not as great as formerly, no doubt due to the lack of DX these days. Many of the stations operating the band for the past months having migrated in some cases to 166 M/c and in others to 28 M/c. Purely local contacts have been the order on 50, with an occasional break through of some of the interstate boys. VK3's and 5's have been the only ones heard at this location.

Conditions on Ten are much the same as they have been for some time. DX is fairly plentiful at the same times, and during the ARRL Contest in particular, calls were heard which are unfortunately so few and far between. Several of the locals should have piled up quite respectable scores.

20 and 80 m Improving.

Twenty seems to be on the up and up just now. The European DX is heard at fairly good strength on some mornings, becoming more consistent than it has been of late. Many countries are to be heard and strong American signals are also evident. In the afternoon an increase in the amount of signals has been noted, no doubt a lot more cards will soon be coming this way again. A few of the "Beam Boys" are working Europe in the evening, but signals in my case are only weak.

The usual contacts are being made on 40, with good local and interstate and excellent DX CW contacts being made in the morning at 6 a.m. and at from 6 p.m. at night. The strength of some of the Americans on 40 has to be heard to be believed.

Eighty has improved quite a lot here, the noise is gradually subsiding resulting in the better reception of the stations on the band. It won't be long now and we think there will be quite an exodus to this band, at least for the winter months.

Incidentally, we would like to hear of your experiences on these bands. Let us know of your activities, etc., as there are many readers who will be interested in what you are doing. Letters should be addressed to 16 Louden Street, Five Dock, N.S.W.

RADIO CLUBS.

We would be pleased to hear from Officers of all radio clubs, and amateurs in general. Many people are interested in your activities, and we can help you and them by including in these pages matter which will be of interest to you all. Let us have your ideas and suggestions and make this page for the amateur.

EXPERIMENTAL RADIO SOCIETY OF N.S.W.

Melody Hall, George Street, Burwood.
President: R. A. Blades (VK2VP).
Secretary: W. Hayes (VK2AJL). 'Phone JA7729.

The meetings of this society are held on alternate Thursdays at the above address, and all interested in Amateur Radio are invited to be present.

The Society has been unfortunate in losing the services, in an official capacity, of its President, Reg Anthony (VK2TR), owing to pressure of business. His untiring efforts have been appreciated and the results he has achieved in his long association with this body have been placed on record. Ron Blades has been elected to the vacant office, his enthusiasm and bright manner well fitting him for the position.

The Annual Reunion of the Society will be held in the Club Room on May 6, with the election of Officers following on the subsequent meeting night, May 20.

Meetings for the month: April 8 and 22.

GLADESVILLE AND DISTRICT EXPERIMENTAL RADIO CLUB.

Rear, 117 Victoria Road, Gladesville.

This club has its own clubroom and meets each Thursday at 8 p.m. Three meetings each month are devoted to Technical discussions, lectures, etc., with the fourth being given to club business.

Of the 27 members no fewer than 13 are active transmitting amateurs and any intending member is invited to contact the Hon. Sec., Mr. Sullivan, 11 Shipley Avenue, Concord. Telephone B6836 or UM6226 after 6 p.m.

The club has wide activities, covering field days, etc., and a transmitter is installed at the club room—VK2ADY—where members can receive valuable advice and training in operating technique.

KINGSFORD DISTRICT AMATEUR RADIO CLUB.

48 Rainbow Street, Kingsford.
President: V. H. Wilson (VK2VW).

Just a year ago a few local amateurs arranged a meeting in the "shack" of VK2ABU and the Kingsford District Amateur Radio Club came into being.

Since that first meeting the club has steadily grown, and today has a membership of 35, approximately half of whom are licensed amateurs. Meetings are held every Tuesday night at Griffith Hall, 48 Rainbow Street, Kingsford. Technical and Morse classes are a regular feature and several members are due to face the A.O.C.P. in the near future.

The club has a 166 mc transmitter and receiver whilst a larger station for 40 and 20 metres operation is planned among the future devlopments. In addition an application has been made for a club call sign.

Recently a sale of radio equipment was held and visitors came along from the Gladesville Club to help make it a success.

The club caters for all who are interested in "Experimental Radio" and visitors and new members are always welcome.

Personal Notes.

VK2WJ—one of our Vice Presidents, mainly active on 50 and 166 mc bands, has four element beams on both bands and has plans of building bigger and better ones.

VK2UV—is active on 166 mc/s with a four element beam. Has new receiver which gives excellent results. Plans to come back to 20 metres soon.

VK2CP—not heard much lately—rebuilding and holidays.

VK2VW—Active on 14, 50 and 155 mc bands. Four element vertical or horizontal dipole on 50, and vertical dipole on 14 Mc's. Was lucky enough to make first two-way Sydney-Newcastle contact recently on 166 mc/s. VK2BZ the other end.

VK2ABB—Active on 166 mc/s but rebuilding all band transmitter.

VK2ABC—returned to VK after long absence, active on 50 mc/s with 3 element beam.

VK2ABU—off the air for a while owing to a fire in the transmitter.

VK2AB—mainly on 40 metres but heard occasionally on 20.

F.M. ANTENNAS

(Continued from page 31.)

Installation of F-M Antennas.

The first step in installing an F-M antenna is to make a survey of the location, check on the line-of-sight of direction between the F-M station and the receiver and also determine the location of possible noise interference sources. It is also necessary to determine what the length of the transmission line is to be. If over 100 ft. it is advisable to use a low-loss line, such as a coaxial line, unless the antenna is in a location where the signal strength is quite high.

As a general rule, the antenna should be as high as possible and as far from any noise source as feasible, always bearing in mind that the longer the transmission line the greater will be the line loss. In residential sections, a height of from 30 ft. to 40 ft. above the ground or 10 ft. to 20 ft. above the roof is, in most cases, satisfactory.

Horizontally Polarized Antennas.

Most American F-M transmitting stations now use horizontally polarized antennas. This means that the elements of these antennas are horizontal or parallel to the ground. The receiving dipole should also be installed in a horizontal position. Some F-M stations may, however, employ vertically polarized antennas, and in areas where signals from both types of transmitting antennas are present it may be necessary to make a compromise when installing the receiving dipole antenna. This can be effected by tipping the dipole to a diagonal position, half horizontal and half vertical.

The transmission line between the dipole and the receiver should be as short as possible to keep losses at a minimum. It should also be weatherproofed and should also have the correct surge impedance. When bringing the transmission line into the house it should not be cut, as is sometimes done, and connected to window strips since this will change the surge impedance of the line and will probably cause enough of an impedance mismatch to introduce a loss in signal. The transmission line should always be continuous from antenna to receiver.

DISTANCE MEASURING EQUIPMENT

(Continued from page 10.)

The present status of the project.

The present position as regards distance measuring equipment in Australia may now be briefly summarized. The airlines and the Department of Civil Aviation are both satisfied as to the practicability of distance measuring equipment for civil aviation and to the desirability of its early installation throughout the airlines. The present intention is that the airlines will instal equipments produced in quantity to the tender of some Australian manufacturer, whilst the Department of Civil Aviation will purchase, instal, and operate a network of radar beacons to provide an adequate service on the major internal air routes.

It is of interest to note that distance measuring equipment has been accepted internationally as a standard short-distance navigational aid, at recent conferences of the International Civil Aviation Organization. That is to say, aircraft on international routes will carry such equipment, and beacons will be installed at all large International airports. It is proposed that ultimately a carrier frequency of 1000 megacycles/sec. will be used for this service. For Australia's internal service it is proposed to use, at least for some time, the 200 mc. frequency band, since equipment using this frequency can be produced much more expediently than could 1000 mc. equipment; further, a great amount of experience in suitable techniques at 200 mc. is already available.

Active development of distance measuring equipment is being carried out in Britain, the United States and Canada, as well as in Australia. However, it is believed that Australia is the first country where development has advanced to the stage that full-scale airline trials have been carried out.

Future Trends.

As to future design trends in airborne distance measuring equipment, attention will probably be directed to such aspects as: Further improvement in the accuracy at short ranges, so making the equipment more useful in the final stage of the descent to the airfield; means of selecting any beacon in range by turning a switch (a refinement on the present procedure of allowing the equipment to *search* for a beacon, with manual release should the beacon *found* be not the one required); and means for reducing the rate at which the airborne equipment interrogates the beacon, so reducing the load on the beacon. In future work on beacon design, attention will be paid to such aspects as improving the ability of the beacon to discriminate against noise interference, and against interrogating pulses from aircraft other than those using that particular beacon.

CLEANING SWITCH CONTACTS

(Continued from page 23.)

upper contacts clearly shows the distortion due to drag. It was known that a film of grease had been applied to the above switches during manufacture. Thus the increased life of the untreated switches can be attributed to the presence of this film. This was further confirmed by tests on treated samples which had a new film of grease applied in the manner about to be described. The presence of this grease produced no significant change in contact resistance.

Ideal Cleaning Fluid

It may be concluded that the ideal switch-cleaning fluid is one which will remove any foreign matter, but will leave a film of grease deposited on the contact surfaces. A suitable method of achieving this result is to use a cleaning fluid with lubricant in solution. Such a solution when applied to a faulty switch would wash out any foreign matter in the manner previously described. Furthermore on evaporation of the solvent a film of grease would be deposited on the surfaces. A suitable solution was found to be 10 per cent. lanolin in white spirit or trichlorethylene.

There is a danger of flooding the switch in an attempt to make sure. This must be avoided, as excess fluid will spread over the insulation, and the thickness of film on the contact will not be increased. The effect of flooding the switch would be to deposit grease on the surface of the switch insulation. As this will also tend to collect foreign matter, trouble may eventually occur due to surface tracking.

The continued use of this method of contact cleaning may eventually lead to insulation troubles as mentioned above although no cases of this nature have been brought to the author's attention. This difficulty may be overcome, however, by periodically cleaning the entire switch with neat solvent and when dry applying a drop of lanolin solution to the contacts. In cases where low insulation losses are of vital importance this latter method may be adopted every time such a switch is cleaned.

A method of controlling the application of this solution by colouring with an aniline dye, has been suggested to the author. This would give a visual indication of the area covered by the solution, and would also serve as a warning of large deposits of grease on vital insulators. Conversely the effectiveness by removing this excess grease may be observed.

Technical BOOK REVIEW

THE RADIO HANDBOOK.

Published by Editors and Engineers Ltd. Stiff cover, 512 pp. Price, approx., 24/6, plus postage.

Now in the eleventh edition, this internationally known "amateur" handbook should prove a welcome addition to the operating amateur's library. The latest edition is a radical departure from all previous editions, in that the overall size has been greatly increased, whilst the inside contents have been very attractively printed.

The scope of the book is quite comprehensive, being divided up into four main sections. Part 1 covers the necessary fundamentals, such as Vacuum Tube Principles, Amplifiers, Receiver Fundamentals, Transmitter Design, Adjustment, Radiation and Propagation, Workshop Practice, etc. Part 2 deals with the construction of Radio Equipment, Power Supply Operation and Design, Transformer Construction; Part 3, Antenna Construction and Adjustment; and Part 4, Test and Measurement Equipment.

This is an excellent book for the price, and is well recommended to the amateur or in fact anybody interested in this sphere of radio activity.

RADIO ENGINEERING.

By E. K. SANDEMAN, Ph.D., B.Sc., A.C.G.I., M.I.E.E. Published by Chapman and Hall Ltd. Stiff cover, 775 pp. Price, approx. 77/6, plus postage.

Although perhaps the author could have chosen a more appropriate title to differentiate between the already well-known American publication of the same name, this book should still be of considerable interest and value to all engaged in the radio profession.

As stated in the preface, this book has two main objects — firstly, to enable the non-technical reader to obtain a practical knowledge of the subject in the shortest possible time, and, secondly, to provide a book of reference for engineers having some experience in the field. Whilst some may question the wisdom of endeavouring to combine these two somewhat broad aims in the one text, it must be admitted in this case that a satisfactory balance of text matter appears to have been achieved.

The entire book is written in a clear, lucid manner, and for the complete understanding of the text it is only necessary for the reader to have a working knowledge of elementary algebra and logarithms. The balance of the mathematics encountered in the text, are explained in full as the occasion for their use arises.

In all there are sixteen chapters in the book, and of these the first nine may be considered of an elementary nature. After a brief outline of how broadcasting is carried out in the first chapter, other typical chapters are: Chapter 2, Electrical Effects and Units; Chapter 3, Sine Wave and Vectors; Chapter 4, DC Voltage and Current Relationships; Chapter 5, AC Voltage and Current Relationships; Chapter 6, Resonant Circuits; Chapter 7, Power in Alternating Current Circuits; Chapter 8, Harmonic Analysis and Distortion; Chapter 9, Thermionic Valves.

From this stage onwards the book assumes a more technical character, and the remaining chapters deal specifically with more advanced topics, such as: Amplifiers, Oscillators, Modulators and Modulation, Operation of Transmitters, whilst the final chapter deals very adequately with the subject of Feeders, Aerial Coupling and Aerials.

A very comprehensive index is included (even covering the second volume, yet to be published), and the system of numbering the paragraphs of each chapter makes is very easy to find out information on a particular item. In conclusion, this is a very good text, and whilst primarily of value to the broadcast engineer, it can also provide the basis of a complete radio engineering course for the ambitious student.

PRINCIPLES AND PRACTICE OF WAVE GUIDES.

By L. G. H. HUXLEY, M.A., D.Phil. Published by the Cambridge University Press. Stiff cover, 328 pp. Price, approx., 33/3, plus postage.

This volume is the first of a new series of monographs now in the course of preparation, and published under the general heading of "Modern Radio Technique". The whole object of the series is to acquaint the reader with the many wartime developments and advances in techniques, which up to the present time have not been made available to the public.

The scope of the book is based on the course of microwave techniques, which were given during the war at the Radar School of Telecommunications Research Establishment. Consisting of seven chapters, it covers in an admirable manner the various properties of the rectangular and circular wave guides, discussing at some length the various modes and wave propagation properties in them.

The mathematical aspect of the topic has not been stressed to any great extent in the first six chapters, thus allowing the reader to obtain a clear concept of the physical arguments involved. However the last chapter is devoted to the mathematical analysis of certain selected topics, necessitating careful study for its complete understanding.

It is a thoroughly up-to-date and quite comprehensive book, and should interest all engaged on any UHF development work.

All copies from Angus & Robertson Ltd., 89 Castlereagh St., Sydney.

The Mail Bag

Technical Query Service

In response to many requests for a technical query service, this month we introduce "The Mailbag". This space will be devoted to answering of any technical enquiries and is a section we anticipate will eventually become the forum for the "airing" of readers' ideas, opinions and comment on any technical radio subject.

Readers are therefore invited to send in any technical problems either dealing with our circuits or of a general nature, and an earnest endeavour will be made to assist you through the medium of these columns. For convenience, keep all letters to the point, with questions set out in a logical order, as space is rather limited.

All technical enquiries will be dealt with in strict rotation and the replies will be published in the first available issue of the magazine. Address all letters to RADIO SCIENCE, Box 5047, G.P.O. SYDNEY, and mark the envelope "Mailbag".

V.C.G. (Brownsville, via Dapto) asks for diagrams showing how to replace the cord or cords on the many cord-driven tuning systems.

A.—Yes, we agree that some of these systems are complicated and no doubt information of his nature would be of benefit to many servicemen. However due to the great number of variations possible, it would be difficult to locate information on each model, but possibly a general article indicating some usual arrangements will be included in a future issue.

B.M.E. (West Ryde) is interested in the one valve receiver described in the February issue, and mentions we omitted the size of the coil former.

A.—Unfortunately this information was omitted from the article, and the standard 1¼in. ribbed moulded former is the type required. If you wind the coils according to the details shown, then there should be little difficulty in getting this set to operate satisfactorily.

W.S.W. (West Croydon, S.A.) is interested mainly in broadcast reception and transmission, and asks us to publish photographs and details of any new transmitters or stations.

A.—Your request will be forwarded to our DX correspondent, Mr. Roy Hallet, and no doubt photographs of the type you mention will be seen from time to time in his columns.

A.G.H.McI. (Highgate Hill, South Brisbane) sends in a very interesting letter and offers several suggestions regarding future articles.

A.—Many thanks for the letter and subscription. The Continental types you mention are quite satisfactory, and have little tendency to instability if used correctly. The S.W. Listening idea seems to have possibilities and this will be forwarded along to our Short Wave Correspondent for comment. The articles on feedback and use of valves etc., will be certainly featured, as we realise such information is a boon to the technician and experimenter.

R.B. (Kyancutta, S.A.) forwards a subscription and requests that we publish a list of the Civil Aviation frequencies used by aircraft and ground stations.

A.—Unfortunately we have not information you require. However, the Civil Aviation Dept. regularly issues bulletins for airline use giving this information, and possibly you may be able to obtain a copy on application to the department. Many thanks for the subscription.

G.S. (Dunedin, N.Z.) is a radio serviceman, who has written an interesting letter in appreciation of the first issue of RADIO SCIENCE.

A.—Thanks for the appreciative remarks and can assure that future issues will even better this standard. You will find the low cost amplifier well up to expectations and would appreciate any reports on its performance.

T.A.W. (Dulacca, W. Q'ld.) suggests we describe a large amplifier using 6V6-GT'S in the output stage and operated from a vibrator unit.

A.—An amplifier of this type will eventually be described in the magazine, as it is our intention to include a full range of AC and vibrator equipment. In the meantime, the small amplifier described in this issue will possibly be of interest to you, although it is not as large as the one you suggest.

Answers to Quiz

A.1. All except (f) refer to wire coverings. The abbreviations stand for (a) Double Silk Covered. (b) Single Cotton over Enamel. (c) Single Silk Covered. (d) Double Cotton Covered. (e) Single Silk over Enamel. The term ESE is simply a compass direction and means East South East.

A.2. (c) To be technically correct there will be a formation of bubbles on both leads, but the effect is more pronounced around the negative lead, enabling easy identification. Another method is to stick the two leads into a slice of raw potato —when a green spot will form around the positive lead.

A.3. (c) There is no set rule for the grid cap connection. This is frequently used for either the plate or control grid connection depending on certain manufacturing necessities.

A.4. (a).

A.5. (d).

A.6. (d) or (f).

A.7. (b) The ohmic resistance, which is the opposition to the flow of electric current, depends largely on the material, size and temperature of the conductor.

A.8. (b).

A.9. (a) This type of connection avoids the high and often uncertain resistance effects usually encountered with the bearing and sliding type of contact.

A.10. a. (E). b. (D). c. (G). e. (A and C). f. (F). g. (H). h. (G).

A.11. (b).

A.12. (c).

A.13. (a) The unit usually consists of a suitable coil and tuning condenser, and this enables the circuit to be adjusted to reject the unwanted signal.

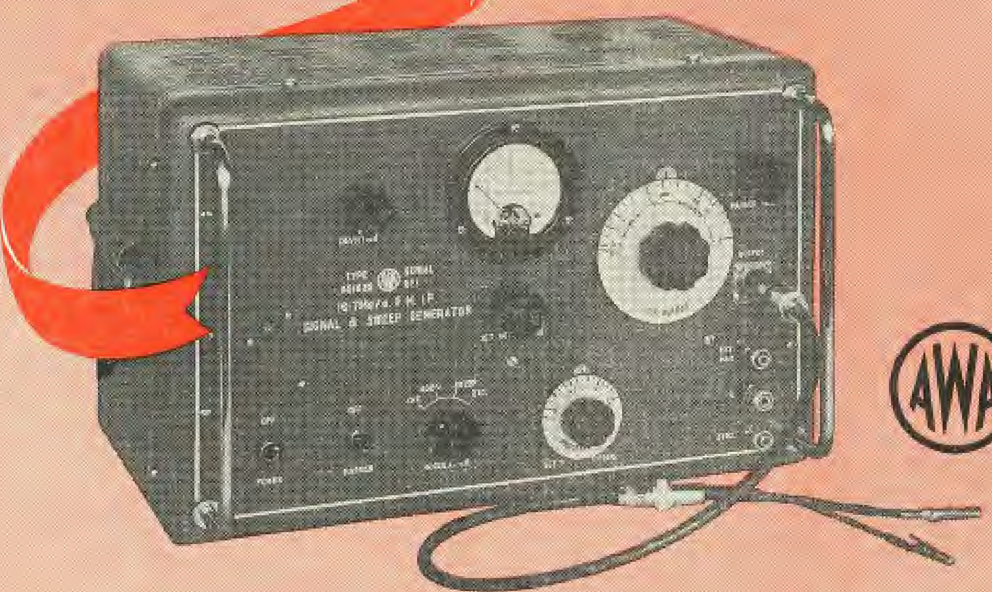
A.14. (d).

A.15. (b) This component is a condenser, whereas all the others are resistors.

ACKNOWLEDGMENT:
The article "Cleaning Switch Contacts" on page 23, first appeared in "Wireless World", and is reprinted by special arrangement with the publishers.

Be prepared for FM!

INTRODUCING



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