RADIO SCIENCE

Vol. 1.—No. 9. Registered at the G.P.O., Sydney, for transmission by post as a periodical. OCTOBER, 1948

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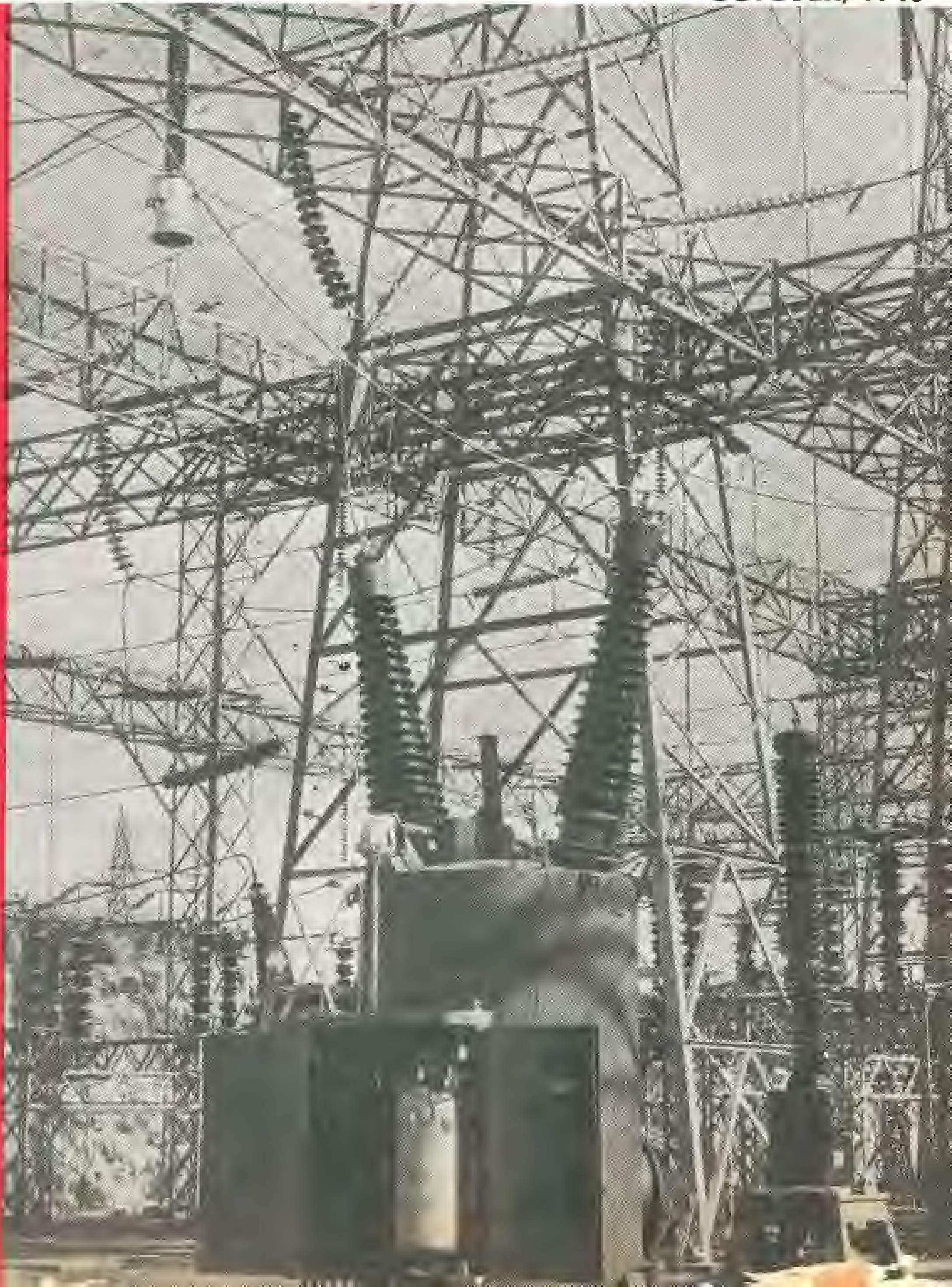


VALVES AND THEIR APPLICATIONS

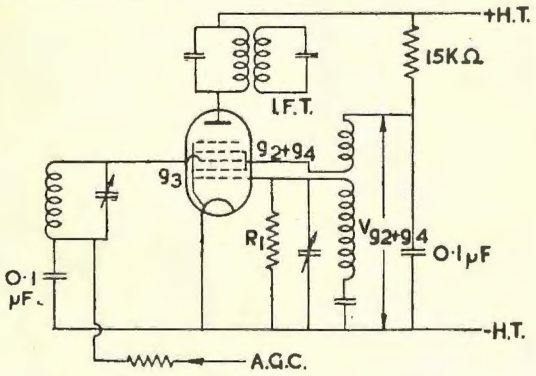
By M. G. SCROGGIE, B.Sc., M.I.E.E. (Eng.)

No. 3: MULLARD HEPTODE FREQUENCY CHANGER IR5

THIS is a miniature all-glass single-ended heptode with a filament consumption one twelfth that of a pen-torch bulb. An obvious role for it is in portable receivers, especially of the "personal" calibre.

In this country the triode-hexode is so popular that not everbody may be sure about how to use the heptode, or pentagrid, particularly as there are several different kinds. So here are a few notes on the 1R5.

The prescribed range of H.T. voltage is 45 to 90, but g_2+g_4 (used as the oscillator anode) must be limited to $67\frac{1}{2}$, by a dropping resistor if necessary.



This skeleton circuit diagram is merely to show how the valve should be connected; the details of tuning arrangements can follow conventional lines. An alternative scheme, for making the whole mutual conductance of the valve effective in the oscillator, is to take the +H.T. lead from the I.F. transformer via the oscillator reaction coil instead of direct. Any voltage-dropping resistor must be inserted on the g_2+g_4 side of the reaction coil and shunted by the by-pass capacitor. It is then not available for sharing with the screen of the I.F. valve.

Normally, however, the oscillator section is quite capable of providing sufficient amplitude without help from the I.F. anode. Such help, too, is liable to be varied by A.G.C. bias on g_3.

The amplitude of oscillation is not at all critical, and there is little to be gained by striving earnestly to keep it at optimum all the time; it is generally more important to economise in H.T. current. The amplitude is measured by a micro-ammeter in series with R_1. Although $200\mu A$ is recommended, the effective optimum, with $Vg_2+g_4=45$ or so, is nearer $100\mu A$, and there is not much loss of signal even at $50\mu A$. Fortunately the optimum increases with Vg_2+g_4. The less oscillator voltage on g_2+g_4 the better; the reaction coil should be comparatively small.

A.G.C. may be applied to the 1R5; the grid base is roughly one fifth of Vg_2+g_4. It is important that the g_3-to-cathode impedance at oscillator frequency should be low, otherwise the action of g_3 may be upset by oscillator voltage from g_2+g_4. It is true that it can be neutralized out by a few pF from g_1 to g_3, but there is no need for this complication if the previous condition is fulfilled.

e d i t o r i a l.

TRANSISTOR—

A Challenge to the Radio Valve?

The announcement of a replacement for the ordinary radio valve in the form of a germanium crystal amplifier/oscillator may well prove to be the most important electronic development of the past decade.

From reports, it would now appear that after some 41 years of unchallenged supremacy, the radio valve as we know it today, will be superseded in many applications by a seemingly simple crystal unit capable of performing efficiently all the normal valve functions. This new device, referred to as a **transistor,** and not unlike the well-known germanium or silicon crystal in appearance, works on an entirely new physical principle discovered during the course of fundamental research into electrical properties of solids.

Being housed in a cylinder less than an inch long and about as thick as a pencil, this unit has neither vacuum, glass envelope, grid, plate, nor cathode. Two hair thin wires touching a pinhead of semi-conductive material such as germanium or silicon mounted on a metal base are the principal parts of the unit. Since there is no cathode to heat up, the transistor starts to work the instant the current flows. To make the unit operate as an amplifier or oscillator, all that is required is two low voltage, low current bias voltage sources.

As can be readily realised, this transistor will provide some exceedingly interesting possibilities for the design engineer. For whilst it has been successfully demonstrated in telephone, television and radio receiver circuits, there are definite limitations at this laboratory stage of development, which will preclude its widespread commercial use.

One of these concerns the available power output. This is limited to approximately 50 milliwatts for a push pull stage, although greater output is possible by using a combination of transistors and ordinary output valves. Another limitation is in regard to operating frequencies. Due to the effect of transit time in the crystal, the upper frequency is now limited to 10 mc. In addition, certain other circuit difficulties manifest themselves in that the input impedance is relatively low, whilst the output impedance is very high—the exact opposite conditions to those encountered with the radio valve.

However, as the possibilities of this device have not yet been fully explored, it is reasonable to assume that as more experience is gained in both their use and manufacture, these limitations will be of only a temporary nature.

Although at this stage of development there appears to be no cause for expecting that this device will result in the wholesale replacement of existing radio valves, it does seem likely that certain valve functions may be taken over by transistors, much in the same way as has already been done by silicon and germanium diode crystals. Thus, this latest discovery in the ever-expanding electronic and radio field, may well usher in the beginning of the end of the "radio valve" era.

RADIO SCIENCE

FOR THE ADVANCEMENT OF RADIO AND ELECTRONIC KNOWLEDGE.

Vol. 1.—No. 9 :: OCTOBER, 1948

EDITORIAL CONTENTS

OUR COVER: The multi-grid De-ion circuit breaker as used in recent tests at Grand Coulee. Climaxing a series of 15 tests were two tremendous short circuits with total R-M-S currents reaching 17,800 and 18,200 amperes respectively. These correspond to a three phase fault of 7,500,000 kva at a bus voltage of 238 kv. —Photograph courtesy Westinghouse Electric Coy.

Published Monthly by RADIO AND SCIENCE PUBLICATIONS, and printed by Publicity Press (1938) Pty. Ltd., 71-75 Regent St., Sydney.

Address all Correspondence to BOX 5047, G.P.O., SYDNEY.

EDITOR: C. E. Birchmeier (A.M.I.R.E., U.S.A.)

MELBOURNE REPRESENTATIVE: J. Cecil Corboy, 18 Queen Street, Melbourne — Telephone MB 1989.

SUBSCRIPTION RATES:—Single copy, 1/-. Australia, British Empire (except Canada) 12/- per year, 21/- for two years; Canada and U.S.A., $2.50 for 1 year, $4.00 for two years. All other countries, 15/- (Aust.) per year. Post free to any address. Foreign remittances should be made by International Money Order or Bank Draft negotiable in Australia.

CONTRIBUTIONS: Articles of a suitable technical nature will be considered by the Editor, and if accepted paid for at current rates. Accepted material is subject to any revision or changes deemed necessary. Contributions will be handled with reasonable care, but this magazine cannot be held responsible for any loss or damage. A stamped addressed envelope should be included for the return of manuscript if unsuitable for publication.

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MODERN
Atom Smashers

By B. G. MILLS, B.Sc., B.E.

In the new science of Nucleonics, atom smashers are the major tools of the nuclear physicist. To explore the mysteries of the atom, several types are now in use or in the course of construction, and this article describes briefly the operating principles of the newer machines.

Since the end of the war has lifted the brake on fundamental scientific research, there has been a renewed and greatly increased interest in high energy accelerators or atom-smashers. This interest, of course, reflects the successful practical application of nuclear physics in the form of the uranium pile and the atom bomb. Many new ideas for accelerators have been put forward, and a great variety of machines are at present under construction. These two articles describe briefly the principles on which the new machines operate.

The large and impressive Van de Graaf electro-static generators which usually grace the pages of an article on atom-smashers have been found wanting when the highest energies are required, as it is found too difficult to generate a D.C. voltage in excess of about 4 or 5 million volts across a discharge tube. The scientist has, therefore, had recourse to machines such as the cyclotron, which produce particles of high energy by means of a very large number of successive accelerations across a relatively low voltage. The cyclotron itself, in its original form, suffers from severe limitations in energy, but as it is the basis of more modern developments, it will be described in some detail.

THE AUTHOR

B. G. MILLS graduated in Science in 1940 and in Electrical Engineering in 1942, from the University of Sydney. He joined the staff of Radiophysics Laboratory, C.S.I.R., in 1942, and until 1946 was engaged in radar developmental work, particularly in regard to receiver and display systems. In 1946 he transferred to the newly-established Radiophysics Valve Laboratory and has been engaged in research work on high energy electron accelerators.

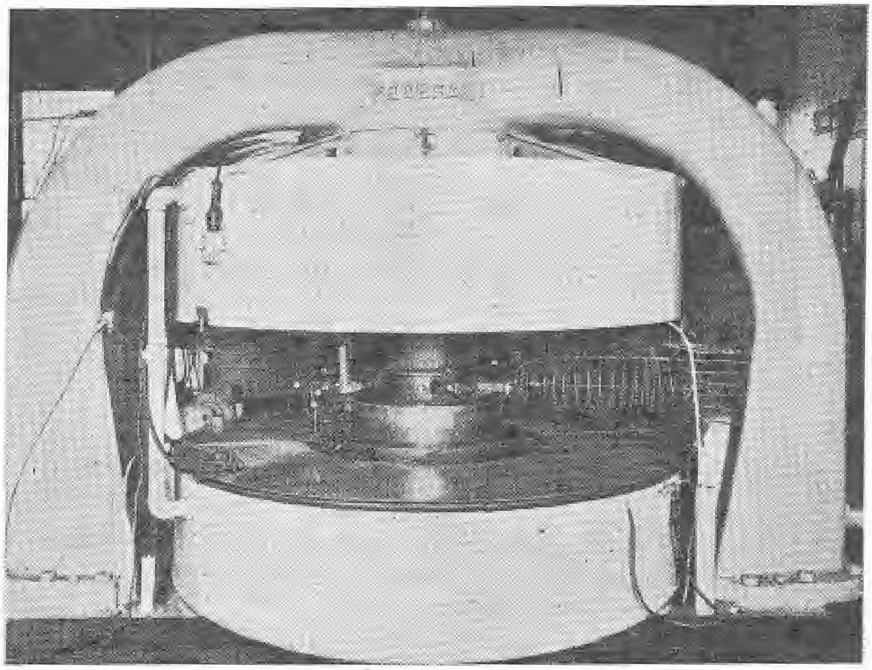

Fig. 1.—A view of a typical cyclotron.

The Cyclotron

In Fig. 1 is a photograph of a typical cyclotron, and in Fig. 2 a diagram of the essential components. Two flat, hollow electrodes, commonly called *dees* because of their shape, are placed in a vacuum chamber and arranged in the uniform field of a powerful electromagnet so that the lines of force are at right angles to the paper. A radio frequency oscillator is connected to these electrodes, producing an alternating voltage of the order of 100 K.V. between them.

Ions are produced at the centre of the structure by a low pressure discharge, and are accelerated by the electric field between the *dees*. Because of the presence of a powerful magnetic field exerting a side thrust on the charged particles, they describe arcs of circles within the dees. The important property of this motion is that the radius of the circle is proportional to the speed of the particles, so that the time taken to traverse a semicircle within the dees is independent of the speed and a function only of the ratio of the charge to mass of the particle and the magnitude of the magnetic field.

By making a half-period of the oscillator frequency equal to this time, a particle which crosses the accelerating gap in one direction when the electric field is at its maximum, will return to the gap at the other side of the centre when the field is at its maximum in the opposite direction. Thus each crossing of the gap will increase the speed of the

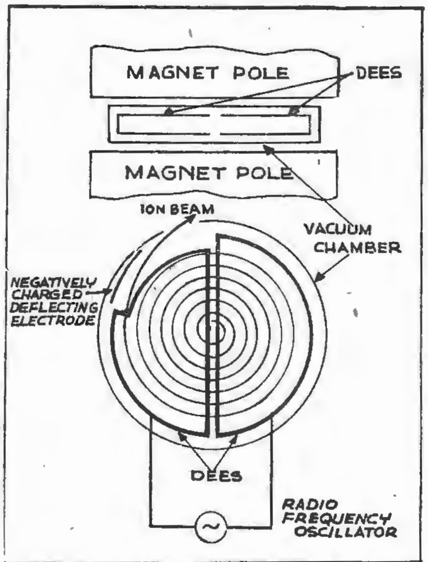

Fig. 2.—The essential components of a cyclotron.

particle and it will spiral further away from the centre until it can be removed by a charged deflecting electrode placed near one of the dees.

With a peak dee voltage of 100 K.V., a singly-charged ion, after 50 revolutions, would have crossed the gap 100 times and would have an energy of 10 M.E.V. The unit of energy, when dealing with atom-smashers, is commonly taken as the million electron volt or M.E.V., and it is the energy which an electron would acquire after acceleration through a potential difference of one million volts.

There are three types of ions which, by virtue of their physical properties, can be usefully employed in a cyclotron, the proton or hydrogen nucleus, the deuteron or deuterium nucleus (deuterium is the isotope of hydrogen of mass two), and the alpha particle or helium nucleus. All three have their particular uses in nuclear experiments.

Limitations of Cyclotron

A limitation on the energy that can be imparted by a cyclotron is imposed by the relativistic increase in mass of the ions when their velocity becomes comparable with the velocity of light. With increasing mass the ions take an increased time to complete their semi-circular orbits within the dees and therefore the ions which started out at the peak of the dee voltage, lag behind in phase and are eventually no longer accelerated. This limit occurs at about 15-20 M.E.V. for deuterons.

For a long time it was thought that this was a fundamental limitation which could be only partially overcome by ever-increasing values for the dee voltage, a very expensive procedure. It was left to a Soviet physicist, V. Veksler, in 1945, to point out first a theoretical way round the difficulty and thus pave the way for vast increases in energy. The idea is quite simple.

When the ions have lagged sufficiently far behind in phase, they settle down in a stable orbit, crossing the dees when the electric field is zero and thus undergoing no acceleration. This is illustrated in Fig. 3, where the accelerating phase and the phase which results in a stable orbit is marked. The orbit is stable because any slight change in frequency or magnetic field intensity will result in the ion arriving at the dee gap when there is still an electric field present which will either increase or decrease the energy and therefore the mass of the ion, until it is once again crossing at the phase of zero field.

Thus by gradually decreasing the oscillator frequency or by increasing the magnetic field, it is possible to accelerate the ions trapped in this stable orbit. The practical application of this principle is leading to the development of quite a number of different types of accelerator generally termed "synchrotrons" by analogy with a synchronous motor.

The Synchrotron

The most straightforward application has been in the frequency-modulated cyclotron or *synchro-cyclotron.* Here the ions are allowed to be trapped in the stable orbit from the beginning, and are accelerated by decreasing the oscillator frequency whilst keeping the magnetic field constant. Theoretically, there is no limit to the energy which may be so attained, but in practice the size of the electro-magnet required is the limiting factor. One great advantage is that the dee voltage can be much smaller than in the conventional cyclotron.

So far the most successful machine of this type is the 184in. cyclotron at the University of California, which accelerates deuterons to an energy of 200 M.E.V. and alpha particles to an energy of 400 M.E.V. (the energy is double with alpha particles, as they carry twice the charge of deuterons). A photograph of the machine is given in Fig. 4. The dee voltage is only 15 K.V. and the ions make some 10,000 revolutions in the magnetic field. The oscillator frequency is varied between 12.6 and 9 megacycles at the rate of approximately 120 cycles per second by means of a rotating mechanical vacuum condenser.

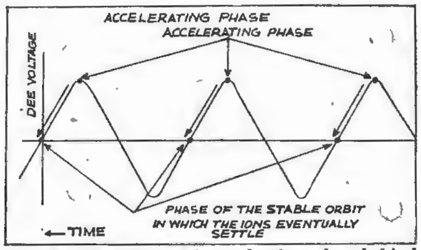

Fig. 3.—Illustrating how the ions lag behind the accelerating phase and settle in a stable orbit undergoing no acceleration.

Successful accelerators using the synchrotron principle have also been constructed for electrons, and in these it is the magnetic field which is varied instead of the oscillator frequency. Because of their small mass, electrons behave quite differently from the heavy positive ions when they are accelerated.

A velocity practically equal to that of light is attained very quickly (a million volt electron has a velocity nearly 95 per cent. the velocity of light), and thereafter their velocity remains practically constant and their mass continues to increase steadily as they gain energy. Thus, if the oscillator frequency is fixed, all high energy electrons have orbits of nearly the same diameter, and the magnetic field need only cover a very small annular ring, greatly decreasing the cost of the magnet. This is illustrated in Fig. 5,

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Fig. 4. This new 184in. cyclotron in the Radiation Laboratory of the University of California has accelerated particles to energies of hundreds of million of electron volts.

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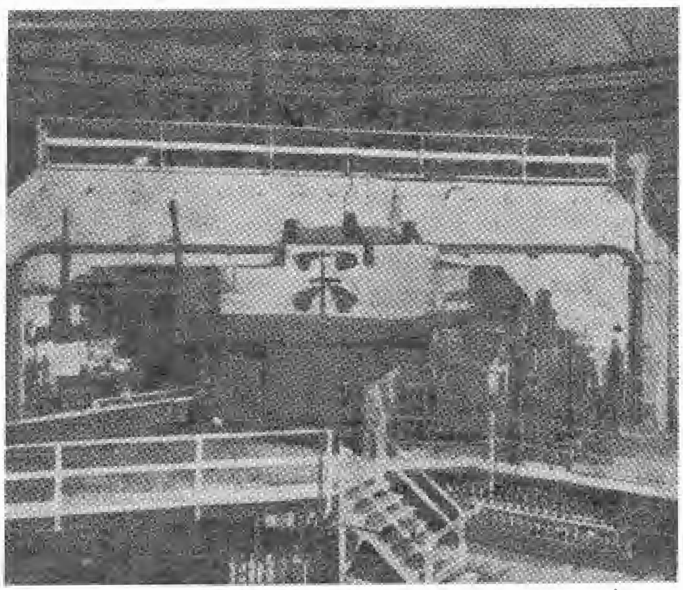


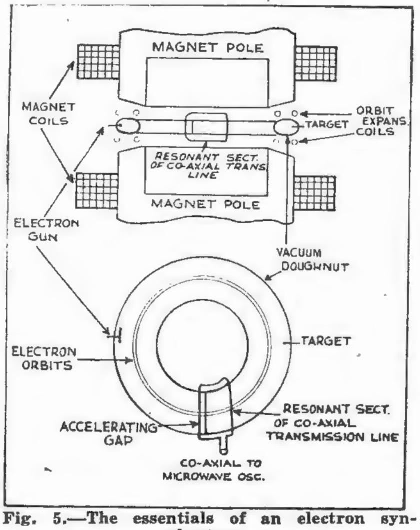


Fig. 5.—The essentials of an electron synchrotron.

where the elements of an electron synchrotron are shown.

The vacuum chamber is in the form of a doughnut placed between the magnet pole pieces and the dees are replaced by a section of resonant transmission line arranged around the doughnut as shown, with a single accelerating gap at one end. This arrangement is possible because a very high frequency is employed for the oscillator, resulting in a resonant section of small dimensions. The electrons may either be injected at a high energy—in practice quite a difficult matter—as they have a tendency to strike the walls of the doughnut instead of settling into their desired orbit, or else released by a small electron gun placed inside the doughnut at a low energy and accelerated to a few million volts by the betatron principle, to be described in the second article.

The latter is the method which has so far been employed in practical synchrotrons. The varying magnetic field required for acceleration is produced by applying a low frequency A.C. voltage across the magnet coils. A bank of condensers is connected in series with the coils to form a system resonant at the supply frequency. Electrons are injected when the magnetic field is near zero and increasing.

The high energy electrons which are present when the field is at its maximum value are not used directly, but are allowed to impinge on a tungsten target suspended within the doughnut, producing high energy X-rays. Orbit expansion coils through which a pulse of current is sent at the appropriate time cause the electrons to strike the target.

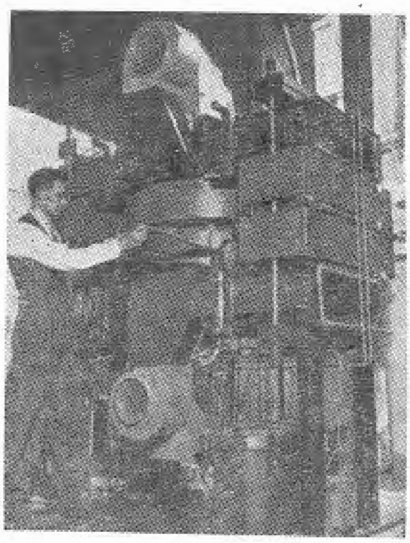
A 70 M.E.V. electron synchrotron constructed at the General Electric Research Laboratory in America is shown in Fig. 6. One designed for 300 M.E.V. is under construction at the University of California.

The Cavitron

A proposed electron accelerator employing the synchrotron principle, but with several novel features, is the *cavitron.* This is expected to yield the very highest energies in an extremely compact machine. Acceleration takes place within a resonant cavity of the sphere and re-entrant cone type shown in Fig. 7.

The very intense magnetic field necessary to produce an electron orbit of sufficiently small diameter to fit inside the cavity is to be produced entirely by an air core coil carrying a very large current. In order to increase the electrical conductivity of the cavity walls and the field coil, the whole structure is to be immersed in liquid helium. This results in a tremendous decrease in the power dissipation required to reach a given energy. A design has been worked out for a 500 M.E.V. machine.

Although representing spectacular increases in energy, it is not expected that any of these machines will give very much further information about nuclear structure. On theoretical grounds an energy in excess of 600 M.E.V. is necessary before experiments likely to produce revolutionary discoveries in the field can be carried out. This is being attempted at the University of Birmingham, where a synchrotron is under construction, which it is hoped will accelerate protons to an energy of 1,000 M.E.V. The project is being undertaken by Professor Oliphant, leading a team consisting largely of Australian scientists from The Council for Scientific and Industrial Research.



The 70,000,000-volt synchrotron in the G-E Research Laboratory. This machine accelerates particles to higher energies than do present-day betatrons, compared with respect to the weight of materials composing the machine. Fig. 6.

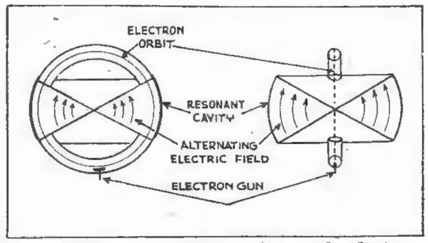


Fig. 7.—The resonant cavity and electron orbit in a cavitron.

By utilising a ring-shaped magnetic field, as in the electron synchrotron, the tremendous cost of a magnet necessary to produce the uniform field of a synchro-cyclotron is avoided. However, in sary to vary the magnetic field and oscillator frequency simultaneously over a wide range, leading to design problems of great complexity. Few details of the machine are yet available.

American Projects

Far overshadowing this, however, are two projected American machines modelled on the same lines, but vastly bigger. They are intended to produce 10,000 M.E.V. protons. So far the projects are only in the design stage and it will probably be many years before they are in operation. Although the designs have been carried out quite independently, both machines are reported to be of the same size; that is, 160ft. in diameter, and having a 12,000-ton magnet. The estimated cost is about £5 million each. In Fig. 8 is shown the construction of these machines. The varying magnetic field in this case is produced by suddenly connecting the magnet coils across a powerful D.C. generator. The generator is order to maintain the size of proton orbit constant during acceleration, it is neces- effectively shorted, but because of the large inductance of the coils, the field takes several seconds to reach its maximum value, during which time the protons are accelerated. When completed, these machines will undoubtedly advance tremendously our knowledge of nuclear structure.

(To be continued.)

RADAR NAVIGATIONAL AID

According to a recent Civil Aviation Department report, the radar navigational aid — Distance Measuring Equipment, is to be used on Australian air routes.

The development and application of this equipment, together with details of the Australian Air Line tests to prove suitability of the system was given in the March and April, 1948 issues of RADIO SCIENCE.

Limited copies of these issues are still available, and can be obtained by writing direct to our Subscription Department, Box 5047, G.P.O. Sydney. The price of each issue is 1/-, and this can be remitted in either postal notes or stamps.

RADAR AIDS TO NAVIGATION

AIRPORT APPROACH CONTROL

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

In this final article of the series dealing with the application of microwave radar equipment to airport approach control, the installation in the Control Tower at Kingsford Smith Airport, Sydney, will be considered.

In this part of the installation there are the units of the radar equipment proper which are complementary to those located on the airfield, and also the re-plotting equipment by which the picture received on the radar is transmitted to the flight control officer in a suitable form.

The units of the radar equipment proper consist of an antenna to receive the pulses, at a carrier frequency of 60 mc., which are transmitted across the airfield from the radar there; a synchronizer unit which performs similar functions to the corresponding unit on the airfield, described in the preceding article; two Plan Position Indicator units, one for the radar operator and an auxiliary unit located actually in the control tower for the use of the flight control officer; and the associated power supply units, control and junction boxes, and the like.

Receiving Antenna

The receiving antenna mounted on the Control Tower is a 4-element horizontal array of the Yagi type. Figure 1 is a photograph of the aerial. This type of aerial has highly directive properties and the reasons for its use are to provide high gain for signals from the transmitting dipole across the airfield and to discriminate against noise coming from other directions which would impair the quality of the signal.

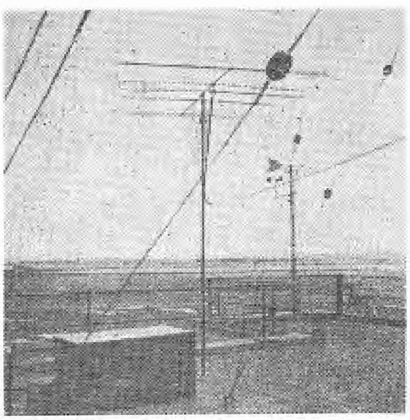


Fig. 1.—Yagi relay receiving aerial on Control Tower.

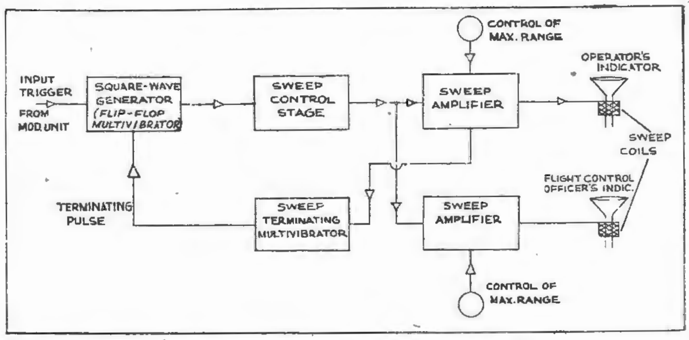


Fig. 2. — Block schematic diagram of sweep generator.

As described in the previous article of this series, the synchronizer unit comprises a number of sub-units, as follows: **L-F amplifier, video amplifier, automatic frequency control, sweep generator, and range mark pulser.** Of these sub-units, the first three have already been described in connection with the field installation. The signal from the receiving aerial is applied to the input of the L-F amplifier, and is then amplified and detected in the way already described. The video amplifier of the tower installation differs somewhat from that at the airfield radar, being modified to differentiate the received video pulses, i.e., to reduce their duration. This modification results in a clearer picture on the indicator screen.

The sweep generator and range mark pulser circuits have an important part to play in the presentation of the picture or display on the screen of the Plan Position Indicator (P.P.I.).

The purpose of the sweep generator is to produce a sweep current which, when fed to the deflecting coils of the P.P.I. cathode ray tube, causes the beam to trace across the tube screen at a definite rate, displaying echoes at their correct relative ranges in a manner which will be discussed when we come to consider the indicator. The desired sweep current is of an intermittent saw-tooth wave-form, and the method of achieving it is as follows:—

It will be of assistance, in studying the action of the sweep generator, to refer to Fig. 2, which is a block schematic drawing of the circuit, and to Fig. 3, in which the principal wave forms are depicted.

Flip-Flop Multivibrator

It will be recalled from the description of the modulator unit that there is available from this unit a pulse of relatively low voltage which coincides precisely with the instant of transmission of the radiated pulse. This small *triggering* pulse is fed to a stage in the sweep generator known as a *flip-flop* or *one-shot* multi-vibrator. This circuit resembles somewhat the conventional multi-vibrator, or square-wave generator, but differs, in that it does **not**, of its own accord, produce a series of square waves; in other words, it is not *free running*. The flip-flop multivibrator circuit produces a *single* "square-wave" only when a triggering impulse is applied to it; this is illustrated in Fig. 3. The commencement of the "square-wave" coincides with the instant when the trigger is applied.

In the usual flip-flop multi-vibrator circuit the square-wave terminates at a time dependent on the constants of the circuit, the stage then reverting to its original "stable" state at any time after which it may again be triggered. In the present equipment, however, a *terminat-*

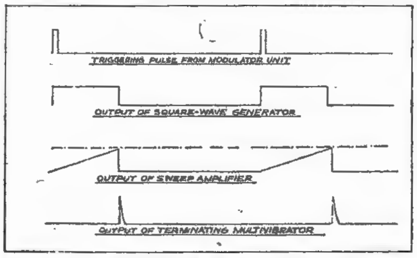


Fig. 3.—Waveforms in sweep generator.

ing pulse is applied to the multi-vibrator, bringing the square-wave to a finish or completing the cycle at some instant before its natural terminating point. The original of the terminating pulse will be made clear later.

We therefore have a square-wave, of which the start is coincident with the radiated pulse. This wave is applied to, and in effect made to "switch on", a valve in the anode circuit, of which is a series combination of resistance and capacitance; as a consequence the capacitance commences to charge in the usual exponential manner. The steadily increasing voltage across the condenser is applied to an amplifier of several stages, having negative feed-back and the output of the amplifier is fed to the sweep coils of the indicator. The feed-back assists in making the sweep current linear with respect to time.

It is necessary to terminate the sweep at an instant corresponding to the maximum range which has been selected; in other words, the square-wave which has been applied to the sweep control valve must finish at that instant. This is achieved by applying the saw-tooth sweep voltage to another flip-flop multi-vibrator stage. This stage is normally in a stable state, but when the applied sweep voltage reaches a certain level, the stage is triggered, providing an output which is the *terminating pulse* previously referred to, and which, when applied back to the original square-wave generator (multi-vibrator), causes the latter to complete its cycle.

The square-wave produced in the sweep generating process is applied also to the anode of one stage in the video amplifier. Consequently, the amplifier is operative only during the period of the sweep, which is, of course, the only time during which it is required. By rendering the amplifier inoperative at all other times, unwanted signals are prevented from causing any disturbance (background illumination) on the screens of the indicators.

The maximum range which is normally displayed on the radar operators' indicator may be varied between 15 and 20 miles, while that on the flight control officers' indicator may be varied independently between 4 and 8 miles.

The method of varying the maximum range is to adjust the gain of the corresponding sweep amplifier by changing the amount of negative feed-back.

Range Mark Pulser

The purpose of this sub-unit is to provide pulses accurately spaced in time by known intervals, corresponding to convenient ranges, as for example, 5, 10, 15, and 20 miles. These pulses are fed into the video amplifier and appear on the screen of the indicator as concentric circles, which provide convenient references for the measurement of the range of echoes. The action of the indicator in producing these range circles will be explained shortly. The circles may be seen in Fig. 4.

The output of the square-wave multivibrator in the sweep generator circuit is used to initiate the generation of the range mark pulses. It is applied to the grid of a so-called *squelch tube,* which is coupled to a self-oscillator stage. When there is no input to the squelch tube,

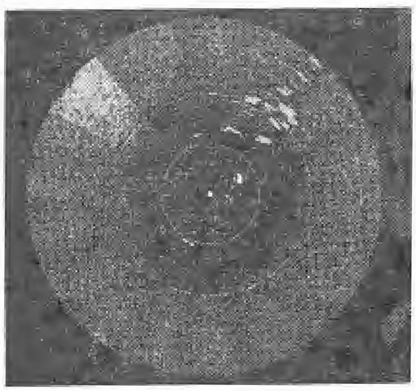


Fig. 4.—View of face of Plan Position Indicator, showing echoes from several aircraft.

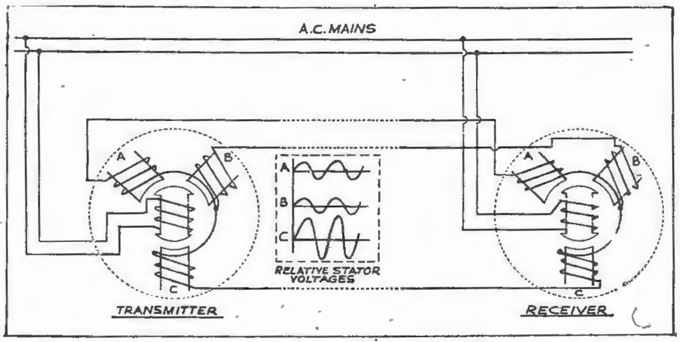


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Fig. 5.—General arrangement of Selsyn units; waveforms are also illustrated.

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the action of the latter is to prevent the operation of the self-oscillator, but with a square-wave applied to the squelch tube grid, the oscillator immediately becomes operative at its natural frequency. The squelch tube thus has the function of an electronic switch.

The oscillatory action is arranged to be very strong, and as a consequence, the oscillator output is a much-distorted sine wave approximating to a square-wave oscillation. This oscillator output is differentiated by a transformer, resulting in a succession of pulses, alternately positive and negative, being produced at the oscillator frequency. The differentiated pulses are applied to a biased cathode follower, the negative pulses are cut off and positive pips only appear at the output, whence they are fed to the video amplifier as already described.

The oscillator frequency is chosen in accordance with the range marks to be produced. For example, if marks at 5 mile intervals are required, the period of the oscillator is adjusted to a value equal to the time required for a radio wave to travel 5 miles (go and return).

The combination of squelch tube and oscillator is such that as soon as the square-wave is applied to the squelch tube, oscillation commences immediately. This means that the first range mark occurs precisely at zero range, as is necessary if the series of range marks is to be accurate.

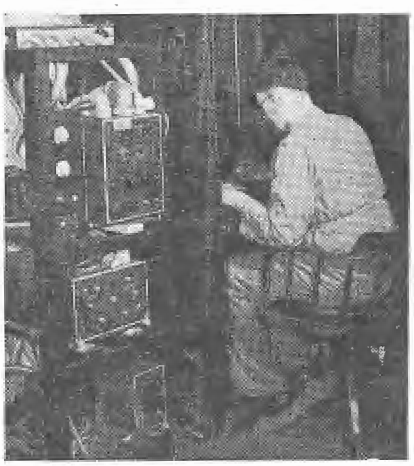

Fig. 6.—Radar operators' enclosure and units of the Control Tower radar installation.

The Plan Position Indicator

The Plan Position Indicator, as its name implies, presents the positions of reflecting objects in the form of a plan, of which the centre point is the radar itself. Bearings and distances to reflecting objects can therefore be read off with great ease.

The cathode ray tube used is of the magnetic-deflection type, a deflecting or sweep coil being mounted around the neck of the tube. When the sweep coil is unenergised, the beam of cathode rays if correctly focussed, produces a small spot of light at the centre of the tube. The brightness of the light spot may be varied by changing the potential of the grid of the tube. When the sweep coil is energised, the beam of cathode rays is deflected from the centre of the tube towards the wall; the direction in which this deflection occurs depends on the orientation of the deflecting magnetic field and hence on the angular position of the sweep coil. The corresponding effect on the face of the tube is a straight trace of light extending radially from the centre of the tube towards the edge.

The trace is visible as a line because of the long-persistence property of the screen material, which continues to glow for a short time (of the order of a second or so) after the removal of the impinging cathode ray beam.

The saw-tooth form of the current in the sweep coil causes the spot of light to move radially at a uniform rate outward from the centre of the screen. The outward deflections occur in synchronism with the transmission of pulses from the radar, and their frequency is 750 per second. The duration of the outward sweep is equal to the time of travel of a radio wave and to and from the most distant objects which it is proposed to detect with the radar.

If now the sweep coil is rotated around the neck of the tube at a radially slow uniform rate, the effect will be that the radial trace on the screen rotates at a corresponding rate. Assuming that no signals are applied to the cathode ray tube grid, the appearance on the face of the tube will be that of a rotating arm or line of light, leaving behind it a glow which is brightest at the line itself and gradually falls off in intensity as the distance from the line increases.

Method of Operation

The method of operation is to rotate the sweep coils in synchronism with the radar antenna, some relationship having been fixed between the direction of the beam of radiation and that of the deflection on the face of the indicator; e.g., the deflection may be at top dead centre of the screen when the aerial points due north.

When a signal from a reflecting object reaches the radar, the corresponding video output is applied to the cathode ray tube grid, causing the intensity of the light spot to increase. It will now be clear from the preceding description that when a reflection is received from an aircraft in a particular direction, a bright spot of light will appear in the corresponding direction of the screen, and further, this spot of light will be at a distance from the centre of the screen, which is linearly proportional to the range of the reflecting object. Hence the position of the aircraft or other object is indicated to scale on a plan, as required. The appearance of the screen of the tube is seen in Fig. 4, in which echoes from several aircraft can be clearly seen.

Actually, because the beam of the radar antenna is not a straight line, but rather a narrow cone, a reflection from a relatively small object such as an aircraft appears on the tube screen as a small arc of light, occupying about 5 deg. This arc of light is intensified each time the sweep passes it, and is persistent enough to be visible until the sweep reaches it again; the interval between successive *paintings* of the echo signal is about 2½ seconds.

As has been mentioned already, it is

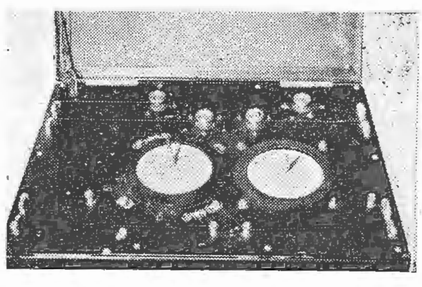

Fig. 7.—View of plotting console, with cover raised. The Selsyn pulleys and the plotting stylus may be seen. (The second cathode-ray tube is intended for use with a long-wave radar installation.)

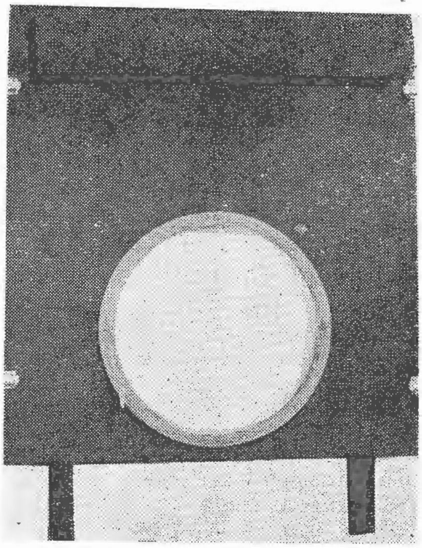

Fig. 8.—View of Daylight Display Unit.

necessary for the indicator sweep coils to rotate in accurate synchronism with the radar antenna. This is achieved by the use of *Selsyn* motors, and for the benefit of those readers who are not familiar with the operation of such motors, a brief description will be given.

Selsyn Motor System

A *Selsyn* system usually comprises a transmitting unit and one or more receiving units, and has the property that when the shaft of the transmitter is rotated through a given angle, the shaft of the receiver simultaneously moves through an equal angle. The transmitter unit consists of a two-pole single-phase rotor, and a 3-pole stator, the 3 windings of the latter forming a Y-connected 3-phase arrangement. The shaft is coupled to the rotating element of which it is desired to transmit the angular position, and the rotor is connected to a supply of alternating current. With the rotor in any given position, its magnetic field will cut the three stator coils, producing voltages in each, which are all in phase, but which differ in magnitude because of the different disposition of the rotor relative to each stator. This is illustrated in Fig. 5.

The 3-stator winding of the transmitter are connected to the corresponding windings of the receiver, which is identical in form to the transmitter unit. This is shown in Fig. 5. The rotor of the receiver is fed from the same A.C. supply as that of the transmitter, so that both rotor currents are in synchronism. The voltages from the 3-stator windings of the transmitter cause corresponding currents to flow in the 3-receiver stator windings and the magnetic fields of the 3 windings combine to form a resultant field which has a certain definite angular orientation. The rotor, which, it will be remembered, is energised, is driven round to a position where its own magnetic field, in combination with the resultant stator field, produces no force on the rotor. At this position the rotor is in equilibrium and there is only one such position in 360 deg. of rotation.

Should the transmitter shaft be rotated through some angle, the relative voltages in the transmitter stator coils will change, causing the resultant field in the receiving unit to rotate and driving the receiver rotor through the same angle. The system thus acts so as to transmit angular movement.

In the radar system being described, the transmitting Selsyn is driven from the rotating antenna through a 1 : 10-gear. Buried cables across the airfield connect this unit to the receiving Selsyn, which drives the sweep coils of the indicator through 10 : 1 gearing. By the use of these gears any error in transmission of angular position by the Selsyn system is reduced to one-tenth of the value obtained with direct drive; consequently, the rotation of the sweep coils is closely in synchronism with that of the antenna.

It may be noted that the introduction of gearing means that a given position of the Selsyn rotors and hence of the sweep coils, can correspond to any one

Fig. 9.—View of Daylight Display Unit with front cover removed.

of 10 positions of the antenna. To resolve this ambiguity, a system of cams and contacts is used at the antenna and the indicators to ensure that the sweep coils can interlock with the antenna in one way only.

Replotting Equipment

The final stage in the Approach Control Radar installation is that involving the transfer of information from the radar operators' indicator to the Flight Control Officer in the form most convenient for the latter.

The principal requirements which the final display system must provide are:—

(1) It should be large enough to be easily seen from a distance of some feet.

(2) The displayed information must be clearly visible in daylight and under artificial light.

(3) The position, identity and movement of all aircraft in the control area should be clearly displayed.

(4) No unnecessary distracting matter should appear on the display.

A re-plotting equipment which fulfils these requirements has been constructed. The radar operator is seated in a darkened enclosure at a desk or console in which is mounted the Plan Position Indicator. This enclosure is depicted in Fig. 5, and a close-up view of the console, with the top cover raised, is shown in Fig. 7. The operator follows on the face of the tube the movement of aircraft detected by the radar by using a stylus, which holds a pencil of the *Chinagraph* variety, suitable for writing on glass.

To the tip of the stylus are connected two very light wires, each of which is wrapped around a pulley on the shaft of a Selsyn transmitter unit and kept taut (see Fig. 7). Consequently, as the stylus is moved over the screen, one or both Selsyn shafts are rotated. The two transmitting Selsyns are connected electrically to two corresponding Selsyns in the Daylight Display Unit. This unit has a vertical paper screen some 15 inches in diameter, over the surface of which a lightweight writing point can move. This writing point is suspended by two thin wires attached to pulleys on the shafts of the two receiving Selsyns.

The action of the system is such that when the operators' stylus moves across the face of the C-R tube, the writing point moves in a precisely similar way across the screen of the Daylight Display Unit. The external appearance of the Daylight Display Unit is seen in Fig. 8, while Fig. 9 illustrates the unit with front cover and screen removed; in the latter picture the pulleys which drive the writing point may be seen in the top corners of the unit.

The radar operator plots the movement of each aircraft in turn. The mark left by the stylus on the tube face allows each plot to be continued on from the point at which it was previously left.

Daylight Display Unit

The method by which the writing point marks the screen of the Daylight Display Unit is as follows:—The writing point is metallic and rests lightly on the surface of the paper screen, which is kept moist and is impregnated with a mixture of potassium iodide, starch and sodium carhonate. When the radar operator makes a plot on the tube screen, he simultaneously presses a button which causes a voltage to be applied to the writing point of the Daylight Display Unit. Electrolysis occurs at the contact between the point and the moist paper, and free iodine is released, which discolours the starch and causes a dark mark to appear on the paper. The action of the sodium carbonate is to cause the plots on the screen of the Daylight Display Unit to fade after a lapse of some 5 minutes. This prevents the screen becoming filled with a confusion of plots, and ensures that the Flight Control Officer has only the most recent information on aircraft positions and movements.

Fig. 10.—Preparation of the impregnated paper screen of the Daylight Display Unit.

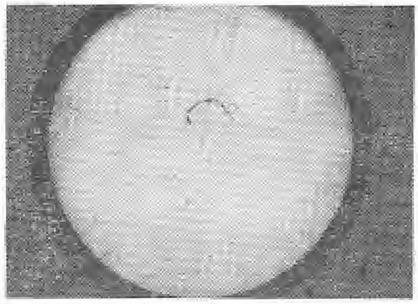

Fig. 11.—Close-up view of the screen of the Daylight Display Unit; the coast outline and range circles are faintly marked, while the plot of an aircraft circling the airport may be seen.

Fig. 10 shows a technician preparing the impregnated paper for mounting in the Daylight Display Unit.

Fluorescent lamps built into the Daylight Display Unit behind the screen allow it to be clearly seen under all lighting conditions likely to be encountered.

An outline map of the control area and range circles are etched on to a Perspex window immediately in front of the paper screen, allowing the position of aircraft to be determined. The appearance of the screen is shown in Fig. 11, in which a plot of an aircraft circling the airport may just be discerned.

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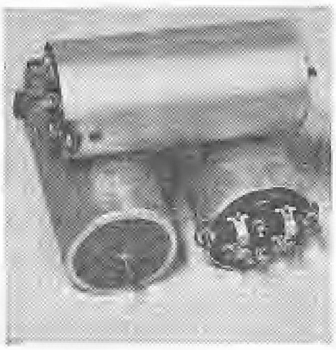

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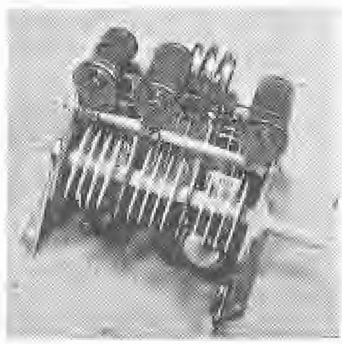

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KOVAR—*Seals Metal to Glass*

Among the thousands of metals, the alloy Kovar occupies a unique position in that it was developed specifically to join metal to glass. The importance of this means of joining glass and metal in high quantity production of radio, radar and other military electronic tubes has been incalculable.

Among men or materials there are many roads to fame. An alloy called Kovar has achieved deserved distinction because it expands with heat at the same rate as hard glass. This fortunate fact enables permanent, glass-to-metal joints to be made or re-made easily, quickly, with average skills.

Many modern electrical devices operate within airtight enclosures. In some cases the enclosure is evacuated, in others it contains a special gas or vapour. Often it has the sole purpose of protecting vital elements against the damaging effects of moisture and dirt. Lamps, radio tubes, ignitron tubes, X-ray tubes, refrigerators, transformers, and meters are equipments in which a sealed enclosure is an essential part. Even small transformers and combat equipment function better when in vacuum-tight cans.

All of these enclosures have one feature in common—current must be carried into and out of the enclosure and the electrical leads must be insulated. This must be done without sacrifice of tightness. Glass at once suggests itself as the insulating material, because it is gas-tight, but to be usefully applied, it must make a vacuum-tight seal with metal. For lamps, photo-electric cells, and observation windows, glass is particularly useful for its satisfactory characteristics of visible light transmission.

Fig. 1.—An idea of the range of seals possible with Kovar is given by these typical metal-to-glass seals now in regular production.

Expansion Factor

In sealing glass to metal, the most important factor is the match in expansion of the two materials. Glass, being brittle, cracks if unduly stressed. The range of expansion co-efficients among both metals and glasses is great, although there is a considerable amount of overlap. Certain glasses have a rather low co-efficient of expansion. This is matched closely only in unalloyed metals, by the expensive molybdenum and tungsten. These two metals seal into hard glass (resistant to thermal shock), but offer manufacturing difficulties in machining and fabrication, and their cost is excessive.

Prior to the advent of Kovar, seals of glass to metal were limited to small areas, or to soft glass, and often had questionable mechanical properties. Usually these seals were made of *feather-edged* copper, in which the metal is made to absorb all the stresses arising from difference in expansion. Because copper amalgamates with mercury, the copper in seals exposed to mercury vapour (as in rectifier tubes) must be plated with a mercury-resistant metal. This introduces additional expense and offers questionable protection. Other disadvantages of copper were the high degree of skill and tedious low-temperature baking or degassing of the seals required by the housekeeper (feather-edge) technique. High-chromium-iron alloys seal only into soft glass. This combination offers inadequate resistance to thermal shock, and such alloys are difficult to fabricate.

An alloy for sealing to low-expansion hard glass must embody the following properties:—

1. **Must seal readily into hard glass, which is highly resistant to thermal shock.**
2. **Must have substantially the same expansion from low temperature to the annealing temperature of the glass.**
3. **Must produce a permanent and gas-tight seal.**
4. **Must be easily machined or fabricated to permit the use of small and intricate shapes.**
5. **Composition must be controllable to permit duplication of results.**
6. **Must resist mercury attack.**
7. **Must be usable without need for feather edge on tubular or intricate shapes.**

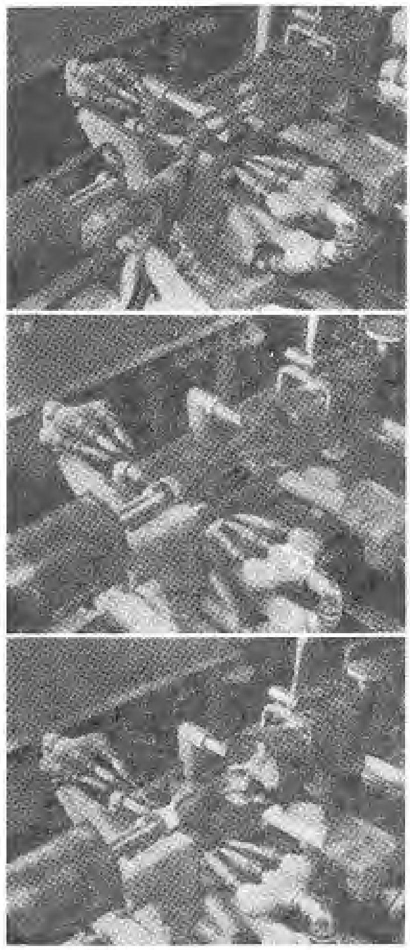


Fig. 2.—Sealing Kovar to glass is a simple operation lending itself to high speed production methods and requiring no unusual skills. In (a) the glass tubing is formed under heat to mate with the Kovar part. The Kovar and glass both spinning in the flames of the glass jets are brought together in (b). The seal between Kovar and glass remain in the flames until the glass flows sufficient to ensure complete joining and dissolving of the oxide coating of the metal into the glass, making a mechanically strong bond as in (c).

8. **Must be relatively inexpensive, eliminating restraints on size.**
9. **Must be weldable, solderable, or brazeable to other metals.**

Kovar supplies all these needs. It is an alloy of 29 per cent. nickel, 17 per cent. cobalt, and 54 per cent. iron, produced in the induction furnace. By careful control of composition, the expansion of a hard glass is matched with precision. The two Kovar seals in Fig. 1 show the approximate commercial size range now practicable.

In mechanical properties and in working and fabricating characteristics, Kovar is quite typical of the nickel alloys. Annealed, its tensile strength is about 70,000 pounds per square inch, with a hardness range of 160 to 180 Brinell. It can be forged, rolled, drawn, and machined, and therefore is available in sheet, wire, tubing, cups, eyelets and other miscellaneous shapes.

High Resistivity

Kovar has a high electrical resistivity (45 microhms per cm.) and is ferromagnetic, having approximately the same magnetic properties as annealed low-carbon steel. It is more resistant to corrosion than ordinary steel, but is inferior to stainless steel in this respect. A high degree of resistance to scaling or to corrosion is not required by present Kovar applications. However, there have been no cases in which the usefulness of Kovar has been limited by corrosion. It can be joined to other metals by brazing, soldering, or welding. Brazing is commonly used because brazed joints are reliably vacuum-tight and can withstand the moderately high temperatures encountered in sealing Kovar to glass.

The seal between Kovar and glass is a chemical bond. The seal is heated and the surface oxide that has been formed on the Kovar part is dissolved into the glass at the glass-Kovar interface. This forms a perfect hermetic seal, permanently vacuum- and pressure-tight under all climatic conditions. The process is basically quite simple. The part to be sealed is designed to prevent sharp corners at points to be sealed. The Kovar part is annealed in a decarburising atmosphere to remove the effects of cold work and to eliminate residual carbon at and near the surface. The part is then brought to a dull-red heat in an oxidizing atmosphere until a thin adherent oxide film is obtained. Molten glass may then be applied immediately or it may be reheated for sealing in a separate operation. A final sealing operation is shown in Fig. 2.

Ease of Manufacture

One of the outstanding features of the Kovar-to-glass seal is the ease of manufacture. This results in low scrap loss and a more satisfactory product. Unlike the feather-edge seal, should the operator fail to make a good Kovar seal, it can easily and quickly be re-made without loss of the materials.

Another feature of the seal is sturdiness. Because the match between the co-efficients of expansion of glass and Kovar is accurate, the parts can be designed for rigidity and strength. An electronic tube, for example, does not deform under atmospheric pressure when pumped out, and stands relatively great abuse without mechanical failure. The experience of Kovar seals in combat equipment, where ruggedness is at a premium, has been excellent. These features can be used by the design engineer in many ways, to increase useful life, to improve appearance, to increase rating, to decrease weight, etc. An X-ray tube, for example, in which a feather-edge of copper was sealed into the glass, was redesigned to use a Kovar seal. This conversion resulted in a saving of 10 per cent. factory scrap and eliminated 10 per cent. of field failures. To these savings must be added the savings of the extra costs of making field replacements.

In military operations, equipment must function under adverse conditions. Temperature range from sub-zero to tropical heat. High humidity, insects and fungi contribute to rapid deterioration of such equipment as communication and range-finding apparatus. To shield against these deteriorating influences, total enclosures using Kovar-glass seals for leads were applied to transformers, resistors, capacitors, condensers, vibrators, switches, receivers, transmitters, and various other electrical components. Adequate protection was given to sensitive instruments and their performance improved. The small seal shown in Fig. 1 is a type of terminal used in such an enclosure. It must be able to withstand the heat shock of soldering or immersion in cold sea-water without failure at the other extreme. The seals must remain rugged and permanently pressure- and vacuum-tight.

Thousands of experiments now being conducted in laboratories throughout the country are contributing new applications and uses for Kovar. The ease of rolling, forging and spinning Kovar into many forms and shapes, enhances its use in a number of diversified fields of application that are continually expanding. Kovar-glass seals in particular materially contribute to the successful operation and long life of equipment in the fields of television, electrically operated and controlled appliances, private and public communication systems, production machinery and other electronic applications. The experience gained in the war use of Kovar, together with its sturdy simplicity, will make for superior peace-time products where glass-to-metal seals are required.

Data courtesy "Westinghouse Engineer"

A Technical Survey of Latest Overseas Developments

H.I.F.A.M. . . . LATEST V.H.F. A-M SYSTEM

Since the introduction of the F-M method of transmission, considerable controversy has taken place in regard to the merits of this system as against using A-M transmissions on the same frequencies. Many engineers have held the opinion that these high frequencies could be utilised more economically for A-M instead of F-M transmissions.

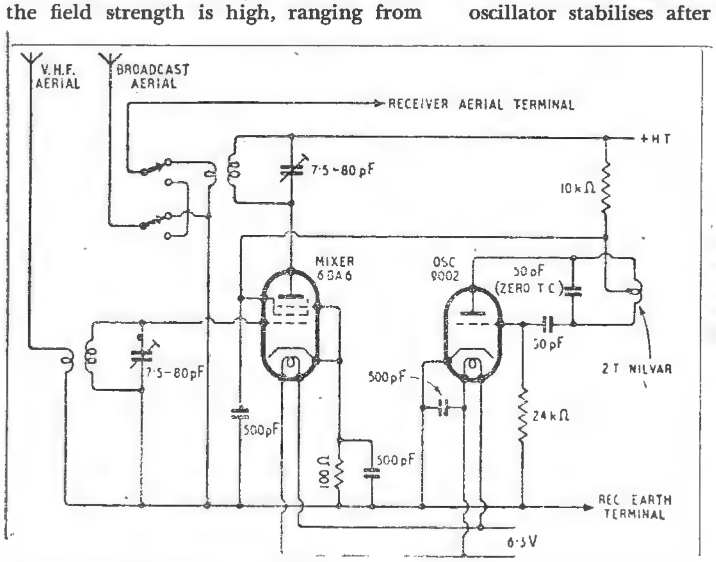
In order to study the radio service possibilities of such a system, particularly for small communities, an experimental station, W9XHZ, has been erected in U.S.A. This operates on 87.75 Mc., with a radiated power into the aerial of 200 watts. The term "H.I.F.A.M." (high-fidelity A-M) has been evolved to describe the new service.

The transmitter uses a non-directional aerial, which is mounted some 795 feet above sea-level. It consists of eight co-axial units mounted vertically and hanging down from the tower platform, and has a power gain of approximately 10. It gives vertical polarisation, which has advantages when small vertical aerials are used for reception.

In the area served by the transmitter, the field strength is high, ranging from 250,000 to 5,000 uV/metre. The 50-uV per metre contour is about 25 miles, with 200 watts of radiated power. The maximum power output of the transmitter is 500 watts. The fidelity characteristic of all components was specified as: 3 db from 30 to 10,000 c/s. A compression amplifier is used in order to maintain a relatively high modulation level. The fidelity characteristics of the studio equipment is -ldb from 30 to 15,000 c/s.

The use of A-M permits the use of inexpensive converters with the standard broadcast band receiver. The circuit arrangement of such a converter is shown in the accompanying diagram. The problem was to build a highly stable oscillator with a frequency stability of 0.002 per cent., and also maintain a high signal-noise ratio in the mixer stage.

The frequency stability was obtained by using a *chimney* type of construction which maintains a flow of cool air at room temperature past the oscillator components. An Invar oscillator coil and zero-co-efficient capacitors are used in the oscillator tank circuit. In all cases the oscillator stabilises after 10 minutes.



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Circuit diagram of the converter unit. The input frequency is 87.75 Mc. and the output 1500kc.

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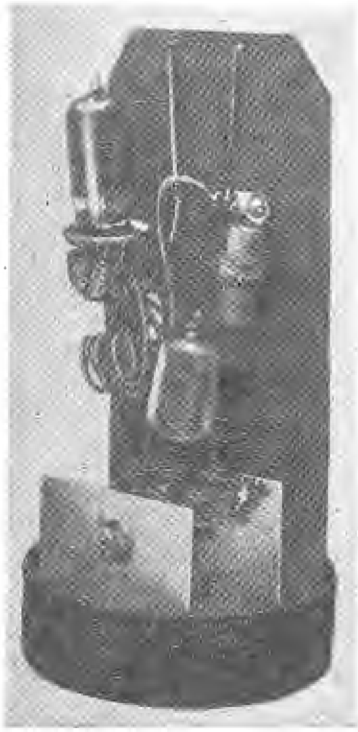


The inexpensive converter used for the American experiments in A-M broadcasting to small communities on 87.75 Mc.

To-date very satisfactory operation has been obtained with the radiated power of 200 watts, and there has been no trouble from atmospheric interference, because the frequency used is inherently immune. Man-made electrical disturbances cause very little interference at 88 Mc and higher.

Due to its nature, H.I.F.A.M. needs a much narrower band of frequencies than F-M. This permits the assignment of a greater number of stations on a given frequency spectrum. The number assigned will depend, of course, on the highest modulation frequency.

—*Courtesy "Wireless World".*

SUPERCONDUCTIVE DETECTOR

At a recent meeting of the Franklin Institute, Dr. Donald H. Andrews announced that superconductive rectification could detect radio signals in the region of 50 to 110 megacycles. Previously, the bolometer low temperature detector had only been known to operate around the long-wave and broadcast band spectrum.

Transition Temperature

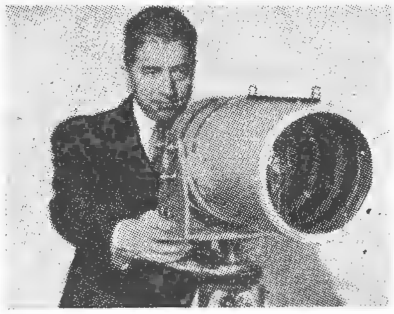
The superconductive bolometer is a new instrument developed by the John Hopkins University for the detection of infra-red radiation. The rectification of radio energy was an accidental discovery made in the spring of 1947 by Major Clark and Dr. Andrews. The bolometer consists of a minute ribbon of columbium nitride cooled to a temperature of –259 deg. centigrade, or about 14 deg. Kelvin. It has been found that in cooling some metals there is a certain transition state when radio signals may be detected.

The property of superconductivity was discovered at the University of Leyden in the Netherlands. Upon cooling, a few metals and alloys below the 7 deg. Kelvin a state is reached where the resistance of the metal drops from its normal value to zero. It is known, for example, that an electric current induced in a doughnut shaped lead ring will keep travelling around the ring as long as it is cooled to super-conductivity. This phenomenon appears to violate physical reasoning since at these low temperatures it would be more probable that all electron, molecular and atomic motion would be arrested.

The low temperatures necessary for this work can only be reached through the use of liquid helium and hydrogen. The super-cooled liquid is then placed in a cryostat which is attached to the bolometer. The bolometer is prepared by cementing a very small strip of columbium nitride to the top of a copper block with bakelite lacquer. The copper block is in contact with the liquid hydrogen. The bolometer is then placed in a copper shield with only a rock salt port or window.

Detects Infra-Red

When the internal temperature of the bolometer is maintained at the critical transition temperature any heat producing radiation (particularly infra-red radiation) passing through the window and falling on the columbian strip will change the effective temperature and vary the resistance between normal and superconductivity. This change in resistance is converted by a voltage drop into a pulse which is then amplified in the usual fashion by a Class A audio amplifier. The change in temperature may be less than a ten-thousandth of a degree. Thus, a bolometer of this type is sufficiently sensitive to pick up the heat of the flame of a single candle at a distance of about 20 miles.



A flake graphite bolometer having extreme high sensitivity.

Making a slight change in the temperature and connecting the amplifier to a loudspeaker allows the bolometer to detect local broadcast stations. A tuned circuit is placed in series with the bolometer. The sensitivity of radio wave detection varies and generally drops off at about 1600 kilocycles. New experiments have shown that the sensitivity is restored at about 50 mc. and is very high at 105 mc.

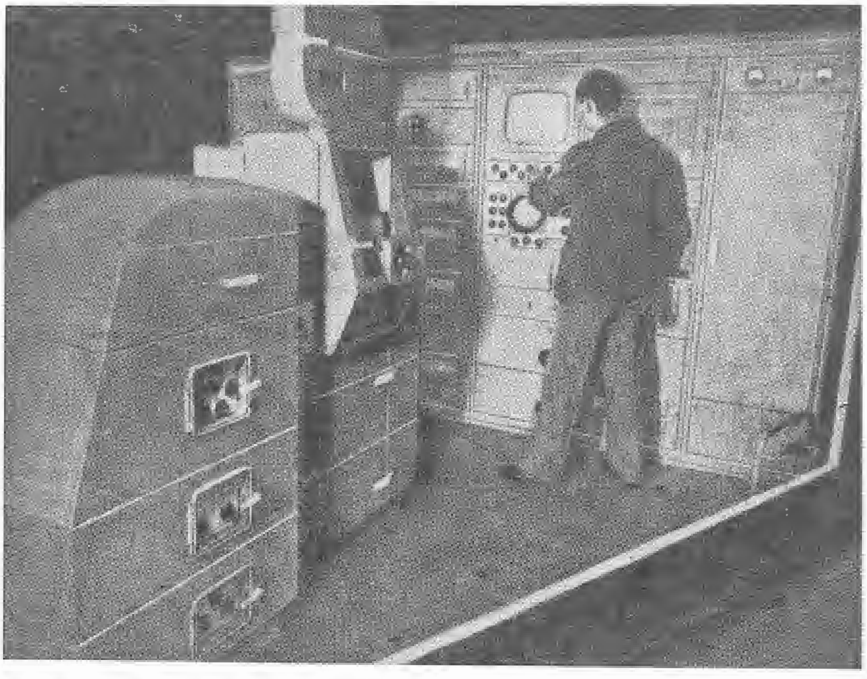
While undoubtedly the superconductive bolometer will never replace the usual radio receiver, it is, however, interesting to speculate that superconductivity experiments have shown that resistance noise may be reduced by about 8 to 10 db in certain cases. Probably noise reductions of a similar nature can be made in the first r-f stage circuits of radar receivers, thereby increasing their sensitivity far below the normal limits.

Courtesy "CQ"

"Electronic Tracks" For Aircraft.

An air navigation and traffic control system, called "Tricon" is being developed by General Electric engineers. Using triple coincidences of pulses as the base of the system, a master station and "slave" units, a 50-mile section can be scanned with triple coincidence about once a second.

An airplane in the area continually establishes its position by means similar to the block system in railroading. The master station thus has complete data on a given sector and transmits the information to the instrument panel of each aircraft in the area.



The Telecine film scanner shown above was an outstanding exhibit at the recent British Industries Fair at Olympia, and was designed for televising of motion picture film with the highest possible degree of definition and picture quality.

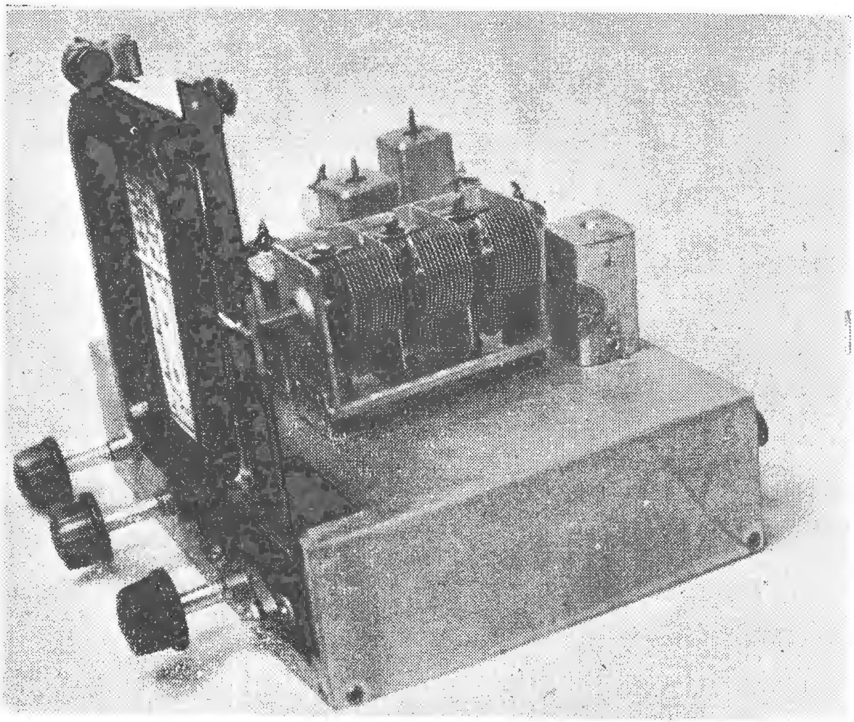
The scanner (left) contains two film boxes, a vision unit and sound unit. The film is continuously scanned by a cathode ray tube, the light from which is focussed on to a multiplier photo-cell. The sound track is scanned by a standard sound film projection lamp and photo-cell. Interlacing is obtained by the use of double optical system, and as the film moves continuously through the gate, one half of the scan is obtained by the movement of the film itself and the other by the frame time base of the tube. The scanner is equipped to take ordinary positive film and will handle reels up to 3,000 feet in length.

The manufacturers claim that in this specially designed scanning system, mechanical drive, and fully corrected amplifier circuits, they have evolved a method of transmitting films which will become accepted as practical and technically correct throughout the world.

Courtesy "Electronic Engineering"

The Countryman's Five

ALL BATTERY RECEIVER



The tuning section of the receiver. The controls are: Tuning, On-Off and Economiser Switch, and Volume Control.

Here are full constructional details for a modern five valve all battery receiver. Incorporating an RF stage to ensure maximum sensitivity, a special economiser circuit and the latest 1.4 volt valves, this is a design which should interest all country readers requiring high performance in conjunction with economical operation.

The problems of the country listener are entirely different to those of the city dweller, and consequently certain factors have to be taken into consideration when designing a receiver for such operation. First and of paramount importance is the question of selectivity and sensitivity. Whilst during the daylight hours, normal listening is restricted to perhaps one or two nearby transmitters, the situation in the evenings is entirely different. Here the sky waves from the various transmitters come into being, due to ionospheric reflections, thus permitting the reception of distant stations.

Since in many areas, interstate stations operating on nearly the same frequencies may be received at approximately equal strength, it is essential, in order to prevent interference, that the receiver must be sufficiently selective to separate all these stations. For this reason the addition of an RF stage is practically a necessity for the country receiver. In addition to providing the required selectivity, it also improves the signal-to-noise ratio and enables many distant stations frequently missed with a smaller receiver, to be heard at reasonable strength.

The other important consideration is that of economical operation. Since the frequent replacement of batteries represents a large factor to the average listener, it is essential that the current drain of the receiver be kept at a minimum, consistent with good performance. To permit some measure of control over this, a special "economiser" circuit has been included, and this operates on the IT4 screen grid circuits of the R-F and I-F amplifiers, as well as altering the back bias resistor value. Such an arrangement is simple but very effective, and allows the current drain to be considerably reduced when only low volume is required. So much then for the general considerations.

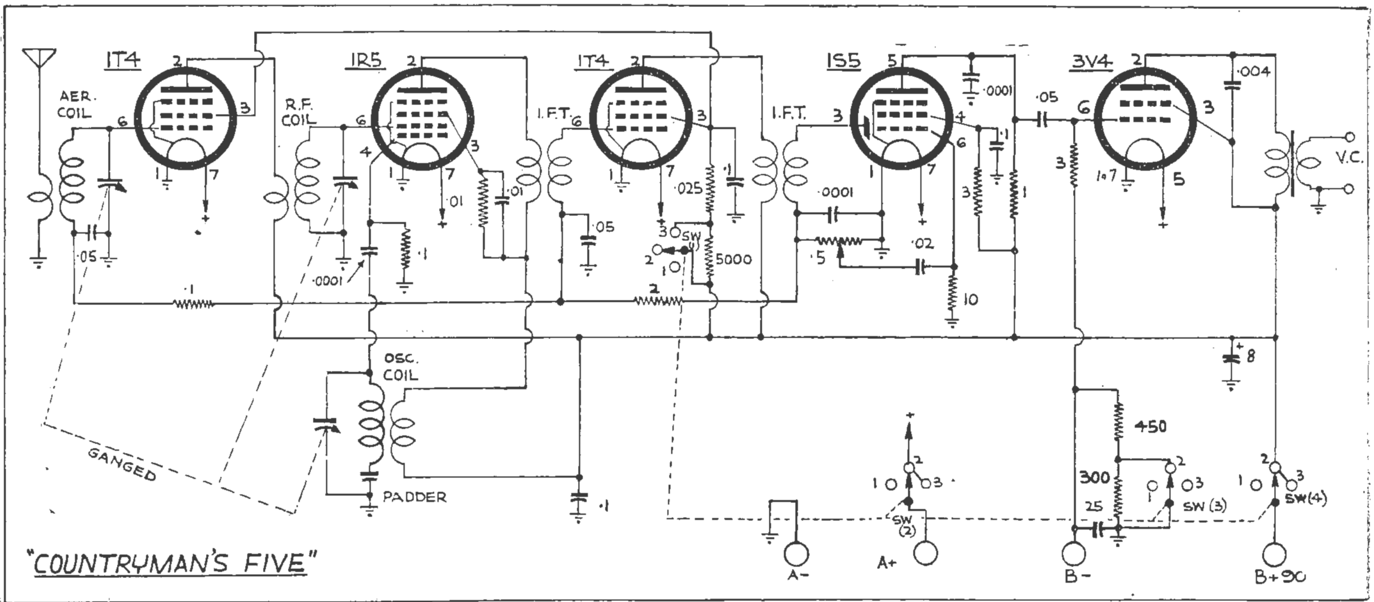
Circuit in Detail

As can be seen from the circuit diagram, the valve line up consists of IT4's in the R-F and I-F amplifier stages, a IR5 converter IS5 combined diode detector, A.V.C. and first audio, and a 3V4 output valve. Although such an arrangement permits little variation from what is generally considered normal practice, there are several points of interest in this circuit.

In the r-f and i-f stages it will be noticed that the IT4 screens are connected together, and fed from the B plus line through a .025 meg and 5,000 ohm resistor connected in series. The 5,000 ohm resistor is connected across one section of the switch, and as this forms part of the "economiser" circuit, further reference will be made of this when dealing with the output section.

The converter stage uses a IR5, and since the connections here are somewhat unusual, the following explanation should be of interest: As this valve has no separate oscillator plate, it is usual for the screen grid to serve the dual-purpose of screen and oscillator plate. Under 90 volt operating conditions this screen voltage should be 67½ volts. Consequently, instead of returning the screen direct to the O.P. connection on the coil, as is usual, it is now fed through a .01 meg resistor. It should be further noted that the .01 mfd. screen by-pass condenser, instead of being connected between screen and earth, is now wired directly across the screen dropping resistor.

The IS5 serves as a combination diode detector and first audio amplifier. As this valve contains only one diode, this is used for both the A.V.C. control as well as detection. The A.V.C. circuit is



The circuit used follows standard practice and is capable of excellent resultc. The four switch sections (SWL-SW4) are part of the 4 x 4 rotary switch, and should be connected up as shown. The numbers around each valve diagram indicate the socket connections.

the conventional series arrangement, with the control voltage being obtained from D.C. voltage drop across the diode load resistor and applied only to the r-f and i-f stages. The converter stage is left uncontrolled, allowing this valve to be operated at maximum gain, thus ensuring high sensitivity at all times.

Although some constructors may consider it preferable to control all three valves, it will be found that the connections shown will be quite satisfactory for most purposes. The efficient A.V.C. action on the R-F stage will prevent any possibility of the converter stage overloading and consequently there will be little danger of distortion, etc., occurring on strong signals.

The diode load consists of a .5 meg potentiometer, which also serves as the audio volume control. If required, this circuit may be modified to include a .05 meg resistor and .0001 mfd condenser in the "hot" end of the volume control to act as an R-F filter. Such a precaution is often advantageous when high gain audio stages are employed. The audio output is applied to the 1S5 grid via the .02 mfd. condenser. The necessary grid bias for this valve is provided by the 10-meg resistor connected from the grid to earth.

The constants shown for the pentode section, that is screen resistor, 3-meg, plate load, 1-meg are those recommended by the valve manufacturers for this particular application, and they should be used if maximum gain is to be realised from this stage.

The output stage comprises a 3V4 valve—a logical choice in place of the often-used 3S4, mainly because it can be operated with 90 volts on the plate and screen. In the case of the 3S4 with 90 volts on the plate, maximum screen voltage is 67.5 volts, and consequently, if used in this circuit, it would be necessary to use a series dropping resistor to reduce the screen voltage to the correct limits. Actually the 3V4 is the better performer of the two and its distortion figures are considerably less than with the 3S4.

"Economiser" Circuit

The "economiser" circuit includes a 4 x 4 rotary type switch which in addition to controlling the 1T4 screen and 3V4 output bias voltage, also provides a convenient ON-OFF switch for the "A" and "B" batteries. Whilst these two battery connections are self explanatory, it should be noticed that the No. 1 pin on all switch sections is left blank.

When the switch is turned to the No. 2 contact, the set is in the normal operating position—that is the 450 ohm back bias resistor is the only one in the circuit, as the second series resistor is now effectively shorted out. This arrangement applies the normal bias voltage to the 3V4 thus permitting maximum output to be obtained. At the same time the screen circuit switch is "open," which means that the screen feed consists of the 5000 ohm and .025 meg resistors in series, thus reducing the screen voltage in this section of the receiver.

On turning to position 3, the section across the bias resistor is open, thus forcing the current to flow through the additional series resistor and increases the bias on the output valve, which under normal conditions draws some 75 per cent. of the total receiver current. Simultaneously in the screen section, the switch is now connected across the 5000 ohm meg resistor, thus shortening it out and so raising the screen voltage. This action tends to offset the

PARTS LIST

1 Chassis, 7½ x 6 x 2
1 3 gang tuning condenser
1 Tuning dial to suit
1 Aerial, 1 RF and 1 Osc. Coil
2 455kc. I.F.T's.

Condensers:
1 25 mfd Electrolytic
1 8 mfd Electrolytic
3 .1 mfd Tubular
3 .05 mfd Tubular
1 .02 mfd Tubular
1 .01 mfd tubular
1 .004 mfd tubular
3 .0001 mfd mica
1 padder (Variable or .0004 mfd Mica)

Resistors:
1 10 meg ½ watt
2 3 meg ½ watt
1 2 meg ½ watt
1 1 meg ½ watt
2 .1 meg ½ watt
1 .025 meg ½ watt
1 .01 meg ½ watt
1 5000 ohm ½ watt
1 450 ohm ½ watt
1 300 ohm ½ watt
1 .5 meg potentiometer

Valves:
2—1T4, 1—1R5, 1—1S5, 1—3V4

Batteries:
1—1.4 volt A bottery
2—45 volt "B"

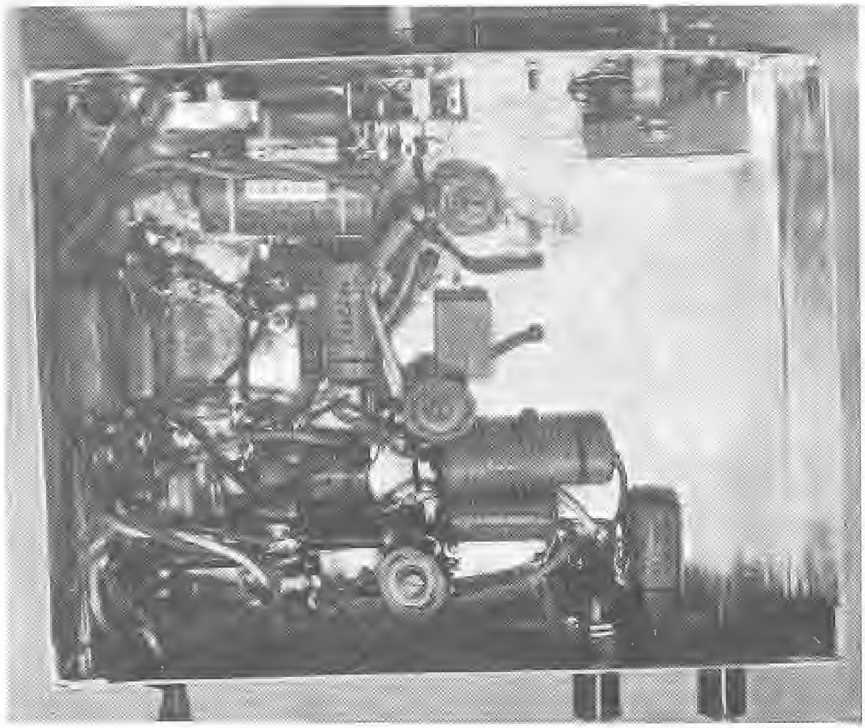
Sundries:
5 miniature sockets, 2 terminals, 1-4 x 4 rotary switch, 3 knobs, nuts and bolts, hookup wire, braided wire, solder lugs, etc.

lowered output gain resulting from the overbias condition of the 3V4. However, since the total screen current of the two 1T4's is rather small in comparison to the output plate current, there is essentially no lost economy in raising the screen voltage when the set is switched to the "economiser" position.

Constructional Details

The actual construction of the receiver is not difficult and the layout of the various components on the $7\frac{1}{2}$ x 6 x 2 chassis can be readily seen from the various photographs. The tuning dial, which is the recently released Efco vertical type, is mounted on the extreme right-hand side, with the miniature three-gang Roblan condenser immediately behind. Three tuning coils are used—one Aerial, one R-F and one Oscillator, and although miniature components were used in the original receiver, the larger variety would serve equally as well providing the layout was altered to accommodate them.

It will be found that the gang condenser is not fitted with small trimmers, and as these are necessary so as to enable the tuned circuits to be accurately aligned, they should be mounted either on the gang, or, better still, across the respective terminals of the coil, as shown in the underneath photograph. However, make sure in mounting them that the outer plate is the one connected to earth. If connected incorrectly, it will be found that the trimming is altered each time the adjusting screw is touched with a screw driver.



This underneath photograph shows the location of the various components. For convenience, the three trimmer condensers have been connected across the respective coil windings instead of being mounted on the gang condenser.

The wiring should cause little complication, as with the layout shown, all components can be readily mounted directly onto the various coil terminals, valve sockets, etc., without the necessity of any mounting plates. All leads should be kept short and direct, with the plate and grid leads well separated to prevent any chance of feed-back.

When earthing the filament minus pin on the valve socket, also ensure the central metal sleeve is earthed, as this forms a partial shield betwen the plate and grid pins. The leads to the volume control should be made with shielded wire, with the outer braid earthed at several points.

As this receiver was designed primarily with the view that it would be fitted into a console or mantel cabinet, it is suggested that a high-class permagnetic speaker be used with it. This should be preferably a 6-inch or larger type, and fitted with a 10,000 ohm. output transformer. The .004 mfd. condenser connected across the speaker is to prevent any audio instability, and in addition forms a simple tone corrector, improving the frequency response. This value is not very critical and may be varied from .001 to .006 to give the best results.

The battery cable is brought out through the rear of the chassis, and to prevent any misconnections these should be colour coded. The batteries required are 2-45 volt "B" and a 1.4 volt "A" battery. In cases where the set is to be used fairly continuously, it is preferable to buy the larger heavy duty variety, in place of the smaller portable types. Although slightly dearer, the increased operating hours more than offset the extra cost.

When the wiring is completed and checked over for any possible errors, connect up the "A" battery and switch on. If the wiring is correct, the filaments should be seen glowing dull red in subdued lighting. Ensure the speaker is connected, then switch in the "B" batteries. As a safety precaution at this stage, wire a small torch globe in series with the "B"-minus lead to act as a fuse, should there be any high tension short circuits. Loosen off the trimmers approximately half-way, and if everything is in order you should be able to hear some broadcast stations coming through.

Alignment Procedure

The next step is to align the various tuned circuits. Tune in a station at the high frequency end of the band and check the aerial and r-f trimmers for maximum output. Next tune in a station at the low frequency end of the band and adjust the aerial coil slug for maximum output. At the same time loosen off the dial drum and adjust the dial pointer to register correctly on the known station.

Again re-tune the receiver to a known station at the high frequency end of the band and position it correctly by means of the oscillator trimmer. Check the aerial and r-f trimmers for maximum gain. Then, if the coils, tuning condenser and gang are accurately matched, it will be found that the various stations are received at their allotted dial position.

In Conclusion

As this set has been designed mainly for country use, it is essential that a good aerial and earth system be used if the maximum results are to be obtained.

In most cases an aerial about 50-60 feet long, and erected as high as possible should be sufficient. It will be found that the height factor is more important than length, as too long an aerial usually damps the input circuit, frequently upsetting the alignment and selectivity. In mounting the aerial make sure it is kept well away from any building, metal roofs, etc., since the effective height of the aerial is simply its height above the surrounding objects.

The earth connection, which is a necessity with any battery receiver, should be taken to piece of piping, buried several feet in the ground, and preferably in a damp spot.

Under these conditions, you will be assured of good listening and should have little trouble in hearing those often elusive and borderline stations.

Radio Valves replaced by

Transistor—New Crystal Amplifier

The introduction of a new crystal device designed to perform efficiently nearly all the functions of an ordinary radio valve may prove to be one of the most important electronic developments of the year. Now, for the first time since its invention some 41 years ago, the radio valve has a rival in a tiny, seemingly simple unit called a "transistor."

This new amplifying device known as the TRANSISTOR (TRANSfer resISTOR) is essentially a triode form of the well-known germanium crystal diode. Operating on entirely new physical principles and capable of many functions of the electronic vacuum tube, but having neither an evacuated envelope nor a hot cathode, it was discovered by members of the Bell Telephone Laboratory staff in the course of fundamental research into the electrical properties of solids. The new discovery now answers a question scientists have been pondering for many years—how to make semi-conductors amplify and thus provide a simple, more rugged and smaller device that can perform the many functions of a vacuum tube.

Because of its unique properties, the transistor is destined to have far-reaching effects on the technology of electronics and will undoubtedly replace conventional electron tubes in a wide range of applications. With the elimination of heater and filament circuits, lighter and smaller radio receivers will be possible as the transistor only requires two low voltage, low current bias voltage sources to operate as an amplifier or oscillator.

Under typical operating conditions it draws only 0.1 watt from the bias sources (about the tenth of the power consumed by a flashlight bulb) and delivers 25 milliwatts of useful output, thus having an overall efficiency of 25 per cent.

In its present experimental form the Transistor is a metal cylinder 3/16-inch in diameter and $\frac{5}{8}$-inch long, and not unlike the well-known germanium or silicon crystal in appearance. It has no vacuum, no glass envelope, no grid, no plate, no cathode and therefore no warm up delay. It will serve equally as well either an amplifier or an oscillator.

Inside the cylinder is a block of germanium soldered on a metal disc, and to which it makes low resistance contact with the upper face of the germanium at points 0.002-inch apart. See Fig. 1 and 2.

Circuit Applications

As far as circuit applications are concerned, the transistor may be compared to the conventional vacuum tube triode if the emitter contact is considered as the control grid, the collector contact as the plate, and the semi-conductor base as the cathode.

An input signal in series with a small positive bias voltage (approximately 1.0 volt) is applied between the grounded face and the input cat whisker (Emitter). A large negative bias voltage (approximately 45 volts) is applied between the ground and output (Collector) point contact. The output signal appears across the load resistor in series with the negative bias.

In this manner a power gain of 100 (20 db) is obtained between the input and output of a Transistor.

Gain can be controlled by varying the amount of bias applied to the emitter contact in much the same way as the gain in a triode can be varied by changing the grid bias.

Present Limitations

The present transistors have voltage gains of approximately 10—roughly the equivalent of a medium-mu triode. However, there are several limitations on its use at this stage of development. The first is the amount of power which can be developed in the units. The power output is restricted to about 25 milliwatts per unit, or 50 mw from a pushpull stage. A transistor capable of developing several watts output does not seem feasible at present. Parallel operation of two or more units is possible however, and could be used to increase the power to a load several fold.

The second limit is the maximum frequency at which it will operate satisfactorily. The upper frequency of operation is limited to about 10 Mc by transit time with the germanium crystal. Whilst the transistor is at present useful at audio, video and the lower radio frequencies, it is unsuited for vhf and uhf applications. Furthermore, the noise generated within

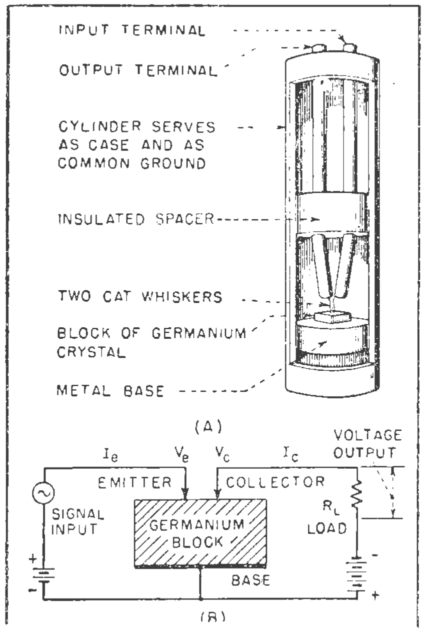


Fig. 1.—Crystal triode (A) consists of two cat whiskers connected to a separate input and output circuits as shown in diagram (B).

a transistor is appreciably greater than that produced in vacuum triodes.

However, the maximum frequency and the power limits of the transistor have not yet been explored and it is quite probable that with the knowledge gained from more experience in their use and manufacture both figures will be raised.

The remaining temporary obstacle to their immediate use is engineering this new device into the circuit. One of the principle problems requiring development is matching the input and output impedances of the transistor to the circuit.

The input impedance of the transistor is low (200-1,000 ohms) because the bias in the input circuit causes current to flow in the forward direction through the point contact of the emitter. On the other hand the output impedance of the transistor is much higher (10,000 to 100,000 ohms) than the input impedance because its bias causes current to flow in the reverse direction through the point contact of the collector.

These impedance levels are the opposite of those for vacuum tubes and require a new approach to the coupling circuits between amplifier stages. Intensive work on this problem is under way.

The future outlook for the transistor appears to be definitely established. Having a long (yet undetermined) life, instant operation (no filaments to heat up), small, compact size, and requiring only moderate voltages in the power supply, these transistor units will have many radio and communication applications when they pass from the research laboratory and are placed into production.

Practical Demonstrations

Laboratory demonstrations to date emphasise the many uses to which the transistor may have in wire communication as well as its ready adaptability to the electronic techniques of radio and television.

In one demonstration a transistor was used to amplify the electrical speech waves travelling between two telephones, a function now performed by vacuum tubes.

In another the audience heard a radio broadcast from a commercial radio set re-built so as to operate entirely without vacuum tubes but using, instead several of the tiny transistors to provide amplification. A transistor was also used to generate a standard frequency tone, thus demonstrating its role as an oscillator.

These demonstrations have indicated that the new device is useful in a regular broadcast receiver to replace all valves when a power output level of not more than 50 milliwatts is required. For larger outputs a vacuum tube amplifier stage of the usual type can be added.

As the transistors can amplify over a wide range of frequencies including the very high frequencies used for video. They can replace any of the valves in a television set for example where the 50 milliwatt 10 Mc limit ratings are not exceeded.

In addition they can be used as repeaters enabling television programmes to be transmitted over ordinary telephone wires. This should provide a simple means of linking many cities into a television network just as the telephone lines now furnish radio networks. At present television can be sent from city to city only over a coaxial cable or microwave radio relay systems.

Process of Conduction

Although a great deal of information has been amassed regarding the operation of this unit, the exact process of conduction is still a debatable point. However, the following theory based on experimental data should be of interest.

During experiments it was found that there is a thin layer of electrons at the surface of the germanium. This surface

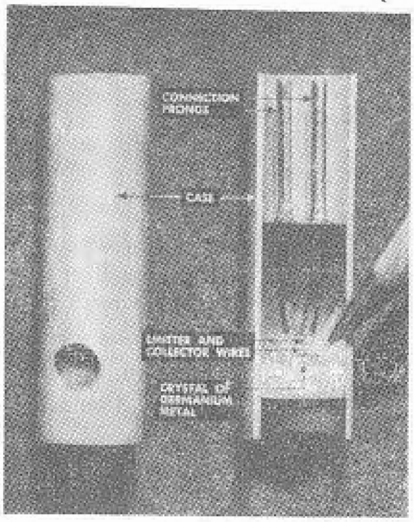


Fig. 2.—A cross section of a transistor, showing method of construction.

layer would prevent the penetration into the body of the semi-conductor of an externally applied field and thus account for the smallness of the changes in resistance observed in the capacitor experiment. The field created by these surface electrons causes the formation of holes in the adjacent material, and these holes conduct current.

When a single point contact is made, the surface layer determines the conductivity for reverse currents or small forward currents. For large forward currents there is an increase in the concentration of carriers (electrons and holes). In either case (forward or reverse current) a large part of the current is carried by the surface conducting layer within an area of interaction very close to the point. Within this area the conductivity, which is mainly by holes, is much greater than elsewhere in the semiconductor. The second point contact for the transistor is added within this area of interaction.

Transistor Characteristics

In a unit, the positive point contact causes the release of holes in the surface layer of the germanium, which is prepared in a similar manner to a high backvoltage rectifier. These holes spread away from the point, flowing in all directions along the surface (but not into the body of the semiconductor). The holes reach the other contact point, 0.005 cm. away, in less than a ten-millionth of a second. This is the transit time that limits present performance to frequencies below about ten megacycles. From this observation, it is estimated that the holes travel at the order of 100,000 centimeters per second. Higher applied potentials and smaller spacings, as used in vacuum tubes to increase high-frequency performance, may reduce this transit time. That there are holes capable of moving from 10 to 100 times this speed is known from estimates of their thermal velocities.

The negative bias applied to the collector causes a very small current to flow from the germanium in the absence of hole conduction produced by the emitter. When the positive bias is applied to the input, however, holes are attracted to the output point contact, which is biased negatively, and these are absorbed, thus increasing the current in the output circuit. Variations in the input current change the number of holes released toward the collector and thus vary the output current proportionately. The transistor circuit thus closely resembles a grounded-grid triode circuit.

In a grounded-grid vacuum triode the current from the cathode is controlled chiefly by the potential between it and the grid (ground); the plate potential has little effect. In the transistor the positive bias (about 1 volt) of the emitter (cathode) causes a small current to flow into the semiconductor. The negative bias (up to 50 volts) of the collector (anode) is made large enough so that it withdraws about the same current (a few milliamperes) from the semiconductor. While the collector is a poor emitter of electrons, it is a good collector of holes.

Not Universal Substitute

At the present stage of development, the transistor will not substitute for all vacuum tube applications. Consider for example the case of an ordinary cascaded resistance coupled amplifier. Normally the grid leak resistance of a succeeding stage is made as high as possible in value (commensurate with frequency response) —considerations to minimise its shunting effect on the plate resistor of the preceding stage.

Cascaded transistors would require transformer, direct valve or some other form of coupling since the input impedance is only 1/10 or so of the output impedance. Again because the transistor output is limited to about 50 milliwatts and since current portable battery receiver designs provide up to 250 milliwatts of power for driving the loudspeaker, a vacuum tube power amplifier would have to be included in these applications.

An interesting and important feature in the use of transistor, however, is that since the input and output circuits are connected through the crystal element, no 180 deg. phase reversal occurs between the two voltages as in the case when vacuum tubes are employed. This can result in important design changes in television circuits where phase reversals produce positive and negative pictures when signal levels are sufficiently above transistor noise levels but below output power requirements.

RECENT OVERSEAS CIRCUITS

Compiled from overseas technical journals, the following three circuits should be of interest to all radio experimenters. Although of an unusual nature, only standard parts are required, and consequently they should offer little difficulty to the average enthusiast.

EFFECTIVE DIVERSITY ADAPTOR

One of the most annoying characteristics of short-wave reception is the fading encountered on weak and distant signals.

This fading is caused not only by the fluctuation of signal amplitude at the receiving antenna, but also by change of polarization of the radio wave. An effective way to minimize the fading encountered on any one antenna is to use two or more antennas located a few wavelengths (or more) apart or of efficient characteristics. Sufficiently different characteristics may be obtained by using one vertical and one horizontal antenna, two horizontals at right angles to each other, or a beam and a long wire antenna.

The two antennas cannot be simply connected in parallel and attached to the receiver, as under some conditions the two signals might be actually of good strength, but out of phase, causing cancellation of the signal and apparent fade-out.

Although receivers with dual r-f and i-f channels have been made for diversity reception, the cost of such an arrangement is out of reach of most amateurs. The alternative to using duplicate receivers is to switch the receiver from the antenna to the other as the signal fades. As this cannot be done manually with any satisfaction because of the delay in the human nervous system, an automatic electronic switch may be constructed and put to work by wiring up the simple circuit to be described.

This circuit automatically switches the two antennas back and forth, searching intently for a signal. As soon as the receiver finds one on either antenna, it keeps the switch thrown to that antenna as long as the signal is of satisfactory strength. If the signal fades, it switches instantaneously to the other antenna, which in most cases will restore the signal to normal strength again. As the receiver tunes in various signals in the band, the unit always chooses the antenna with the greatest signal strength.

Eccles Jordan Scale-of-Two Counter

The nearly human action of the unit is achieved by using a 6AC7 amplifier tube connected to each antenna, with the d.c. tube circuit arranged as a modified Eccles-Jordan scale-of-two counter. This counter is a circuit similar to a multi-vibrator, except that it responds to low frequencies, including d.c.

Since the time constant of the feedback network is infinity when one tube is conducting, the other is cut off, and will remain so indefinitely. A pulse from another source introduced into the circuit will cause the counter circuit to reverse. This circuit is generally called a *flip-flop*. The 6AC7 which was conducting will be cut off and the 6AC7 formerly cut off will conduct. Since only the conducting 6AC7 will allow antenna signals to pass, an instantaneous switch of antennas is acomplished in the common r-f output circuit of the two 6AC7's.

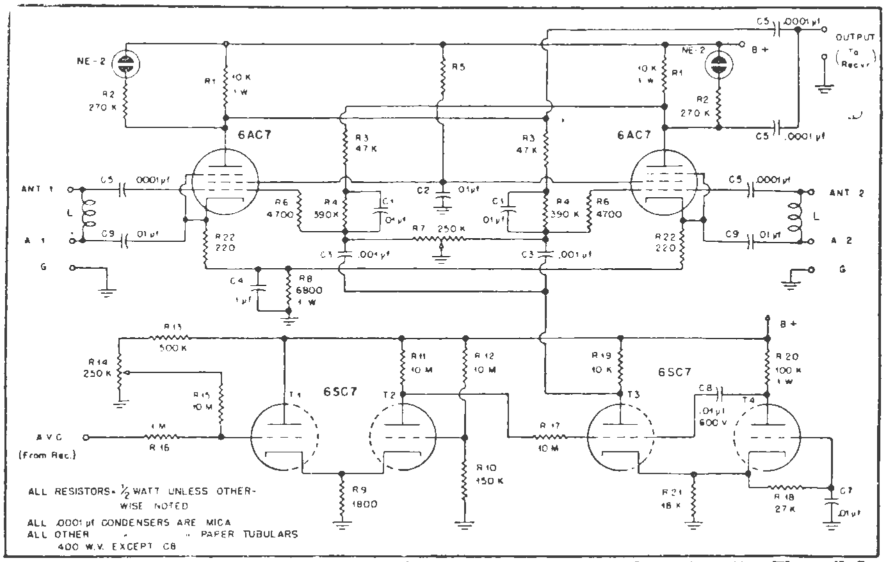
The tube used to generate pulses is a 6SC7 double triode. The two triodes obtain positive feed-back through the common cathode resistors and the coupling condenser C8. The overall configuration is that of a cathode-coupled multi-vibrator with one short time constant (R18 and C7), and one long time constant (C8 and R17). This results in the generation of short duration pulses repeated several times a second. The pulse output is differentiated by C3 and the grid-to-ground resistors in the 6AC7, the flip-flop of the 6AC7's, being actuated by the leading edge of the T3 pulse.

In order to stop the switch when a signal appears, a lead is brought out from the A.V.C. bus in the receiver. This goes to the 6SC7 double triode d.c. amplifier through a voltage adjusting circuit. The output of the 6SC7 is connected to the grid return of one triode of the 6SC7 pulser tube. When as little as .05 volts of A.V.C. is developed in the A.V.C. system, the pulser tube stops, and allows the 6AC7 amplifier tube which caused the A.V.C. to remain conducting.

The voltage adjusting circuit contains a potentiometer which serves the dual purpose of compensating for the normal voltage present on the A.V.C. system of various receivers and adjusting the level at which the A.V.C. stops the switch. For easy adjustment to suit various receiving conditions, this control is brought out on the front of the chassis.

Circuit Details

Two antenna input terminals are provided for each antenna system. A balanced feed line is connected to "ANT" and "A". An unbalanced antenna, such as a long wire, is connected to ANT and "A" is grounded. A coil of about 20



Circuit diagram of the diversity adaptor. The value of R5 is 2700 ohms, 1 watt. The coil L, is a 20 microhenry choke or 50 turns of No. 30 enamelled wire on 9/16in. form, spaced by wire diameter. The exact value of this coil is not critical.

microhenries shunts the input to reduce the possibility of cross-talk from nearby broadcast stations. Its value is not critical and it may be omitted if no powerful stations are in the vicinity.

The impedance of the antenna is not of great importance, but in general the higher the impedance, the more the output of the unit. Any frequency from 3 to 30 megacycles will be passed by the 6AC7's without using any tuned circuits. If greater antenna selectivity or an improved signal-to-noise ratio is desired, a tuned circuit may be connected between ANT and "A", with a grounded and inductively coupled to the antenna feed lines.

A small Neon bulb with a limiting resistor is connected across each 6AC7 plate resistor and serves to indicate which antenna is being used at any moment. These bulbs are mounted through the chassis in rubber grommets near the proper antenna terminals and associated amplifiers.

The filament circuit requires 6.3 V.A.C. at 1.5 amperes. The plate supply may be any voltage between 200 and 300 v. d.c. and draws about 15 ma. The 6SC7 tubes draw very little current. Most of the 15 ma. is used in the conducting 6AC7. The plate and filament power can usually be drawn from the communications receiver unless it is a small Transformer fairly hot.

Putting It Into Operation

The unit may be tested for proper operation with only the tubes in place and the power leads connected. Turn the sensitivity control (R14) to the ground end and set the balance control (R7) near the middle of its range. Turn on the power and watch the Neon bulbs as the set warms up. One bulb should be on and one off. Turn up the sensitivity control until a regular flickering is noticed in the Neon bulbs.

If the balance control is properly set, the bulbs will light alternately, showing the switching is taking place. If they do not alternate properly, but only sit still and flicker, adjust the balance control. The best setting of the sensitivity control is where the Neon bulbs blink on and off two or three times a second. When the unit appears to be working properly, connect the antennas, receiver input and A.V.C. lead. Readjust the sensitivity control if necessary and you are ready to go.

Courtesy "CQ"

SIMPLE AUDIO OSCILLATOR

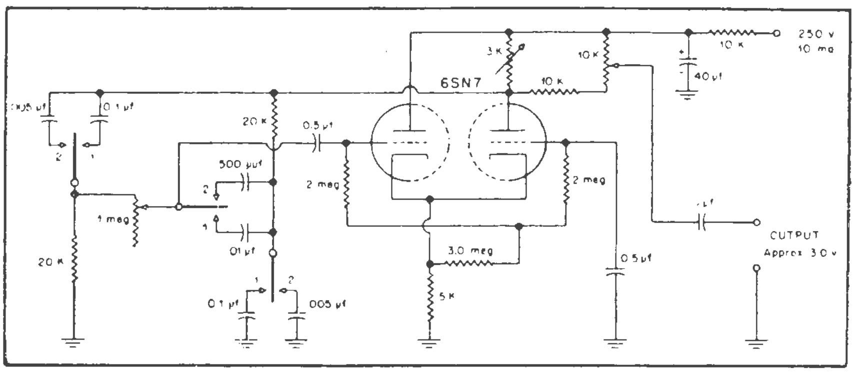
A unique circuit for a simple audio oscillator was described in a recent issue of "Wireless World". The oscillator is of the R.C. feed-back type, but differs from the conventional circuit, in that a single variable element is used as the frequency-determining control.

The circuit, shown below, also utilises an automatic gain control arrangement to stabilise the output voltage. Basically, the oscillator is a two-stage amplifier with cathode coupling. Since the grid swings of the two tubes are opposite and very nearly equal, even harmonics are practically eliminated. The plate loads are small, however, so the Ip-Eg characteristics of each tube are not linearized and the over-all slope can be reduced by the application of grid bias without increasing the distortion appreciably.

The bias, which serves to reduce the gain, is obtained with a grid leak and capacitor in the usual way, but in order to reduce the phase distortion and assist the symmetry of the two stages, most of the leak is made common to both grids. It must be remembered that this arrangement has a long time-constant, and several seconds are required for it to charge up when the oscillator is switched on, so that oscillations do not start as soon as the tube is warmed up.

With the constants shown, the two ranges are from 35 to 800 cps., and 700 to 16,000 cps., with the output being flat within 1 db. throughout the two ranges.

By adding other capacitors, it is possible to increase the range of the oscillater so that with four bands, coverage can be had from 5 to 120,000 cps.



The circuit diagram of oscillator covering 35 to 16000 c/s.

EFFECTIVE NOISE REDUCER

Modern phono pick-ups, amplifiers and reproducers have excellent fidelity throughout the audio range. Unfortunately, hiss, scratch, hum and other background noises usually accompany the desired sounds to spoil what is otherwise life-like reproduction.

Two types of noise reducers are now used in high-fidelity phonograph reproduction and broadcasting. Each is capable of causing as much as 20 db. drop in background noise.

They range from complicated 15-tube circuits for broadcasting to simple 3-tube affairs which give excellent noise reduction with good response for home phonograph reproduction. Fig. 1 is the schematic of the latter model.

The first tube is a 6SQ7 voltage amplifier whose diode plates are used to provide control voltages for the two 6SJ7 electronic gates. For convenience the diode plates are shown as independent rectifiers, D1 and D2. The triangular component of each rectifier is in each case the 6SQ7 cathode.

Operation of the Gates

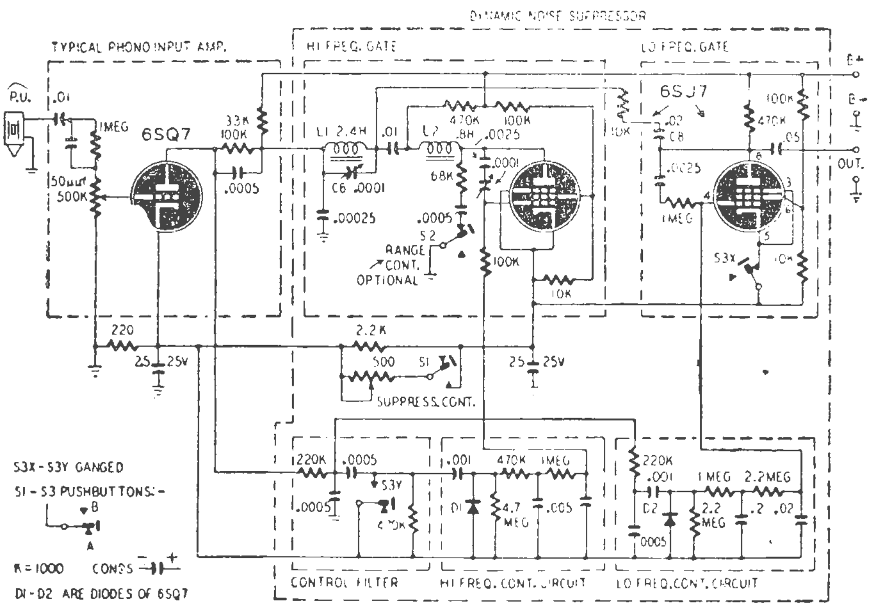
The a.c. component of the 6SQ7 plate current flows through the control filter and high-frequency control circuit and is rectified by one of the diode plates (shown as the rectifying element D1). FUNDAMENTALS of desired high frequency components are filtered out and applied at varying bias to the control grid of the first 6SJ7. The filter allows only a narrow band of frequencies near 3,000 cycles to control the high-frequency gate. This band was selected because it was found to contain the fundamentals of most of the high-frequency harmonics whose inclusion is desirable for good reproduction. If higher frequencies were permitted to operate the gate, the high-frequency noise itself would be able to open the gate. This of course would nullify the action of the circuit.

The parallel-tuned circuit L1-C6 the inductance L2 and the capacitive reactance of the first 6SJ7 comprise a low-pass filter. The varying grid bias causes a change in the tube reactance which changes the upper cut-off frequency. When this frequency is high enough, fundamentals and harmonics of high-frequency speech and music are transmitted through the amplifier.

The other 6SJ7 is connected as an inductive-reactance tube. This reactance—together with condenser C8 and the circuit capacitance — forms a high-pass filter with variable cut off frequency, depending upon the instantaneous grid bias. The bias voltage is derived from D2, the second diode plate of the 6SQ7. After filtering, it contains only harmonics of low-frequency speech or music. Low-frequency noises such as rumble and hum do not operate the gate because these have negligible harmonics.

Several refinements are included in this suppressor. When S1 is opened suppressor action is removed. S2 limits the amplifier frequency range for reproduction of very noisy records. S3 is a ganged push-button switch, added to demonstrate the effectiveness of the suppressor. When switched to B the circuit becomes a low-pass filter. High frequency noise along with high-frequency sound components are attenuated.

—Courtesy "Radio Craft"



High and low-frequency gating circuits control the response of this suppressor.

NEW CATHODE-RAY TUBE

A recent development in cathode ray tubes is the application of an aluminium coating to the fluorescent screen. This forms a conducting and light reflecting surface and improves operating characterstics.

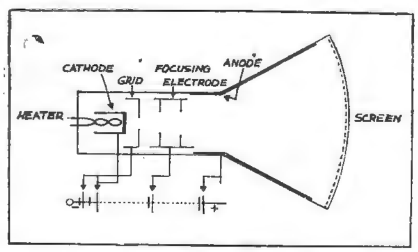
An important development in cathode ray tubes, particularly with reference to those used as television picture tubes, is the aluminized screen. A smooth and very thin coating of aluminium is applied to the back surface of the fluorescent screen, thereby imparting to the screen some highly desirable characteristics. The film is thin enough for the electron beam to penetrate it when sufficiently high gun potentials are employed—say, over 10,000 volts—and at the same time the aluminium forms a conducting and light-reflecting surface and thus overcomes many difficulties that have been experienced in the past with cathode ray tubes.

Racks of Television picture tubes which have just been "aluminized". The aluminium, which is vaporised on the back of the fluorescent screen inside the tube, acts as a reflector to improve light output, image detail and contrast.

Elimination of Sticking Potential

In order to appreciate these factors, some discussion is necessary concerning the ordinary cathode ray tube. This is shown in diagrammatic form in Fig. 1. The tube consists of a heater which heats the cathode, causing thermionic emission from its oxide-coated face. A capped cylindrical electrode serves as a control grid to determine the amount of current flow, and a focusing cylindrical electrode and an accelerating electrode (in the form of an inner conductive coating on the glass walls of the tube) serve to confine the emitted electrons in the form of a beam and to project them at high velocity against the fluorescent screen because of the positive potentials applied to the electrodes.

The electrons, upon striking the screen, cause it to emit light in proportion to their numbers and to the energy with which they strike, that is, in proportion to the beam current and the screen potential. The question will naturally arise: "If electrons are proceeding from the cathode to the screen, how do they, then, return to the cathode once more, since the screen is essentially an insulator and cannot conduct electrons from its centre portions to its edges and thence to the positive end of the power supply?"



This diagram shows the essential parts of a cathode ray tube. Fig. 1.

In the early days of cathode ray manufacture, a very thin and transparent conducting metal was first deposited on the glass face of the tube and the phosphor, constituting the fluorescent screen, was thereupon deposited on this metal film. The latter was then connected together with the second or accelerating anode to the position end of the gun power supply. Electrons impinging upon the phosphor passed through it to the metal film, and then flowed along it to the terminal connection.

It was found, however, that this metal film could be eliminated and yet a continuous flow of electrons maintained to the screen. Further investigation revealed that the mechanism providing the return path was that of secondary emission; the beam electrons striking the phosphor dislodged other electrons from it, and these (secondary) electrons then returned through the space inside the tube to the wall coating and thence to the positive end of the power supply, and through it back to the cathode connected to the negative terminal, and so on.

There is one difficulty with this means of obtaining a return path, and that is that the number of secondaries emitted per primary bombarding electron depends upon its velocity. Below a certain minimum velocity, no electrons are emitted; above this velocity. more than one secondary per primary electron may be emitted; and at a certain higher gun potential and hence beam velocity, the ratio of secondary to primary electrons will drop to unity. This potential may be but a few thousand volts, depending upon the phosphor and its distribution on the glass.

Above this critical potential the ration will drop *below* unity. This means that more primaries will arrive at the screen than are returned by secondary emission. As a result, if the gun potential—as applied between the cathode and the accelerating anode—exceeds this critical potential, the screen will remain at the latter value. by momentarily accumulating more primaries than it emits secondaries, and thus *float* below the accelerating anode in potential.

This critical potential is called the *sticking* potential. One may apply 10,000 volts to the accelerating anode; if the *sticking* potential of the screen is 4,000 volts, then so far as the screen is concerned, this is the effective gun voltage, and the light emitted from it will be on the basis of a beam energy at the screen corresponding to 4,000 volts rather than to 10,000 volts actually applied to the gun.

This is an unfortunate situation, for it renders ineffectual the use of high gun voltage in order to obtain more light. It is a particularly unfortunate restriction in the case of projection picture tubes, where gun (actually screen) potentials of from 20,000 to 60,000 volts are necessary to produce a sufficiently bright picture to compensate for the reduction in intensity produced by the optical enlarging system.

In the past the sticking potential could be raised to nearly the above high values by suitable preparation and thickness of the phosphor, but the sticking potential was not stable and tended to decrease with time. The use of the aluminium film has changed this, and also produced several other desirable results.

When aluminium is used to back the phosphor, it is true that energy is extracted from the beam electrons as they pass through it. Hence, for beam potentials below about 10,000 volts, there is little advantage, if any, in aluminizing the screen, but on the other hand, there is little need for doing so, since the sticking potential can be maintained sufficiently close to the applied gun voltage.

Above 10,000 volts or so, the energy extracted by the aluminium film is relatively small. At the same time the film acts as a conductive return path and essentially eliminates the secondary emission mechanism otherwise necessary. Since the film is connected to the gun supply, the adjacent phosphor is held up to this potential, and therefore receives the full impact of the beam.

A film of from 500 to 5,000 A is sufficient for the purpose. Aluminium is employed because it is readily vaporised and deposited as film, has good light-reflecting characteristics, is fairly permeable to electrons, and does not react with nor spoil the phosphor.

Optical Advantages

There are several other equally important advantages of the aluminized screen. The phosphor emits light in all directions into the tube as well as out through its glass face. The light emitted into the tube from any part of the screen is reflected from the glass walls on to other parts of the screen that may otherwise be dark. This decreases the overall contrast ratio of the reproduced scene and causes it to lack snap and brilliance.

With the aluminium film, such light is directly reflected back out through the same portion of the screen, thereby not only increasing the light intensity of the desired portion of the screen, but also improving the overall contrast ratio. The result is a contrasting picture that is easily seen in a well-lighted room; i.e., it is not readily "washed out" by a high ambient light intensity.

To obtain this reflecting effect, the aluminium film must have a smooth surface next to the phosphor. Unfortunately, the surface of the latter is quite rough. It is therefore necessary to coat the phosphor first with an organic film to fill in all irregularities, and then the aluminium is deposited on this smooth surface and thus forms a specular surface itself.

Other Advantages

There are at least two other advantages of the aluminized screen. One is its inherent elimination of the *ion spot*. The atoms of the residual gas tend to adhere to an electron, forming a heavy negative-ion cluster. This cluster, owing to its mass, moves relatively slowly to the screen and is therefore not appreciably deflected by the magnetic deflection coils. As a result, the centre of the screen is constantly bombarded by such clusters and turns brown. The aluminium film stops these slow-moving ions without being appreciably affected itself, and thus eliminates the *ion spot*.

The second advantage is that the picture is perfectly steady on the screen, and is not affected by moving the hand or any other object over the outer face of the screen. Without the film, the insulating phosphor is sensitive to the capacity effects of such objects, and in turn affects the deflection of the beam. This effect is possibly of more importance in the case of a cathode ray oscilloscope, where a rule may be applied to the tube face to measure the amplitude of the wave reproduced on the screen.

Conclusions

The aluminized screen represents an important advance in the cathode ray tube art, and is being adopted by many other companies besides R.C.A., who developed it. One important practical effect is that it makes the projection tube more efficient, and particularly in the case of the direct-viewing tube, minimises the need for operating the television receiver in a darkened room. Thus it removes one of the objections raised to the use of television in the average home.

TROUBLESHOOTING RECEIVER DISTORTION

This is the first of two articles dealing with the various types of receiver distortion, its causes and how it may be eliminated. This information should prove invaluable to the radio serviceman and assist in developing a systematic method of distortion trouble shooting.

The prime requisite of a radio receiver is that it be able to deliver from its loudspeaker an intelligence which is as nearly identical to the intelligence which is super-imposed upon the carrier wave of the broadcasting station as is possible. To achieve this, the output voltage fed to the speaker must be identical in every respect, other than amplitude, to the voltage wave comprising the modulation envelope of the carrier. Any condition which brings about a deviation from the original, wave-form will introduce distortion into the intelligence received.

These are essentially three (3) types of distortion, i.e.:—

(1) Harmonic Distortion—also referred to as amplitude, or non-linear distortion.
(2) Frequency Distortion, and
(3) Phase Distortion.

Since the ear is very insensitive to phase distortion, it is of little importance in receivers of sound only. Therefore, in this article we will be concerned only with the first two.

Harmonic Distortion

This type of distortion is caused by generation in the receiver of frequencies not present in the signal. These frequencies are harmonics of the frequencies present in the signal, and also frequencies equal to the sums and differences of those frequencies. These sums and difference frequencies are known as intermodulation frequencies.

Harmonic distortion is brought about primarily by improper operating conditions of the tubes, resulting in curvature of the dynamic characteristics, and will generally be held to a minimum if the grid bias, plate voltage, and load impedances are correct, and the signal voltage is not so strong as to cause overloading.

Overloading of any particular stage occurs when the signal voltage is so high as to cause the normal range of operation on the dynamic transfer characteristic of the tube to be exceeded. If the signal becomes sufficiently strong, the plate current may cease to flow entirely during a portion of the cycle.

Frequency Distortion

Frequency distortion is the result of unequal amplification of the different frequency components of a signal and results from the dependance of circuit impedances upon frequency, causing attenuation of some frequencies and accentuation of others, and is generally held at a minimum in circuits not containing transformers or other inductors. There need not be frequency distortion in reactance or transformer coupled stages, however, if the reactors or transformers are properly designed. Impedance mismatches in audio stages are also a source of frequency distortion. If a signal rich in harmonics is fed into a stage with mismatched impedances, some frequencies will be reinforced and others will be attenuated. The load impedance of an audio stage should be high for maximum voltage output, but where current is involved, distortion will be introduced by any mismatch of impedance. Consequently, the load impedance is designed to effect a compromise between power output and distortion.

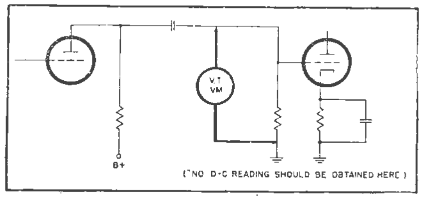


Fig. 2.—If the vacuum tube voltmeter indicates the presence of a voltage drop across the grid resistor, the grid condenser is probably leaking.

Distortion can originate in any stage of a receiver, including the speaker itself. The experienced serviceman can often recognise the peculiar kinds of distortion associated with certain troubles, and can go directly to the source without the aid of any instrument other than his ear. In most cases, however, much valuable time will be saved by the use of test equipment. In a great many cases it is impossible to locate and properly remedy such troubles without the aid of proper test equipment. An oscilloscope is a very desirable instrument to have access to for such work, although a signal tracer with a detector probe will often lead the serviceman to the trouble and require less time to use than the oscilloscope. A modulated signal generator is, of course, a MUST. The writer also considers a vacuum tube voltmeter to be an essential instrument for servicing modern receivers, and especially so in shooting distortion troubles. If one does not have access to either a vacuum tube voltmeter or an oscilloscope, he will waste many hours of valuable time at best, and

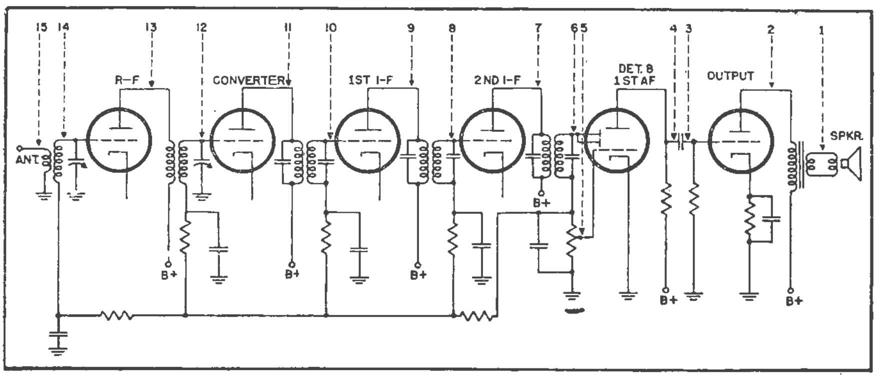
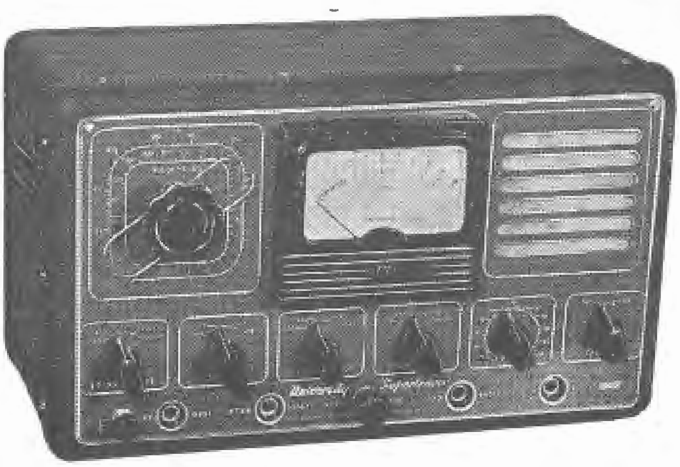


Fig. 1.—A simplified schematic diagram of a receiver showing recommended check points in the order in which the tests are made. The tests are made with a signal tracer while a signal is being fed into the input of the receiver.



HERE IT IS!

THE NEW SUPERTRACER!!

This is the most modern, up-to-date and efficient service instrument that anyone could desire. It is easy-to-use and gives rapid and accurate location of faults in radio receivers and similar equipment. It speeds up testing, servicing and production and will rapidly detect faults which render a receiver inoperative or which make it intermittent or lacking in sensitivity or which cause oscillation, distortion or hum.

It is an attractive, accurately constructed instrument, housed in a brocade finished steel case measuring $14\frac{1}{2}$" long by $8\frac{3}{4}$" high and $8\frac{1}{4}$" wide over controls. The front panel is heavily etched brass with raised nickel-plated lines and letters on a wine-coloured enamelled background. This striking, but dignified colour scheme, adds prestige to your organisation and sets the seal of reliability upon your shop equipment.

The instrument comprises a two stage tuned R.F. amplifier, a diode detector and two stage A.F. amplifier and, of course, a loudspeaker and power supply. In addition, a vacuum tube voltmeter measuring up to 500 volts A.C. or D.C. at a resistance of 11 megohms on D.C. and 10 megohms on A.C. is provided. The tuning range of the R.F. circuits is 175 to 490kc., 550 to 1550 kc., 1.5 to 4 megacycles and 6.3 to 18 megacycles. R.F. sensitivity is such that input voltage of the order of a few millivolts may be detected on all ranges so that the instrument is suitable for use in any district where alternating power mains are available. A capacity type R.F. multiplier in the input circuits in conjunction with the V.T.V.M. enables stage gain measurements to be made.

TEST PROBES: The R.F. test probe is fitted internally with a very small series capacity of a few micro-microfarads so that it does not produce an appreciative detuning effect when applied to the grid or plate of R.F. or I.F. stages in a receiver. The A.F. test probe is a conventional shielded lead for feeding A.F. into the tracer or A.F. out from the tracer for testing A.F. amplifiers or speakers. The D.C. probe contains a series 1 meg. isolating resistor so that the V.T.V.M. may be used to measure plate, bias or A.V.C. voltage under actual operating conditions, without disturbing the action of a receiver.

- **A "SUPER" SIGNAL TRACER**
- **A V.T.V.M. FOR A.C. OR D.C.**
- **A SERVICE SHOP IN ITSELF**

VACUUM TUBE VOLTMETER: The V.T.V.M. features a centre zero scale for direct voltage measurement so that voltages which are either positive or negative with respect to a receiver's chassis are instantly indicated without the necessity of reversing test leads or operating a reversing switch. Zero is at the left for alternating voltage ranges and operation covers the audio frequency range. Voltage ranges are 0/5, 0/25, 0/100 and 0/500 volts at an input resistance of 11 megohms on D.C. and 10 megohms on A.C. ranges. In conjunction with the amplifying stages of the tracer, the meter will indicate R.F. or A.F. voltages down to a value of less than 1 millivolt. Indications are provided by a large, clearly marked rectangular meter with illuminated scale fitted in an attractive modern plastic case measuring $4\frac{3}{4}$" x 4". The V.T.V.M. and tracer may be used simultaneously for observing signals at two distinct points in a receiver. This feature greatly facilitates location of intermittent faults.

POWER SUPPLY: Operation is from A.C. power mains at a voltage between 220 and 260 volts and at a frequency between 40 to 60 C.P.S.

ANOTHER *University* INSTRUMENT

Made by RADIO EQUIPMENT PTY. LIMITED, 5 North York Street, Sydney

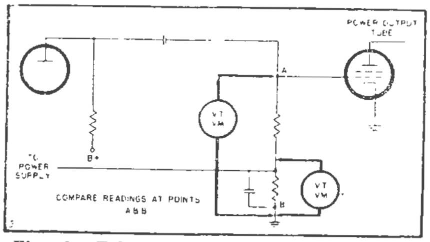


Fig. 3.—Taking two successive readings as shown above, the coupling condenser may be checked. If there is a considerable difference between the readings the condenser is probably faulty.

in many cases probably will not be able to effect the proper cures at all.

Harmonic distortion is responsible for the majority of the distortion troubles in a receiver, and since tube operating conditions are the chief cause of this type of distortion, it is important to be able to determine the exact voltages which are applied to the various tube elements. A vacuum tube voltmeter is absolutely necessary to make these measurements. Many distortion troubles can be located without any instrument other than V.T.V.M.

Since distortion can originate in any part of the receiver, time will be saved by first localising the distortion to a stage through the use of a signal tracer (see Fig. 1). For instance, if a signal taken from the voice coil of a receiver is distorted and the signal appearing on the control grid terminal of the output stage is undistorted, then it is logical to assume that the trouble is in the last stage. If distortion exists at the grid of the output stage, then the output of the preceding stage should be checked, then its input, etc., working back toward the first stage in this manner until the distortion is localised. When the offending stage has been located, it is necessary to test voltages, etc., in the stage where the distortion exists rather than to make haphazard tests throughout the receiver.

The tubes should always be tested first. A defective tube is often the source of distortion trouble and although a tube tester will not point out a defective tube in 100 per cent. of the cases, it will do so in the majority of cases. If there is any reason to doubt the merits of a tube, it is better to check it by substituting a tube known to be good.

Coupling Condensers

No one method can be claimed to be the universal solution to tracking down the source of distortion in a radio receiver. Each case is an individual one and poses its individual problems. It is of paramount importance to utilise one's knowledge of theory, together with logic and reasoning, in analyzing distortion troubles. For instance, one of the most common offenders in audio stages is the leaky coupling condenser, which is connected between the plate of one stage and the control grid of the following stage.

In most cases, this condenser is not "dead-shorted", but has a high resistance leak, sometimes of the order of several megohms. It would be a comparatively simple matter to apply the test leads of any voltmeter between the grid end of the condenser and B—in order to determine a "dead short", as the grid potential would be the same as the plate potential of the preceding stage and therefore a high positive reading would be obtained on the meter. Logic points out, however, that where the leak is in the order of megohms, there would be little use to expect a reading on an ordinary low resistance voltmeter, as the I-R drop across the condenser would be equal to approximately the plate voltage of the preceding stage the instant that the meter became part of the circuit.

If a vacuum tube voltmeter is used (Fig. 2), the presence of any positive voltage at the grid can be readily determined, as this type of meter does not draw current from the circuit. It will not be necessary to disconnect the condenser from the circuit. Where a leak is suspected, the tube, which has its grid connected to the condenser in question should be removed from its socket before dismissing the possibility of leakage.

Flow of grid current may sometimes reduce the voltage at the grid to a minimum, or the bias which is developed across the cathode resistor may be sufficient to cancel out the positive voltage which would otherwise be present. It must also be remembered that if a fixed bias is being applied to the grid, that this bias may be greater than the positive potential. The bias voltage would be less negative than normally, if the coupling condenser is leaking because of the I-R drop which will consequently take place across the grid load resistor. A comparison should be made between the bias supply voltage and the voltage at the grid. A leaky coupling condenser will be indicated if a considerable difference exists between the two readings (see Fig. 3).

Overloading

As previously stated, overloading may take place in one or more stages when the amplitude of the input signal is excessive. In some cases, the signal may swing the grid-voltage beyond the plate-current saturation point. The grid may swing positive and draw current, or the grid voltage may swing past the plate current cut-off point. An oscilloscope is an ideal instrument for detecting such conditions. A sinusoidal voltage from the signal generator may be fed into the input of a circuit and a comparison between the input and output wave-forms will detect the presence of overloading. If the serviceman does not have access to an oscilloscope, there are other methods of approaching the problem.

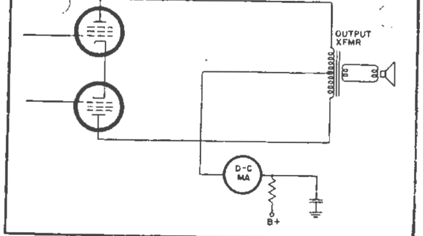


Fig. 4.—A d-c milliameter connected as shown may be used to check the operation of a push-pull class A amplifier.

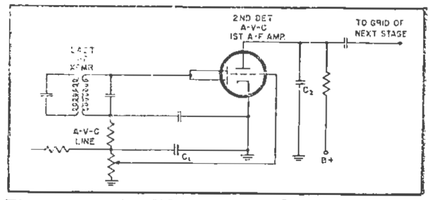


Fig. 5.—A simplified circuit showing a combined second detector, AVC, first audio amplifier.

We know that the grid of a class A amplifier should never become positively charged. A positive potential can be readily detected with the V.T.V.M. and indicates overloading (see Fig. 3). It should be remembered that the grids of a class B output stage may normally swing positive during the cycle of operation.

A D.C. milliammeter can also be used. We know that the average plate current flow should remain constant in a push-pull class A amplifier. Therefore, the reading on a D.C. milliammeter placed in the common B + lead to such a stage (Fig. 4) should remain the same and overloading will be indicated by any fluctuation of the meter reading.

A V.T.V.M. connected to the plate will also detect any current fluctuation, since any change in current flow will produce a corresponding change in plate voltage, although the voltage change may be very slight if the voltage regulation is good. In a stage containing only a single tube, overloading will not necessarily cause any change in the average plate current, because both the negative and positive halves of the cycles are affected. An upward fluctuation of Class A amplifier plate current will indicate excessive negative bias, whereas a downward fluctuation of plate current will indicate insufficient negative bias. Grid current flow in a class A amplifier will indicate either excessive signal voltage or insufficient negative bias, or a combination of both.

A.V.C.

Improper A.V.C. action may be the cause of incorrect operation of the R-F or I-F stages.

The great majority of present-day receivers utilize the diode detector A.V.C.

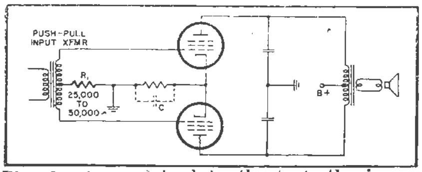


Fig. 6.—As explained in the text, the insertion of R1 will often eliminate parasitic oscillation.

system. A trouble often encountered in this circuit is that of too strong an A.V.C. action. Such a condition will not only reduce the sensitivity of the receiver, but serious distortion may result, especially if the A.V.C. voltage becomes strong enough to bias one or more tubes beyond their cut-off. If one or more R-F stages should have its grid driven negative to the extent that plate current flow ceases entirely during the negative half of the applied signal, the tube will tend to act as a grid bias detector, and a form of distortion known as *cross modulation* results. Two stations will appear to come in together.

Such a condition is not always the fault of the A.V.C. action, however. The D.C. bias supplied to the tube may be too great or the fault may lie in the tube itself. The cut-off point of remote cut-off, or variable Mu. tubes, which are used in A.V.C. controlled stages, tends to approach zero grid bias as these tubes age. New tubes should be substituted before concluding that some other trouble exists.

In a receiver operating normally, the A.V.C. voltage developed may run as high as 40 volts, depending upon the amplitude of the signal and the number of tubes under control. Generally, the fewer the number of tubes controlled, the greater will be the A.V.C. voltage developed for a given signal strength. If it becomes apparent that the A.V.C. voltage is too great, the A.V.C. diode tube should first be checked by substituting a tube known to be good.

A gassy diode will cause excessive A.V.C. voltage to be developed. This diode is often incorporated in the same envelope as the 1st A-F amplifier triode, such as in the 6SQ7, 7C6, etc. The A.V.C. and, or the detector diode may also be incorporated in a separate envelope such as the 6H6 or 7A6. If the tube is not faulty the diode load resistor has probably increased in value. If this load resistor becomes lower in value, the A.V.C. action will not be great enough; that is, the voltage developed will not be sufficient, and a strong signal may overdrive one or more of the stages under control. The absence of A.V.C. voltage is usually accompanied by fading as well as poor tone quality.

In many cases, the volume control potentiometer itself serves as the A.V.C. load resistor as well as the audio load resistor, as shown in Fig. 5. It is important that the potentiometer be of the correct value, not only to assure the correct A.V.C. voltage being applied to the stages under control, but also in order to preserve the time constant. If the value of the load resistor or any of the associated filter condensers or resistors in the A.V.C. line should change in value, or if they are replaced with the wrong values, the time constant will be upset.

The effective time constant, in seconds, in an R-C circuit is equal to the product of the resistance in megohms and the capacity in micro-farads. The optimum value of time constant is a compromise value which is sufficiently great to provide adequate filtering and yet small enough to prevent too long a time lag from being introduced, which, in turn, would prevent the A.V.C. action from keeping pace with rapid fading and tuning operations.

Effect of Time Constant

Generally, the time constant of an A.V.C. circuit should not exceed 0.1 of a second. Many receivers are so designed as not to allow an excess of about 0.06 of a second. Should the time constant be too great, it will become difficult to tune in stations accurately to the point of resonance and the signal will be received with a *plopping* sound.

On the other hand, if the value of time constant is too small, the gain of the stages under control may become a function of the modulation, due to insufficient filtering action. This condition will result in distortion due to the audio frequency modulating the R-F signal, and may also result in howling, due to feed-back.

A leaky by-pass condenser in the A.V.C. line will reduce the A.V.C. voltage and also lower the time constant. The slightest leakage in one of the by-pass condensers will seriously affect the voltage because of the high values of resistors used in these circuits. An absence of A.V.C. action will usually be indicated by blasting as the receiver is tuned and the output will usually be accompanied by excessive static-like noise.

If the small R-F filtering condenser across the audio load resistor (C1 in Fig. 5) should become open, or be too low in value, a high-pitched whistle or howl will be introduced into the output. The value of this condenser is in the order of micro-microfarads. On the other hand, if the value of this condenser is too large,

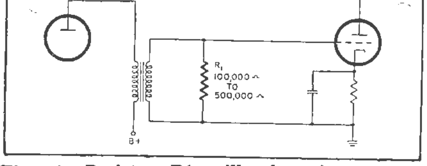


Fig. 7.—Resistor R1 will often improve a receiver's quality.

the high frequency response will be affected and a loss of volume will result.

Small filter capacitors are often (C2, Fig. 5) connected between the plates of one or more of the audio stages and the ground. The same symptoms generally apply to corresponding defects associated with these condensers, as with the detector R-F filtering condenser.

Howling will sometimes originate in a push-pull stage, due to parasitic oscillations. This can usually be remedied by inserting a resistor of from 25,000 to 50,000 ohms in the common grid return lead (R1 in Fig. 6). The filter components, especially the plate by-pass condensers, should be checked first, however. Inherent frequency discrimination in interstage audio transformers used may introduce frequency distortion. A more linear frequency response may often be obtained by connecting a resistor across the secondary winding of the transformer, as shown in Fig. 7. Some receiver manufacturers incorporate this resistor in their receivers. The optimum value of this resistor is that which will give improved frequency response without seriously reducing the amplification. This value will usually lie between 100,000 and 500,000 ohms. The lower the value, the better the tone quality and the lower the amplification.

If the output transformer has been replaced, it is well to make certain that it is the correct replacement, as a mismatch to either the output tube or the voice coil, or both, may result in serious distortion, and possibly loss of volume.

An R-C filtering network is often connected across the primary winding of the output transformer that is used in conjunction with a beam power pentode. This filter network is for the purpose of giving the plate load the effect of a pure resistance, and the values of the resistors and condensers are therefore very critical. If any component of this network becomes defective, or is of the wrong value, serious distortion will result. If there is any doubt about any of these, they should be replaced.

A by-pass condenser is not generally needed across the cathode biasing resistor in push-pull stages and usually one is not used. Current fluctuations, however, due to mismatched tubes and uncancelled odd harmonics, can usually be materially reduced by the installation of a by-pass condenser, as shown in Fig. 6 (C1). The optimum value of this condenser may be determined by the following formula:—

$$R\text{-}C = \frac{1.6}{F}$$

Where R is the value of the cathode resistor in ohms,
C is the desired Capacitance in Farads, and
F is the lowest audio frequency (in cycles per second) to be by-passed.

(To be continued.)

Reprinted courtesy "Radio Maintenance"

U.H.F. Techniques

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

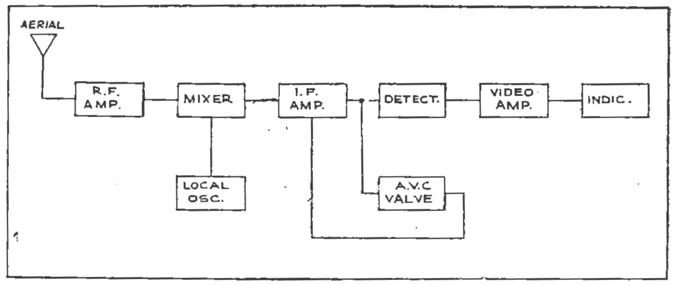
The last link in the chain of any U.H.F. system is the receiver. Whether this system be a communication link employing A.M., F.M., video modulation, or a pulsed radar, the same basic requirements exist for the receiver.

The receiver performs the function of extracting the intelligence from the electro-magnetic carrier-wave. It contains a means for amplifying the small U.H.F. signals to a suitable level, and detecting the modulation.

Further amplification of the modulation is invariably employed before feeding the signals to an indicating device. This latter may consist of a meter, loudspeaker or cathode ray tube.

A complete receiving system comprises an aerial, transmission line, receiver and indicator. In radar applications invariably a common aerial is used for both transmitting and receiving, a duplexing system being employed. Where a separate receiving aerial is used, however, the requirements of the aerial and feeder are simpler. For example, the maximum power handling capacity is insignificant, which means that flexible cable feeders are satisfactory if losses are not important. The size of the aerial is governed either by the space available or by the maximum directivity which can be tolerated.

Although the particular design of any receiver depends upon the wave-length employed and the application, U.H.F. receivers generally follow the same basic lines. The superheterodyne principle is usually employed.



Block diagram of superheterodyne receiver. Most UHF receivers follow this basic layout. Radio frequency amplifiers are not practicable above 1000 Mc. Automatic frequency control is often employed.

In order to provide the basis for discussion of the various components, the block diagram of a receiver is given in Fig. 1. This is identical with the layout of a superheterodyne broadcast or short-wave receiver. It is in the manner of performing the various functions that the U.H.F. receiver differs from the lower frequency sets.

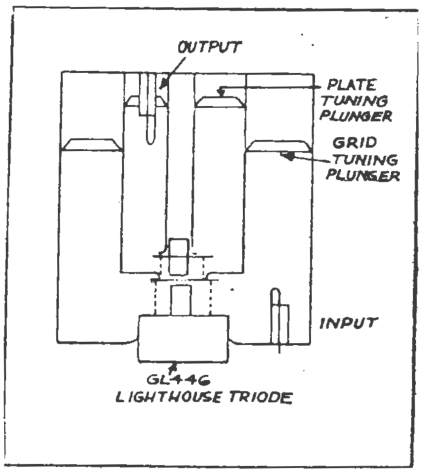


Fig. 2.—A co-axial line tuned lighthouse triode amplifier.

Receiver Properties

The main properties of any receiver are expressed by its sensitivity, selectivity and fidelity. These are defined as follows:—

PART 8.
U.H.F. RECEIVERS

Sensitivity: This represents the ability of the receiver to respond to small radio frequency voltages and is denoted quantitatively by that voltage which must be induced in the aerial to develop a standard output from the audio or video amplified (usually 50 milliwatts).

Selectivity: This enables the receiver to distinguish between signals to differing frequencies. It is expressed in the form of a response curve formed by plotting signal strength against carrier frequency. The width of the response curve between points 3 db down from maximum sensitivity is called the band-width. (It is measured in cycles per second.)

Fidelity: Is a measure of the ability of the receiver to reproduce the different modulation frequencies. This is familiar in audio amplifier techniques and is expressed as a curve of relative output audio (or video) frequency for a fixed input. Transient response is important in receivers handling short pulses or very rapid fluctuations, such as radar and television receivers.

Sensitivity

The sensitivity required of any receiver depends upon the distance between transmitter and receiver, the transmitter power output; aerial sizes and feeder losses. For some applications the sensitivity may be carried to the limit for the sake of maximum operating range. On the other hand, propagation considerations may limit the range to a short distance, so that economy would demand a receiver of less than optimum sensitivity.

The sensitivity depends upon the amount of radio frequency and audio or video frequency amplification employed. A limit is set to the audio or video gain by hum or feed-back, and in addition

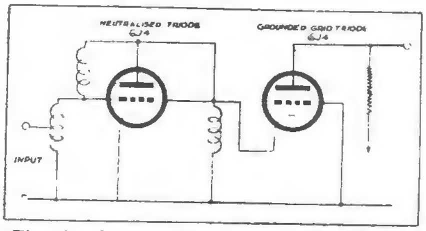


Fig. 3.—A neutralised triode followed by a grounded grid amplifier provides a circuit with a noise factor of 6db. at 200 Mc.

fidelity would suffer if too many video stages were used. Feed-back also limits the gain available to I.F. amplifiers, although if the amplifier is divided into two separate units, it will be less susceptible to oscillation. A limiting figure for the gain of a single 30 Mc/s amplifier is about 90 db, although it is possible to attain about 120 db by careful design and construction.

When high vaules of amplification are employed, radio noise generated in the early stages of the receiver registers on the indicator. The presence of this noise-prevents the detection of other signals. so that the ultimate sensitivity of a receiver is limited.

Noise in receivers may arise from a variety of causes. Thermal agitation noise is produced by the random motion of the molecules of a resistance. It results in a random fluctuating r-f voltage across the resistance. This voltage has frequency components distributed over the whole band of radio frequencies so that the effective value of noise power at the input of any receiver depends upon the band-width of frequencies which the receiver will pass. The wider the band-widths the greater the effective noise voltage.

Since the thermal agitation noise level can be calculated for any circuit, it is used as a standard reference level for determining receiver performance. Other sources of noise are the valves employed in the receiver *Shot effect, interception noise* and *induced grid noise* occur in valves.

The ultimate sensitivity of a receiver is usually specified as a *noise factor.* This represents the difference in level between the actual noise power at the receiver input and the noise power of an "ideal receiver" denoted by KT df watts. (The noise of an ideal receiver is assumed to be all due to thermal agitation in the aerial radiation resistance. The extra noise in practical receivers originates in the mixer, local oscillator and first few amplifying values.

Noise is generated in all amplifying stages, but that from the initial stages only is important, since it is amplified most. At micro-wave lengths, noise from these sources is far greater than thermal agitation noise, as illustrated by the following typical noise factors:—

Frequency Mc/s	Noise Factor Ratio	Noise Factor db
200	4	6
3,000	32	15
10,000	50	17

Since the noise power output increases with band-width, for the same noise factor, a narrow band receiver has a better ultimate sensitivity than one with broad band-width.

Thus noise factor and band-width are just as important factors in determining the maximum range of a radar as the peak power output of the transmitter.

Whilst the minimum possible noise factor is desirable in radar receivers, television and frequency modulation systems do not have such stringent requirements. The transmission in such systems is *one-way* and ranges are limited by propagation factors. As against this, however, greater signal to noise ratios are necessary than for radar. Ratios of at least 20 to 1 are necessary to prevent

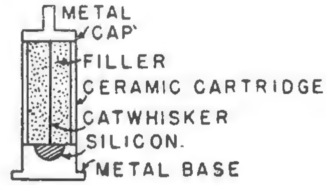


Fig. 4.—A cross sectional drawing of a micro-wave crystal cartridge. The point of the fine cats whisker bears on a polished silicon crystal.

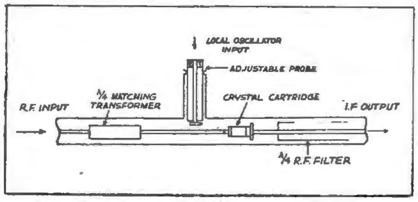


Fig. 5.—A co-axial line crystal mixer.

distortion of reception by noise, whilst in radar, signals far below noise can be detected with a suitable indicator.

Overall Gain

When noise is the limiting factor in receiver sensitivity, the overall gain employed is that necessary to register the minimum useable signal on the indicator.

In radar sets a radio frequency gain of about 120 db, with a video of approximately 40 db, are employed. In F.M. and T.V. receivers about 30 db less gain is required because of the higher signal to noise ratios employed.

Radio Frequency Amplifiers

Radio frequency amplification is used to improve the sensitivity and to suppress the *image* response.

In general, r.f. amplification is employed only if the noise factor is improved. Without r.f. gain the noise factor is determined by the mixer and the first intermediate frequency stage.

Unless a valve employed as an r.f. amplifier provides an improvement in noise factor, compared with the same valve used as a mixer, and also provides some gain, it is not profitable to use r.f. amplification.

For frequencies up to 200 Mc/s, r.f. amplifiers are practicable, a neutralised triode followed by a *grounded grid* triode giving the best noise factor. Typical r.f. amplifier tubes are the 954 acorn, 6AK5 and 6AC7 triodes, RL37 grounded grid triode and 6J4 triode. All are made with very small electrode structures to provide short transit tunes and low interelectrode capacitances.

Above 500 Mc/s it is possible to use the disc seal triodes GL446 (lighthouse) and CV90 as grounded grid amplifiers in co-axial or cavity tuners. Fig. 2 illustrates an amplifier of this type. A noise factor of 11½ db and a power gain of 10 may be obtained at 3,000 Mc/s. However, it is possible to obtain better noise factors with crystal mixers and no r.f. amplification so that r.f. amplifiers are not practicable above about 1,000 Mc/s.

The Grounded-Grid Amplifier

In order to take advantage of the better noise characteristics of triodes, the ground-grid circuit was developed. The grid acts as a shield between cathode and anode when grounded and results in high stability. The input signal is applied to the cathode. The input impedance is low, but is not lower than that of a conventional amplifier at high frequencies; electronic loading causes a reduction of input impedance of normal amplifiers. A circuit embodying a grounded grid amplifier is shown in Fig. 3.

Frequency Converters

In U.H.F. receivers, as in lower frequency receivers, the converter or mixer provides a means for beating the local oscillator signal with the incoming carrier to produce the intermediate frequency signal. A non-linear device is necessary for this purpose.

Whilst pentagrid and hexode converters combine the mixing function with that of local oscillator at lower frequencies, separate units for mixer and oscillator are employed at U.H.F. Triode mixers are satisfactory up to 200 Mc/s. The local oscillator signal is injected into the grid of the mixer through a very small capacitance, and the latter tube is biased to cut off by means of a by-passed cathode resistor.

Local oscillators can be made from low output triodes up to 200 Mc/s.

Crystal Converters

For frequencies above 1,000 Mc/s, crystal mixers are more suitable than valve mixers. A crystal mixer consists of a small crystal-cartridge fitted into some form of co-axial line, wave-guide, or resonant cavity, into which the local oscillator is coupled by means of a capacity probe. The crystal cartridge contains a small piece of silicon with a tiny tungsten *cats whisker* in contact with it. Fig. 4 is a cross sectional view of a typical crystal cartridge. After initial adjustment during manufacture, the cartridge is filled with wax, which gives it mechanical stability.

A crystal mixer assembly is illustrated in Fig. 5. This is a co-axial line with a matching transformer to provide maximum signal voltage across the crystal. The position of the local oscillator injection probe is variable. An R.F. filter is embodied in the output lead to the I.F. amplifier. While this mixer has been *ore-plumbed* to cover the differences in impedance between different crystals, others are provided with matching adjustments.

At 3 cm. wave-length, wave-guide feeders are employed invariably, and mixer construction is simplified. The crystal cartridge is mounted across a wave-guide, whilst the klystron local oscillator is mounted on the wave-guide with a coupling probe projection through the guide wall (see Fig. 6).

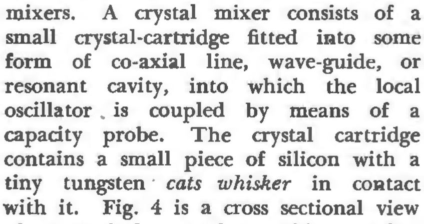


Fig. 6.—A wave guide crystal mixer suitable for 3 cm.

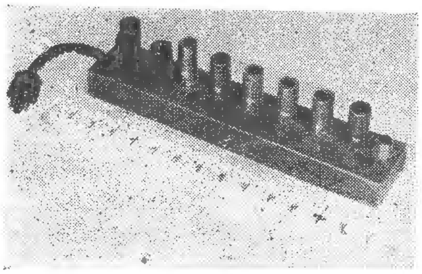


Fig. 7.—A typical 30 Mc. intermediate frequency amplifier.

The crystal mixer and local oscillator contribute about 10 db to the noise factor of a 10 cm. receiver. About 3 db comes from the local oscillator. It is possible to balance this out by means of a balanced mixer using two crystals.

Crystal mixers are usually operated with between 0.1 and 0.5 mill amps of crystal current. This is practically all due to the local oscillator injection which should be large compared with the signal power for satisfactory mixing. Since the local oscillator coupling should be light to prevent excessive losses, an input to the probe of about 20 millwatts is necessary.

The crystal mixer output impedance presented to the I.F. amplifier is approximately 300 ohms. resistance, shunted by 1 picafarad of capacitance.

A disadvantage of crystals is their vulnerability to high signal inputs and their use in radars places a very stringent requirement on the aerial duplexing unit. (See later.)

Other mixing devices comprise diodes and disc seal triodes (suitable for the 500 Mc/s region), beam deflection tubes and velocity modulation tubes.

Intermediate Frequency Amplifier

The I.F. amplifier is responsible for the selectivity and most of the gain of a U.H.F. receiver. It consists of several amplifying stages coupled through band-pass filters.

The frequencies employed for I.F. amplification vary from 15 to 60 Mc/s, 30 Mc/s being a popular figure.

The band-width depends upon the application. Amplitude modulation communication receivers require only narrow band-widths in the order of 10 kilocycles per second. For frequency modulation a maximum band-width of 200 Kc/s has been adopted as a standard. For radar and television, however, where the intelligence has to be transmitted through wave-forms involving very high video frequency components, much broader band-widths are needed. For these require-

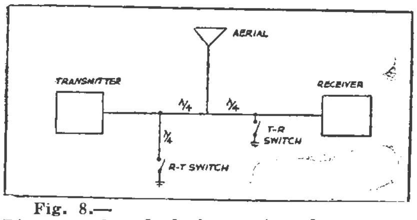


Fig. 8.—
Diagram of a duplexing system for common aerial working in a pulsed radar system. This may be applied to two wire, co-axial or wave guide feeder systems.

ments the band-width may be from 0.5 to 5 Mc/s.

The product of amplification and band-width is constant for any given valve and stage coupling device. The theoretical limit of this product has been shown to be

$$\frac{Gn}{11\,C}$$

Where Gn = the mutual conductance of the valve, and

C = the capacitance across the anode circuit of the valve.

The overall band-width for "m"-tuned stages is

$$(2^{\frac{1}{n}} - 1)^2$$

times the band-width for one stage. Thus for eight stages (which are necessary to attain about 120 db gain), an overall band-width of 3 Mc/s will be the result of each stage, which has a band-width of 10 Mc/s.

The inter-stage coupling networks may be either single-tuned or double-tuned, the former being simpler from the manufacturing viewpoint. For high stage gains double-tuned networks are necessary. To maintain band-width in high gain amplifiers, *stagger* tuning is sometimes employed, although alignment of stagger-tuned amplifiers is complicated.

For optimum performance the mutual conductance of the valves employed should be high, and the tuning capacitance should be small. Inductance tuning by metal slugs is used and wiring capacitances are kept to a minimum. The tube capacitances should be small. Special miniature resistors and condensers have been developed for use in I.F. amplifiers. Coils are usually wound on trolitul formers.

Valves suitable for I.F. amplifiers at U.H.F. are the American 6AC7 and 6AK5, and the English EF50.

Fig. 7 illustrates a typical I.F. amplifier using 6AK5 valves.

If more than one band-width is required of a receiver, it is usual to provide a single band-pass filter, which may be inserted in series to reduce the band-width.

Gain Control

The gain of an I.F. amplifier may be varied by means of the grid bias on variable mu. valves or by variation of screen voltage. The former method requires a smaller control voltage.

Automatic gain control is frequently employed. This is effected by a diode which rectifies the carrier and controls the bias on one or more stages. A D.C. amplifier is sometimes employed to render the control more sensitive.

(Continued on page 46.)

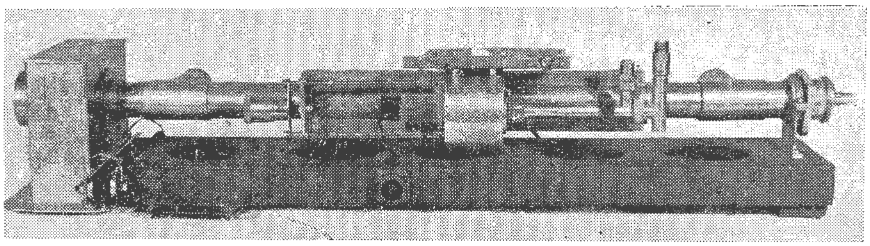


Fig. 9.—25 cm. T-R switch and crystal mixer coupled to a co-axial transmission line.

A.R.R.L.—AND THE AMATEUR

The internationally known amateur organisation—the American Radio Relay League has, and is still playing a leading part in electronics, research into the U.H.F. spectrum and general radio communications.

Through all the 34 years since it was formed in May, 1914, the A.R.R.L.—as the league is known to all its members—has been the organised body of amateur radio in America and abroad. In addition to being its guardian against attack by foreign government or commercial interests, it is undoubtedly the leader in the technical progress of the world's most fascinating hobby. One often wonders in reflecting over the past quarter of a century where amateur radio would be today were it not for the good work done by a few who administer the league from West Hartford, Connecticut.

Since inception, the A.R.R.L. has consistently and rigidly adhered to its policy **"of, by and for amateur radio."** It is the amateurs own association, owned and controlled by its members. From top to bottom it is an amateur organisation; its members, its directors, its officers and the staff at H.Q. all hold amateur radio "tickets." As a result, it is unique among societies.

Founded in 1914

Founded back in 1914 by a group of amateurs headed by the late Hiram Percy Maxim—whose call sign W1AW is now used by the league's own station as a tribute to this wise old man who held No. 1 post from 1914 until his death in 1936—it is and always has been a non-commercial organisation. It is neither sponsored nor owned in any part by a commercial radio firm or publishing house. It is owned solely by the members, who join this great organisation. These members elect 15 directors on a regional basis for two-year terms of office and the directors lay down the policies of the league, determine its attitude towards proposed radio legislation and hire the paid secretary, treasurer and communications manager. These men give their full time to amateur radio.

The directors themselves receive no salary, nor do the president or vice-president. In fact to ensure that the league shall always be an amateur organisation, without commercial taint, its constitution specifies that no one engaged in the sale, rental or manufacture of radio apparatus or literature can be a director.

The A.R.R.L. today is recognised as the official spokesman for amateurs and amateur radio in the United States and Canada. Unofficially it is the world spokesman. Its recommendations usually form the basis for amateur regulations promulgated by the American Governments. Prior to any change being made in regulations the league is always consulted by the Federal Communications Commission, a similar body to the wireless section of the Post Master General's Department in Australia. The president of the league, Mr. George W. Bailey, W2KH, is president of the world amateur radio body—the International Amateur Radio Union.*

By
ROTH JONES
VK3BG

There are many thousands of radio stations of various classes now on the air, and more are constantly being added in practically every country of the world. Even Tibet and Pitcairn, two of the really rare countries now have two instead of the pre-war one! The competition for space on the air among the various services is intense. This competition—the necessity for every class of station to demonstrate that it is operated in the maximum of public interest, convenience and necessity—forces amateur radio, through the A.R.R.L., to maintain a united front in order to preserve its rights. It is for this reason alone every amateur radio body throughout the world should be loyal to the A.R.R.L. due to its strength and respect in America and Abroad.

Such unity is necessary at all times, but it becomes of overwhelming importance under conditions such as are existing today. Amateur radio represents probably the only way private individuals can communicate with each other beyond the range of their senses without using facilities controlled by some corporate or government interest. Such a power represents a tremendous responsibility on the part of the individual. In time of war it invites severe restriction. Only because of strong organisation and loyal support of most amateurs to the A.R.R.L. has this great hobby maintained integrity of such a high order that it has not been successfully challenged.

A further attempt by large overseas commercial interests failed miserably during the recent telecommunications conference at Atlantic City (U.S.A.). Many oversea Governments tried their best to get larger channels for their short wave stations to broadcast propaganda, but it was of no avail.

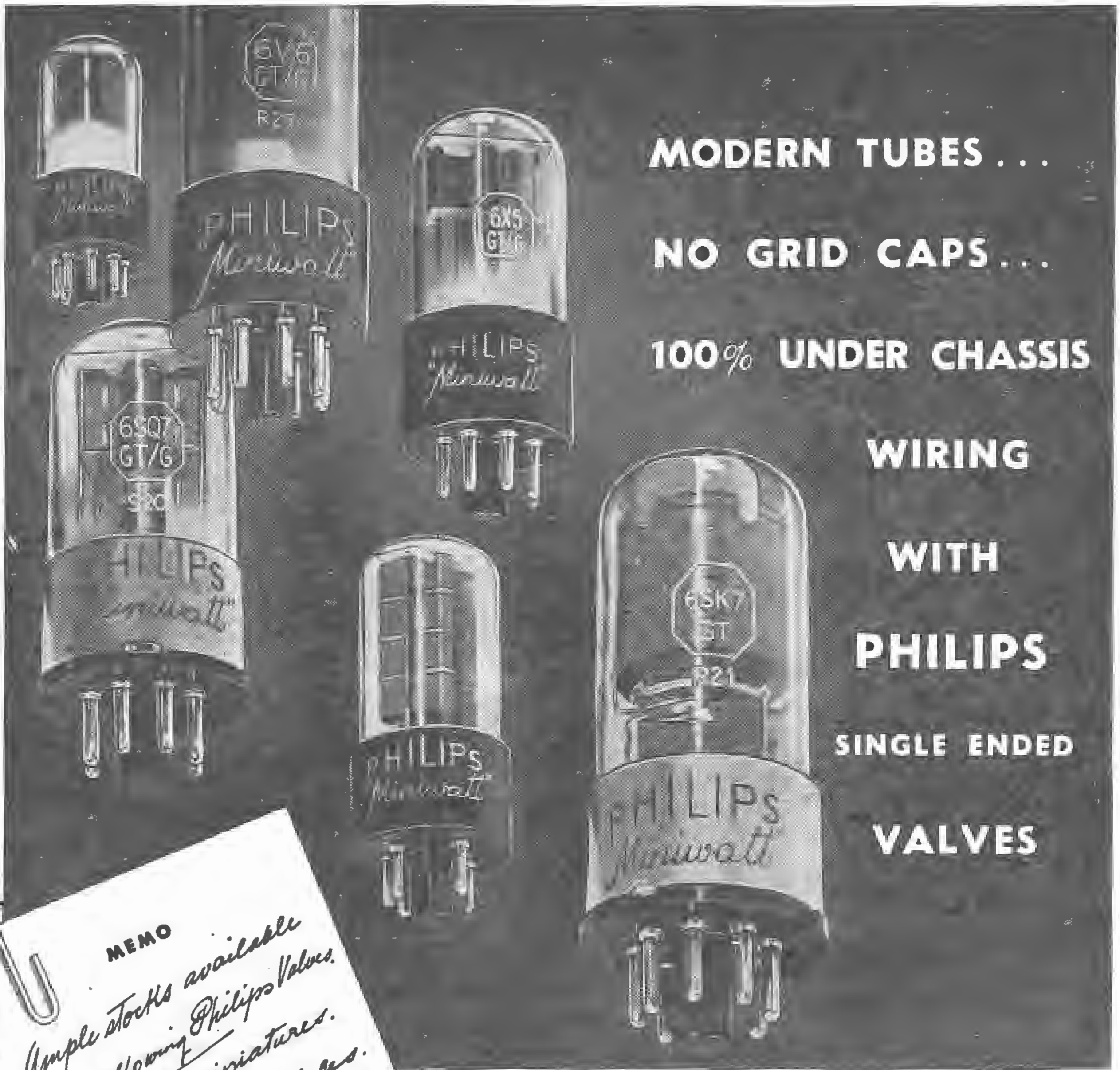
Active Group

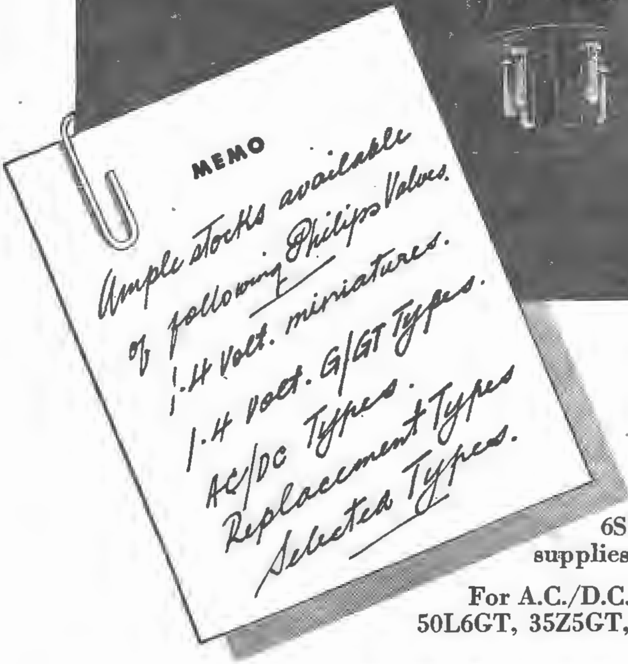
During the war when all licences were cancelled the A.R.R.L. did not go to sleep and wait for it to finish. Instead, among other things—

- ★ **It inaugurated the A.R.R.L. Neutrality Code, which was largely instrumental in avoiding a shut-down in the Autumon, 1939, through official desire to avoid endangering neutrality.**
- ★ **It undertook an expanded internal policing programme to guard against illegal operation under cover of pseudo-amateur status, thus avoiding severe restrictive regulation through fear of espionage carried on under cover of amateur operation.**
- ★ **It offered the services of amateur radio as a body to the various government agencies.**
- ★ **Its representatives conferred with federal officials during the May-June, 1940, crisis (outbreak of total war) to arrange minimum regulatory restrictions during the new "non-belligerent" phases of U.S. war participation.**
- ★ **It secured exception for the 1940 and 1941 A.R.R.L. field days under the portable ban ordered in June, 1940.**
- ★ **It secured exception for ultra-high frequency mobile operation under the portable ban.**

(Continued on page 46.)

* See K2UN's Challenge to the World—"Radio Science," August, 1948.





Ideally suited to the amateur planning new equipment or seeking replacements for gear already in operation, these single-ended Philips Valves are now readily available. They offer simplified equipment design by eliminating top cap wiring.

The 6.3 volt range includes types 6SA7GT, 6SK7GT, 6SQ7GT, 6SJ7GT, 6V6GT, 5Y3GT, and 6X5GT. Continuity of supplies from Philips Hendon Valve Works is assured for each type.

For A.C./D.C. applications we offer types 12SA7GT, 12SK7GT, 12SQ7GT, 50L6GT, 35Z5GT, and Barretter 1954.

V14B-48

PHILIPS VALVES

For your note book

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

Blue Glow in Valves

Modern valves sometimes have *blue glow* tendencies, and it is not always realised that this phenomenon can occur in two different ways. One of these is detrimental to the performance of the set, whilst the other is not.

The kind of blue glow which does not matter at all is that which appears on the inside of the glass bulb. This is actually caused by electron bombardment, and it can vary considerably in intensity when strong or weak signals are being received.

The second kind of blue glow is similar to that seen in the old type soft detector valve, and its presence is simply due to the fact that there is too much gas in the bulb. The blue glow, due to softness, always appears in the neighbourhood of the electrodes and not on the inner surface of the bulb.

This is quite definitely a bad thing in the modern set—in which a soft valve can find no place. It leads to distortion as well as variations in performance, and any valve which suffers from this fault should be regarded as a certain candidate for the dustbin.

If you are not quite sure after a visual inspection whether the harmful or harmless blue glow is occurring, you can make certain with a magnet. Hold it close to the outside of the bulb and move it slowly. The harmless blue glow caused by the electron bombardment will be found to change position as the magnet is moved, whilst the undesirable blue glow due to the softness will remain completely unaffected as the magnet travels about.

Soldering Aluminium

It is possible to solder direct to an aluminium base if the surface can be kept clean to prevent re-formation of oxides.

One method of accomplishing this is as follows:—

Float a pool of fluxless solder on the surface to be soldered and move the tip of the iron back and forth in the pool, at the same time applying firm pressure. The vigorous scraping motion loosens the aluminium oxide and this floats to the top of the solder.

The surrounding solder readily adheres to the pure aluminium surface since now the air is excluded, thus preventing oxidation. This method will also work with other metals that form the troublesome oxides, provided these oxides can be scraped off.

Home Made Radio Cement

A good grade of radio cement can be easily made at a small cost from acetone and celluloid. Experimenters and servicemen will find a cement of this kind extremely handy for cementing speaker cones, insulating bases, repairing valve bases, etc.

RADIO SERVICEMEN!!

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

A small amount of acetone obtainable from any chemist should be placed in a suitable bottle, preferably one with a brush attached to the cork—a discarded finger nail polish will serve admirably. The celluloid strips are then dropped into the acetone where they slowly dissolve to form the cement.

If the cement becomes too thick, simply add more acetone—if too thin, add more celluloid.

Aligning Hint

Frequently when aligning a receiver with two or more i.f. stages, it will be found that the set will break into oscillation as the stages are brought into resonance. This problem may be eliminated by applying degeneration to each stage in the following manner.

Disconnect the cathode by-pass condensers of the i.f. stages and remove the grid returns for these stages from the A.V.C. line or ground and connect them to the cathodes, leaving the condensers disconnected. This reduces the sensitivity enough to check oscillation. Upon completing the alignment, replace the original connections and the sensitivity of the set will return to normal.

Transformer Repairs

If one-half of the secondary of a vibrator transformer opens, the output voltage usually drops to a value too low for satisfactory operation. An emergency repair can often be effected by parallelling the plates of the rectifier valve, thus reducing the internal resistance. Connect the open side of the buffer condenser to earth. Additional filter capacity may be used to increase the filtering and add a few volts to the output.

Protecting Drawings

When constructing a piece of apparatus from a schematic drawing which is to be kept, cover the diagram with a sheet of tracing paper tacked to your workbench or held on a clip board.

In this way, connections may be crossed off the tracing paper, as they are wired, and the drawing will remain clean. This is especially helpful when building several copies of the same circuit, as the paper can be changed easily and always checked against the original schematic.

Around The Industry

LATEST UNIVERSITY "SUPERCHECKER"

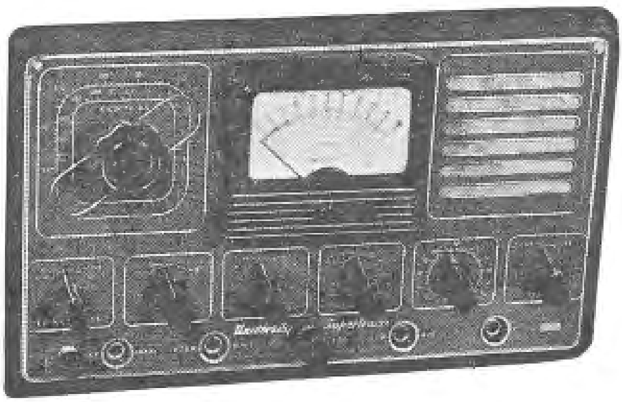
Latest addition to the University range of test equipment is the new "Superchecker", which combines the functions of a signal tracer and an AC-DC Vacuum Tube Voltmeter.

The circuit comprises a two stage tuned R-F amplifier, a diode detector, and a two stage A-F amplifier, feeding into a loud speaker. It has an inbuilt power supply which operates on 230-260 volts, 40-60 cps.

The tuning range of the R-F circuits is:— (1) 175 kc. to 490 kc. (2) 550 kc.-1550 kc. (3) 1.5 to 4.0 Mc. (4) 6.3 to 18 Mc.

The V.T. Voltmeter which measures up to 550 volts AC or DC has an input resistance of 11 megs on the DC range and 10 megs on the AC range. A cavity type RF multiplier in the input circuit used in conjunction with the VTVM enables stage gain measurements to be made. Of special interest is the centre zero scale which enables either positive or negative voltages to be measured with respect to the chassis without the necessity of reversing the test prods or operating a reversing switch.

The VTVM and tracer may be used simultaneously for observing signals at two distinct points in a receiver and this often greatly facilitates the location of intermittent faults. All indications are provided on a large illuminated rectangular meter scale measuring approx. 4¾ x 4 inches.



The complete unit is housed in an attractive brocade finished cabinet measuring 14½ x 8¾ x 8¼. The front panel is of etched brass with raised nickel plated ilnes and letters on a deep red background.

Additional information on this unit may be obtained by writing direct to the manufacturers—Messrs. Radio Equipment Pty. Ltd., 5 York Street, North, Sydney.

"RADAMETA" MODULATED OSCILLATORS

A new range of modulated oscillators is now being marketed by Radameta Test Equipment. Available in five different models this portable unit will give an unbroken coverage from 110kc. to 42mc.

The use of a Colpitts circuit ensures stable operation, with an accuracy of better than 2 per cent. The high frequency end of each band is tuned by means of high "Q" trimming condensers, and the low frequency end by means of iron cores. Each band is checked at all major divisions to ensure high accuracy. A large, directly calibrated semi-circular dial, makes the reading of the instrument a simple operation.

These oscillators are available with the following specifications:

RO68.—A.C. 195 to 255 volts, 40 to 60 cycle, modulation 50 cycle.

RO78.—Above model with built-in 6 volt vibrator.

RO88.—A.C. 195 to 25 volts, 40 to 60 cycle, 400 cycle modulation.

RO98.—Above model with built-in 6 volt vibrator.

RO108.—Battery model, 400 cycle modulation.

All are fitted in a metal box finished in black brocade.

For further information on this equipment all enquiries should be directed to Radameta Test Equipment, Fowler Road, Guildford, N.S.W.

NEW F-M ANTENNA

Following the recent release of the complete range of F-M tuner units, 10.7 Mc. I-F's and special ratio detector coils, Slade's Radio now advise that a special F-M dipole is available.

Consisting of two copper rods, cut to resonate at 92 Mc., the dipole is already mounted on a suitable base. It is fitted with 75 feet of 75 ohm twin lead-in, and other than erecting it in a suitable place, is completely ready for attaching to the F-M Receiver input.

Further details of this equipment can be obtained by writing direct to Slades Radio Pty. Ltd., Lang Street, Croydon.

New AC-DC Valve Range

Of particular interest to the radio trade, is the recent announcement of the Amalgamated Wireless Valve Coy. to include a range of Marconi AC-DC valves in their list of preferred types for 1949.

These valves are scheduled for early arrival in this country and in view of their excellent operating characteristics it is considered they will find a ready application in Australian receivers requiring this type of valve.

The complete range comprises five types:—

X76M—Triode Hexode.

W76—Variable Mu H.F. Pentode.

DH76—Double Diode Triode.

KT71—Output Tetrode.

U76—Half Wave Rectifier.

Additional information regarding these valves can be obtained by writing to Amalgamated Wireless Valve Coy., 47 York Street, Sydney.

TRANS-TASMAN DIARY

By J. F. FOX

4YZ CELEBRATES TENTH ANNIVERSARY

On Monday, August 2, the southernmost radio station in the world 4YZ Invercargill, celebrated its 10th anniversary with a special four hour programme. Actually, the programme was to celebrate the anniversary of the transmitter at Dacre.

The story of 4YZ dates back to September 5, 1937, when the New Zealand Government purchased the former 4ZP for the sum of £1500. The National Broadcasting Service continued to operate as 4ZP, "The Voice of Southland" until November 1, when the call sign was changed to 4YZ. Tests were then carried out for a suitable transmitter site for the new station. Dacre, 15 miles north of Invercargill, on the Main North Road was approved, and the buildings to house the transmitter and staff began in November of that year.

A modern 5000 watt transmitter was supplied and installed by Amalgamated Wireless (Australasia) Ltd. The two 325 feet steel towers support the folded top half wave antenna, the principal radiation coming from the vertical lead. Ten miles of coupled wire was buried for the earth system. The aerial and earthing systems were specially designed to reduce fading and increase the reception area of the station.

An emergency studio is located at Dacre, and is used when a breakdown occurs at the main studio, or if the two landlines to Invercargill fail. The former hall owned by the United Friendly Societies in Tay Street was purchased and converted into the studios and offices.

Heard in the United States

Station 4YZ is heard over a wide area, and reception reports have been received from New Zealand, Australia and the United States of America. The most distant report came from Walnutport, 60 miles north of Philadelphia, the writer stating that 4YZ was the second strongest signal from the South Pacific area, the best being 4YA and the third, 1YA.

The staff in 1937, consisted of Mr. J. F. Skedden, station manager, two announcers and two technicians—today, the staff numbers over 20. The programme department has built up the library of recordings from a few thousand to over 22,000.

Anniversary Programme

The anniversary programme covered the history of the station and programmes. Extracts from popular serials which have been broadcast over 4YZ during the past 11 years were recalled, including the first episode of "Dad and Dave." One of the highlights of the evening was the station staff's version of this serial as it would be broadcast in 1998.

Outstanding sporting events broadcast by the station were also covered, including racing, trotting and the history of the Ranfurly Shield. The development of the children's session and religious broadcasts, the rise in popularity of "Listener's Own," the housewives' session and the local talent programmes were featured.

The programme opened with a message from the Minister in charge of Broadcasting, Mr. Jones, and a message from the Director of Broadcasting, Professor J. Shelley. Further greetings were broadcast from the Mayor, Mr. A. Wachner, two former station managers, Mr. J. F. Skedden (now of 3YA), and Mr. H. C. Trim (now of 1YA). The present manager, Mr. H. A. S. Rollinson also spoke.

New Zealand readers are invited to contribute any items concerning radio, broadcasting, DX-ing and amateur radio activities for inclusion in this section. All letters should be forwarded direct to: Mr. J. F. FOX, 41 Bird Street, St. Kilda, Dunedin, S.2. N.Z.

Royal Tour—Radio Controlled Cars

"Several cars conveying the Royal party during next year's tour of New Zealand will be equipped with two-way radio for intercommunication," said the Postmaster-General, Mr. Hackett, recently. "This two-way radio contact will facilitate the movement of the Royal convoy, and it will enable not only closer co-ordination of movement but also give added safety. Post Office engineers have planned the equipment to be used. It is of standard type, identical with that installed in the cars of the traffic inspectors of the Transport Department.

Radio Science was informed by the Post and Telegraph Department that the arrangements are still in their preliminary stage and the technical details cannot be published yet.

The equipment used in the patrol cars of the Government Transport Department are ex-American aircraft ARC5 transmitters-receivers. These sets have an output power of 15 watts and the patrol cars transmit on 3280 kilocycles.

Milford Track Communications

A comprehensive plan to improve telecommunication facilities in the Milford Sound-Eglinton Valley-Lake Te Anau area is announced by the Postmaster-General (Mr. Hackett). The plan provides for the installation of a radio link giving radio-telephone toll communication between Milford Sound and Te Anau. This will be done by installing modern radio-telephone equipment.

A high-grade metallic telephone toll circuit is in course of erection between Te Anau and Lumsden. In addition, a single-channel carrier telephone outlet will be provided directly from Te Anau to Invercargill. A radio-telephone link between Glade House and Te Anau has already been installed by the Post Office for the Tourist Department.

The new scheme, when completed will, in conjunction with the Tourist Department's Glade House radio link and the existing telephone lines in parts of the area, bring all main points through which tourist parties move into communication with each other. At points where a direct toll telephone outlet will not be provided, arrangements have been made to pass messages and telegrams.

Frequency Modulation

When interviewed recently by Radio Science, the Minister in Charge of Broadcasting, the Hon. F. Jones, stated that there was no possibility of frequency modulation being introduced into New Zealand.

The subject has been discussed between the broadcasting officials and the Minister, and it was decided that the circumstances did not justify frequency modulation broadcasting.

Radio Aids for Aircraft

Radio aids for aircraft are now in operation on the main trunk air route between Auckland and Dunedin. The provision of the radio aids enables pilots to fly blind without a glimpse of land, and will be helpful in maintaining the air services during bad weather.

Radio ranges transmit a beam which forms a lane of sound 10 miles wide. The pilot hears a steady note which changes to a warning morse signal should he fly off his course.

At Whenuapai, New Zealand's overseas airport, four transmitters are incorporated in the radio range which was installed during the war. The sound tracks from Whenuapai extend to Waipapakauri in the north and to Rukuhia and New Plymouth in the south. Another track reaches far into the Tasman and is of benefit to overseas aircraft. Apart from this, radio ranges are installed at New Plymouth, Porirua and Harewood, and fan markers at Mangere and Christchurch, with homing beacons located at Rukuhai, Wanganui, Palmerston North, Ohakea, Paraparaumu and Kaikoura.

National Airways Corporation air liners using the main trunk route are equipped with the radio aids, while the installation of the equipment at the flying control centres is proceeding satisfactory.

ON THE BROADCAST BAND

DX AUSTRALIAN STATIONS

In addition to the many overseas signals now being heard on the normal broadcast or medium-wave bands, stations operating from within the Commonwealth also provide interesting DX for many enthusiasts.

The two-hour time difference between our East and West coast gives the listeners a splendid opportunity to log signals from these stations. West Australian stations, for example, are on the air long after most of the Eastern stations close their night transmissions, whilst signals from Eastern stations may be heard in the West before local stations begin their morning programmes. In fact, with such a small number of stations in operation in W.A., listeners in that State are generally able to tune the Eastern State programmes without interference at practically any time of the night.

Transmitting the A.B.C. Interstate (or light) programme, 6WF Perth, 690 kc. is audible after 4KQ Brisbane (having moved from 650kc. Sept. 1st, of course) concludes its evening programme. 6WF can usually be heard until 2.00 a.m., when it closes down with regional relay stations 6WA Wagin, 560kc. (the best signal from W.A. here from after 3GI closes at midnight), 6GF Kalgoorlie, 720kc. and the comparatively new 6GN Geraldton, 820kc. 6WN Perth, 800kc. carrying the A.B.C. main national programme, leaves the air nightly at 1 a.m. and is also heard at fair level at most locations in the Eastern States.

W.A. Commercial stations heard after midnight include 6PR Perth, 880kc. in relay to the 2kw. 6TZ Dardenup, 1340kc. and the new 6CI Collie, 1430kc. 6IX Perth, 1240kc., with 6WB Katanning, 1070kc. and 6MD Merredin, 1100kc. with the same programme. 6PM, also with studios in Perth, is another heard fairly well, 1130kc. in relay generally with another 2kw. transmitter, 6AM Northam on 980kc. Relay stations frequently close down a little earlier than the Perth stations, allowing one to hear the latter without any chance of confusion with relay units. 6KG Kalgoorlie, 1210kc. and Geraldton 1370kc. are others to listen for.

Only two Australian Stations remain on the air all night—2UW, 1110kc. Sydney, with its 24-hour a day service (which, incidentally brings its 750 watt transmitter operating from the tower in the City into service from around midnight to 6.30 a.m., replacing the 1kw unit some 8 miles away at Homebush Bay), and 3AK Melbourne, 200 watts, 1500kc. which begins service at 11.30 p.m. week nights, earlier Sunday, closing down at 7 a.m. week days, 4 a.m. Sundays.

Stations operating from distant centres on the same channel as a transmitter located not far from one's listening post seldom fails to attract interest, due to the difficulty usually experienced before finally compiling a reception report. 4CA Cairns, sharing 1010kc. with 4MB Maryborough and 7EX Launceston is no exception to this and so the few who possess verifications from 4CA usually speak with pride of its addition to their collection. Just prior to sunset is often a good time to listen for stations on shared channels. At our listening post, for example, 2MW—1470kc. Murwillumbah, reaches us at fine level around 5.30 p.m., while 3CV Maryborough prevents good reception from this one from about 6 o'clock. Late at night is also good on occasions, as one station may close leaving the channel clear for a station still remaining on the air.

By
ROY HALLETT

LATEST AMERICAN STATION NEWS

Although at the time of writing we have had no experience of what this season may offer as far as signals from North America and Europe are concerned, we expect some interesting reception during the month of October. Despite the increased radio interference from static, etc., during our summer months, signals from North America around midnight, and those from Europe around sunset, are very often received at most locations at good strength.

It should be remembered four time zones are in operation in U.S.A. and should a report be sent in which Pacific time has been shown to a station in say, the Mountain time zone then confusion may result, and an otherwise correct report refused verification. As an example, 11 p.m. AEST corresponds to—5 a.m. Pacific standard time, 6 a.m. Mountain time, 7 a.m. Central, and 8 a.m. Eastern S.T. Generally, "Midnight Americans" heard here are in the three former zones.

As previously mentioned, particular care should be taken to identify correctly a particular station, since shared channels are very frequent in the U.S.A. Also, in some cases, stations operate on a basis not as yet in use here, being permitted to operate only during limited periods, while other stations on the same channel have similar permits for alternate periods. On 820kc., for example, at certain times WFAA Dallas, Texas, 50kw. leaves the air and WBAP Fort Worth, also in Texas and with 50kw takes the air.

This particular changeover has been heard taking place but without hearing the announcements it would have been impossible to realise we were not listening to the same station during the entire period, there being no apparent break in continuity.

Try for some of these, around 11 p.m. and midnight—

CBK Watroux, Sask. Canada (M) 540kc.
KFRC San Francisco, Calif. U.S.A. 610kc. (P).
KFI Los Angeles, Calif. 640kc. (P).
KPO San Francisco, Calif. 680kc. (P) and watch out for KABC San Antonio, Texas (C), on this same channel.
KIRO Seattle, Wash. 710kc. (P).
XEX Mexico City, Mexico, 730kc. (C).
KECA Los Angeles, Calif. 790kc. (P).
XELO Ciudad, Juarez, Mexico, 800kc. (C). English language programmes often.
XEMO Tijuana, Mexico, 860kc. (P).
KHJ Los Angeles, Calif. 930 kc. (P).
KFWB Los Angeles, 980kc.
KNX Los Angeles, 1070kc. One of the stronger generally.
KSL Salt Lake City, Utah 1160kc. (M).

Signals from this area should also be good at night on frequencies between 1500 and 1600 kc. and also from as early as 7 p.m., as at present these signals are not cut off by any local transmitters.

READERS' REPORTS

Following our recent reference to reception of privately operated two-way radio communications service, Mr. Dave Harding, Lakemba, has logged Wellington (N.Z.) Police radio, on approximately 1700kc., sending the usual calls to police cars in the area, etc. This one suffers from interference from VKG Sydney, when that station is in operation.

☆ ☆ ☆

Some interesting information has been forwarded from Mr. B. Sanyal, Indian Government Welfare Officer in Sydney, in reply to a request for certain information dealing with radio in his country. After hearing Dacca's 1167kc. station operating from what is now Pakistan territory, we believed several other stations familiar to local DXers may also be operating from Pakistan territory, and this has now been confirmed by our friend, Mr. Sanyal. Lahore and Pashawar, he advises are also now in Pakistan territory. Stations in both these Cities, operating on 886 and 629kc. respectively, are being heard fairly well at present.

Our sincere thanks to Mr. Sanyal for the prompt and thorough attention to our request, and also for his offer of additional information.

☆ ☆ ☆

Mr. Art Cushen is hearing quite a batch of good signals from India, Pakistan and other Asiatic countries at present at his listening post in Invercargill, South Island, N.Z. "Radio Pakistan", 1167kc. is quite fair level with its 1.30 a.m. (AEST) news, while All India Radio stations run a bulletin at the same time, which this DXer hears on 1333kc. from the station at Jullunder—one of the lower power units, reported earlier in this section, with only 250 watts. On 1290 kc. a station at Shillong, Assam, India is being heard well with the 1.30 news from Delhi. This one is heard till after 2 o'clock.

☆ ☆ ☆

Mr. Bryan Richardson has sent information concerning the September re-shuffle in New Zealand, which has proved an interesting addition to our batches of notes on the subject. This reader has just received verifications from KHON and KPOA, and is hearing some interesting signals with KGMB, KNX, etc. coming in well, just after N.Z.'s sunset.

☆ ☆ ☆

Mr. Dudley Philips has written from Gympie, Queensland, to tell us that after reading our recent pages he has been able to indentify a station he has been hearing on the 1500 to 1600kc. part of band as XERF. XERF (1580kc.) has been tuned in several times at Mr. Philip's listening post, being heard from 8 p.m., and also on occasions around 5.30 to 6 p.m. He logged another American station on approximately 1600kc. one evening just prior to 6 o'clock, but has not been able to definitely identify it at the time of writing. We look forward to his further log with interest.

☆ ☆ ☆

Mr. J. Johnston, Manly, looks forward to his copies each month with keen interest. With his 5v. receiver working from an inverted L aerial 90ft. long, erected above a 60ft. block of flats, our friend has been quite successful of late logging stations in N.Z., Asia and North America. JOAK, Tokyo has been heard opening at 5 a.m. and also around 11 p.m. Several reports have been sent to N.Z. stations, listening having been done around 4 and 5 a.m. when these stations are heard free from interference from locals and are commencing their early morning transmissions. Our friend has also been able to log 2YA and 3WV (Horsham, Vic., 580kc.) at fair level at midday, which is certainly not always possible here in Sydney.

SHORT WAVE LISTENER

BY TED WHITING

RECEPTION CONDITIONS IMPROVING

Excellent conditions have obtained on all bands during the past month, and we are hopeful that from the experience of previous years, that such conditions will continue throughout our warmer seasons. It will be noticed that as summer approaches, that there is a falling-off in the strength of the stations heard in daylight hours, but this falling-off is more than compensated by the increase in the level of the stations heard from 4 p.m.

In the section of the station list published in this issue, will be found many stations to be heard on almost any type of receiver in the evenings, and we will be very appreciative of any logs sent in to us.

Many stations have been heard recently, including a few of the rarer ones, comments on which will be found in the body of the notes.

Your Log Book

One of the important adjuncts to the listening post is undoubtedly the Log Book, placing on record as it does the activities of the post, and providing a reference which is invaluable in determining the bands which it may be expected will yield results from time to time. Apart from all this, it is necessary to keep a record of your listening so that at your leisure you can write the reports to stations received.

A book may be ruled so that the columns will contain such information as Date, Time, Frequency, Call Sign, and Location, Signal Strength, Fading, with space provided for details of the programme and other general information. A daily entry should be made concerning the weather and general conditions of reception, and any change in the equipment used may also be noted.

Those readers who, in sending reports to the writer are doubtful as to the information most interesting to us, are assured that all available information is of interest, obviously the weather conditions are generally known, but other details are invaluable.

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.

STATIONS NOW BEING HEARD

INDIA:

VUD8 21510kc. News and music in early afternoon, 1.45 p.m.

VUD7 15160kc. Good signal in musical programme and news in English, 7.45 p.m.

VUD9 15350kc. Another fine signal at 8 p.m., with news and programme details.

VUD5 15190kc. More programme and frequency details at 1.30 p.m.

VUD3 9670kc. Transmission of news in Hindustani, fine signal.

VUD4 11850kc. News and music in English at 11 p.m.

VUD11 15290kc. Similar programme at 1.30 p.m.

VUD10 17830kc. Heard at 1.45 p.m. in service to Chinese listeners in Far East.

VUB2 7240kc. English news followed by music at 10.30 p.m.

VUV 3335kc. and 6170kc. Located at Hyderbad, scheduled on 3335kc.: noon-2.10 p.m., 2.30-6.30 p.m., 9.30 p.m.-4 a.m.; on 6170kc.: 10.30 p.m.-3.30 a.m.

CHINA:

XTPA 11650kc. Chinese music 7.30 p.m., and news in English, 11.15 p.m.

XGOA 5985kc. Oriental type programme, 8.15 p.m.; news in English, 11.15 p.m.

XLRA 11500kc. Another heard in local programmes at 8.30 p.m.

XGOA 17765kc. At 7 p.m., with English news and music, requires reports.

XGOA 9730kc. Mixed menu of Oriental and western fare.

XGOY 6140kc. News in English at 11 p.m. followed by music.

XMTA 12217kc. Good signal at most locations at 7 p.m.

XGOY 7150kc. On edge of amateur frequencies, good signal through evenings.

XGOA 11830kc. Music, followed by Chinese news at 8 p.m.

XNCR 9890kc. Frequency variable, fair level here at 9.15 p.m.

XGOY 15170kc. News in English at 9 p.m., weather reports.

XKPB 9500kc. New station using 200 watt transmitter, 10.30-11.30 a.m., 1-2 p.m., 7.30 p.m.-12.55 a.m. Located at Shansi-Taiyuan, Shansi.

XOPB 12120kc. Located at Chekiang, 500 watts. Schedule: 10.30 a.m.-1.30 p.m., 3.30 p.m.-12.30 a.m.

CANADA:

CFRX 6070kc. Weather reports at good strength at 8.45 p.m., music follows.

CBLX 15090kc. A good one at 10 p.m.; news, music and weather reports.

CKNC 17820kc. Fine transmission in French at 10.45 a.m., music follows.

CHLS 9610kc. Heard well at 7.45 p.m., music and "Canadian Chronical."

CKCS 15320kc. United Nations' service at 1.30 p.m., fine signal.

CHOL 11720kc. Another heard at 7.15 p.m., good level.

PHILIPPINES:

KZBU 6100kc. English news at 11.15 p.m., good at 10.15 p.m. with local programme.

KZRH 9640kc. News and music, "Star Entertainment" 7.45 p.m. Also heard at good level at 8 a.m.

KZFM 11840kc. English news and musical programme at 8 p.m.

KZOK 9690kc. Local programme, good signal at 7.15 p.m.

KZFM 9620kc. Also good on this frequency with local programme, 7.30 p.m.

Voice of America, Manilla, heard on 11890 kc. and 15330kc. at 7 p.m.; fine signal.

THE EAST:

SEAC 17730kc. Details of frequencies given at opening of service at 10.30 a.m.

SEAC 15120kc. Also in same service from Ceylon, good signals.

Singapore 6770kc. Music and news at 8.15 p.m. Watch this one for changes to be made in near future.

Kuala Lumpur, Malaya 6030kc. French and English used. Programme for local listeners at 10.15 p.m.

YDC, Java 15145kc. Dutch news at 10 a.m., good music as in old days from this one.

YHN 10840kc. Music and English commentaries at 8.45 p.m.

YCN3 8090kc. In a bad spot this one, heard at 10.45 p.m.

JKC, Tokio 7250kc. Japanese news and music of western type at 9 p.m.

JVW4 9560kc. Similar type programme at 8 p.m. Best signal from Japan.

JKF 9650kc. English type programmes at 7 p.m., also local services in Japanese.

WLKS 6105kc. Services transmitter, heard with "Hit Parade", 9.30 p.m.

YDZ 4895kc. Biak, Borneo. Signs at midnight in English.

HLKA 7935kc. Heard 8.30 p.m. in Korean programme. Schedule: noon-3 p.m., 6.30-11.30 p.m., 7.30-9.30 a.m. Send reports to Commanding General, USAMGIK, APO 235-2, C/o. Postmaster, San Francisco.

SOUTH AND CENTRAL AMERICA:

XEHH, Mexico 11875kc. Fine signal with news in Spanish at 11.45 a.m., music follows.

XEWW, Mexico 9500kc. Fine signal when heard at 2 p.m. and again at 11 p.m.; all in Spanish. Verifies, but is slow.

XEQQ. Mexico 9680kc. Heard at 3 p.m., with good musical programme; also announces in Spanish.

XEBT, Mexico 9620kc. One of the strongest at 3.30 p.m., similar service in Spanish.

XENN, Mezico 11782kc. "Radio Mundial", heard at 11.45 a.m., with news in Spanish and music.

The notes in this issue are compiled from information supplied to us by the following: Mr. A. T. Cushen, Invercargill, N.Z.; Miss D. Sanderson, Malvern, Vic.; Mr. J. B. Hargreaves, Sydney, N.S.W.; Mr. B. Penhall, Merrylands, N.S.W.; Mr. A. D. Addis, Ascot, Queensland.

LISTEN FOR THESE STATIONS

HRA, Honduras, 9045kc. Now on this frequency, moved from 6048kc.; closes at 2 p.m. Is anyone hearing this one?

OAX2A, Peru, 6000kc. Recently moved from 5620kc.; closes at 2.30 p.m., with fair signal in N.Z.

OAX4P, Peru, 5985kc. This one has been reported closing at 2 p.m. Any comments?

TGLA, Guatemala, 6295kc. Slogan of this one is believed to be "La Voz de Centro America". Opens on this frequency at 10.15 p.m.

Managua, Nicaragua, 6300kc. Opens with recording of song of the same name at 10 p.m. It is reported that two more stations are operating from Managua—"Radio America" on 8170kc. and the other on 8320kc., both signing at 2 p.m.

HC4MN, Ecuador, 9870kc. "La Voz de Democracia," Manta. Heard to 2.30 p.m.

AFRICA:

Capetown, 5880kc. Fair level at 4 p.m. in N.Z., with news relay from BBC. Reports should be addressed to Box 4459, Johannesburg.

Radio Africa, Tangiers. Radiates at 11 p.m.-2 a.m., 5-8 a.m. in French, Spanish and Arabic, using a power of 1000 watts. Address is 39, Calle Shakespeare, Tangiers. Frequency is 7080kc.

CR7BU, Lourenco Marques, Portuguese East Africa, 4810kc. Other outlets are CR7BE 9730kc., CR7AB 3490kc., CR7BV 4930kc., CR7BJ 9640kc. All stations are now on increased power.

EQB, Teheran, 15100kc. French and English news; music at 10.15 p.m.

CNR3, Rabat, 9080kc. All in French; news and music at 7.15 a.m. Fair level.

SUX, Cairo, 7865kc. Service in Arabic at 7.45 a.m.; noisy on this spot, but signal quite fair.

OTC2, Leopoldville, 9767kc. Heard in French at 11.30 a.m., with news and music.

EUROPE:

CS2MK, Lisbon, 11027kc. News and music, news in Portuguese; good one at 8 a.m.

Monte Carlo, 6038kc. Heard at 8.15 a.m. in French news, etc. Fair signal.

HER6, Switzerland, 15305kc. Fine signal and programme of national music at 10.15 a.m.

HER5, Switzerland, 11715kc. News in French and music at 4.15 p.m.

Liepzig, Germany, 9730kc. Good signal, with news and music in German, 2 p.m.

Belgrade, Yugoslavia, 9420kc. Heard at 4 p.m., with male and female announcers, in French news.

SBP, Sweden, 11705kc. Quite a good one at 5 p.m.; news and music.

PCJ, Holland, 21480kc. News of the Netherlands at 7.45 p.m.; fine signal.

LLG, Oslo, 9610kc. News in Norwegian; church service at 5.15 p.m.; fine signal.

OZG, Denmark, 11805kc. Coming through well at times at 5.30 p.m. This one will verify in time.

Warsaw, Poland, 6220kc. News in Polish and music, at good level. Listen for this one at 6.45 a.m.

Rome, Italy, 6085kc. Another one which is heard well at 7 a.m. with news in Italian.

CS2WD, Lisbon, Portugal, 6155kc. This station has recently verified, schedule 5.30-10 a.m. Address is Emisora Catholica Portuguesa, Rue Capelo 5, Lisbon, Portugal.

Radio Stuttgart, 6180kc. Power now 900 watts, schedule 7.30-10.30 p.m., 2-7.30 a.m. and on Sunday, 4 p.m.-8 a.m. Address reports to V. Ziemelis, Chief Engineer Radio Stuttgart, Grossrundfunksender, Muhlacker, Stuttgart, Germany.

Frankfurt, Germany, 6190kc. Schedule now is 2-5.45 p.m., 7.15-11.10 p.m., midnight-8 a.m.

KZCA, Salzburg. Power is 300 watts. Verified to A. Cushen recently. Address to T/3 Robert Graff, Station Manager, KZCA, Salzburg, Austria.

VP4RD, Trinidad, 9625kc. This one was for a time heard on 9648kc., but now are on their assigned frequency. The signal is quite a good one at 8 p.m.. News is read by a female at 8.15 p.m. and later at 9 p.m., a BBC relay is taken. The announcement is Radio Trinidad.

H12T, Dominican Republic, 9727kc. Listen for this one at 8.15 a.m., with good musical programme and news bulletins in Spanish.

HI4T, Dominican Republic, 5985kc. Opens at 9.15 p.m. with march; news and music follows, all in Spanish.

H11Z, Dominican Republic, "Radio Nacional", heard in N.Z. at 8.30 p.m. daily. Address is Apartado 1092, Cuidad Trujillo, Dominican Republic.

COCY, Havana, 11740kc. Excellent level at 2.30 p.m. Chimes and fanfares of trumpets as interval signals. Transmission in Spanish.

COBC, Havana, 9370kc. Heard at 9 p.m.; often interference on this spot; fair level.

COKG, Havana, 8950kc. Noise and interference bad on this frequency also. Fair signal in news, etc., in Spanish. Also reported in afternoon at 3.30 p.m.

TGWA, Guatemala, 9760kc. Heard well in news and music at 2.30 p.m., closes as late as 5 p.m. at times.

HCJB, Quito, 9958kc. Religious transmissions at 2.30 p.m. on this frequency, and on 15110kc. at 4.30 p.m. Various languages used in transmissions.

LRM, Argentina, 6180kc. Fine programmes in Spanish at 8.30 p.m.; heard well.

LRY1, Argentina, 9545kc. Also a good signal at 8.30 p.m., in same type of service.

PRL8, Brazil, 11720kc. "Radio Nacional." Music and chimes as interval signal during Spanish programme. Heard well, mostly at 8.15 p.m.

ZYB8, Brazil, 11765kc. Another good one at 8.30 p.m. in Spanish service. All these stations verify.

ZYC8, Brazil, 9610kc. A little later at 9.30 p.m., this one is heard well; usual service.

HP5J, Panama, 11690kc. CBS relay of music and news in Spanish; heard at 9.15 p.m. Listen for this one at 11 a.m.; may be heard on occasions.

CE622, Chile, 6220kc. In English and Spanish from 9 p.m.; best time is about 9.30 p.m. when signal is quite fair.

HRN, Honduras, 5940kc. Closes at 2 p.m. with usual announcements in English. Power, 1500 watts; heard in N.Z.

CLUB NOTES & NEWS

HURSTVILLE DISTRICT AMATEUR RADIO CLUB

C.W.A. Rooms,
378 Forest Road,
HURSTVILLE.

President: F. Tregurtha.
Secretary: C. Coyle.

Owing to very bad weather on the 18th of July, the above Club was forced to postpone their Field Day, which was to be held at Carr's Park. The Club will now hold their Field Day at the same place, on the 31st of October, 1948, and it is to be hoped that the clubs who were invited to the last Field Day will be able to attend. Hams, would-be Hams and visitors are cordially invited to attend, as an interesting and enjoyable day should be had by all. All particulars can be had from the Secretary (LW1326). Carr's Park buses leave Kogarah Station at 15 and 45 past each hour.

The Club will be transmitting on 40 and 60 metres, and on 144 M/cs during the day, and would be glad to contact any station who happen to hear us on the air.

WORLD WIDE S.W. STATION LIST

For the benefit of those who have no access to a reliable station list we hope to include each month a list of stations by order of frequency and which, under reasonable conditions, are reliably received in Australia.

Call Sign	Location	Frequency	Schedule
YHP	Java	14630kc.	News at 12.15 a.m.
PMS4	Sourabaya	13600kc.	Heard nightly in local transmissions.
Moscow	Russia	13420kc.	Good one at any night.
Omdurman	Soudan	13355kc.	English at 6 a.m.
WNRI	New York	13050kc.	Closes at 9 a.m.
HCJB	Quito	12445kc.	9.45-11.45p.m.; 2.30-5.10 a.m.
CS2WI	Lisbon	12400kc.	News in French at 7.30 a.m.
HCJR	Colombia	12400kc.	Heard at 11 p.m. and 9.30 a.m.
Pnonpenh	Indo China	12360kc.	Regular at 10.30 p.m.
Batavia	Java	12270kc.	Heard well, 9 p.m.
Moscow	Russia	12260kc.	Nightly at 10 p.m.
WXFG	Aleutian Is.	12260kc.	9.30 p.m.-12.30 a.m.
XMPA	China	12210kc.	8.15 p.m. and 10.45 p.m. good.
Tananarive	Madagascar	12140kc.	Listen at 2 a.m.
XOPB	China	12120kc.	8 p.m. nightly.
ZNP	Aden	12115kc.	2.15 a.m.; closes at 3 a.m.
GRF	London	12095kc.	3.30-8 a.m.; 2-7 p.m.; 9 p.m.-12.15 a.m.
GRV	London	12040kc.	Audible most of 24 hours.
CE1180	Chile	12000kc.	9 a.m. and from 10.10 p.m.
Damascus	Palestine	12000kc.	3 p.m. and 6 a.m.
LRS2	Argentina	11990kc.	Closes at 2 p.m.
Tabriz		11985kc.	1.30 a.m.
FZI	Brazzaville	11970kc.	3-4.30 p.m.; 8.30-10 p.m.; 2-10.45 a.m.
HER5	Berne	11960kc.	Audible at 10 a.m.
GVY	London	11955kc.	
ZP5	Paraguay	11950kc.	Spanish news at 9.30 p.m.
Moscow	Russia	11948kc.	Nightly.
GVX	London	11930kc.	
	Java	11928kc.	Midnight.
XGOY	Chungking	11920kc.	Daily, night and morning.
KWID	San Francisco	11900kc.	3.30-9.30 p.m.
CE1190	Chile	11900kc.	Opens at 9.30 p.m.
Dakar	Cameroons	11898kc.	5 p.m. and 10.15 p.m.
KWIX	San Francisco	11890kc.	7 p.m.-12.30 a.m.
Moscow	Russia	11890kc.	Opens midnight.
Brussels	Belgium	11890kc.	5.45 a.m.
KRHO	Honolulu	11890kc.	6.30 p.m.
V of A	Manila	11890kc.	Nightly.
Paris	France	11885kc.	3.30 p.m.
VLH4	Melbourne	11880kc.	6-9.15 a.m.
LRR	Argentine	11880kc.	9 p.m. opens.
XEHH	Mexico	11875kc.	2 p.m. and 11.30 p.m.
VUD9	Delhi	11870kc.	3.15 p.m., 7.30 p.m., midnight.
WBOS	Boston	11870kc.	7.30 p.m.
WNBI	New York	11870kc.	9.30 a.m. and 2 p.m.
Munich	Germany	11870kc.	2.15-8 a.m.
WNRA	New York	11870kc.	7.45 a.m.
HER5	Berne	11865kc.	5.15-7.30 p.m. to Australia, other transmissions through day.
KWIX	San Francisco	11860kc.	8.30 p.m.
GSE	London	11860kc.	8 a.m.-1.30 p.m.
VUD3	Delhi	11850kc.	11.40 a.m.-1.45 p.m., 10.15-10.45 p.m., 11-11.30 p.m.
Paris	France	11845kc.	2.30 a.m.
OLR4A	Prague	11840kc.	4 p.m. and 8 a.m.
KZFM	Manila	11840kc.	Nightly.
Algiers	Algeria	11835kc.	4.30-6.15 p.m., 9.45 p.m.-12.15 a.m., 4.30-9 a.m.
VLW3	Perth	11830kc.	1.30-8.15 p.m.
XGOA	Nanking	11830kc.	Nightly.
WNRX	New York	11830kc.	9 a.m.-4 p.m.
CXA19	Uruguay	11830kc.	News at 11.45 a.m.
Moscow	Russia	11825kc.	9 p.m. nightly.
GSN	London	11820kc.	9 p.m.-11.30 a.m.
Seac	Ceylon	11820kc.	Heard nightly from 8.30 p.m.
XEBR	Mexico	11820kc.	After midnight.
Forces Station	Libya	11820kc.	1 p.m.-2 a.m., 4.15-8 a.m.
HEY5	Berne	11815kc.	To Australia, 5.15-6.45 p.m.
WLWL	Cincinatti	11810kc.	Closing at 11 a.m.
KCBF	San Francisco	11810kc.	1.15-6.45 p.m.
WGEA	Schnectady	11810kc.	11 a.m. opens.
Milan	Italy	11810kc.	5.15 a.m., in Italian.
VLC7	Melbourne	11810kc.	10-11.45 p.m.
GWH	London	11800kc.	4 a.m.-midnight.
	Denmark	11800kc.	4 p.m. and later.
KNBI	San Francisco	11790kc.	7 p.m.-2 a.m.
WLWO	Cincinatti	11790kc.	11 a.m.-1 p.m.
Radio Wien	Austria	11785kc.	

Call Sign	Location	Frequency	Schedule
Saigon	Indo China	11780kc.	7 p.m.-12.15 a.m.
XENN	Mexico	11780kc.	News, 2 p.m.
Moscow	Russia	11775kc.	Opens at 1.20 a.m.
OIX3	Finland	11775kc.	3.45 p.m.-7 a.m.
YDC	Java	11770kc.	Nightly.
WOOC	New York	11770kc.	
GVU	London	11770kc.	
WNRA	New York	11770kc.	7.30 a.m.
WGEA	Schnectady	11770kc.	9 a.m.
ZYB8	Brazil	11765kc.	8.15 a.m.
CKRA	Montreal	11760kc.	Afternoon and early a.m.
VLA8	Melbourne	11760kc.	6-6.30 a.m.; 7.45-9.15 a.m. 4-4.45 p.m.
VLC3	Melbourne	11760kc.	1-2.15 a.m.
VLB3	Melbourne	11760kc.	5-6.15 p.m.; 6.30-9.45 p.m.; midnight-1 a.m.
GSD	London	11750kc.	3-7 p.m.; 1.15 a.m.-1.15 p.m.
Moscow	Russia	11750kc.	Closing at 12.20 a.m.
HVJ	Vatican City	11740kc.	5.30 p.m.
COCY	Havana	11737kc.	Night and morning.
Moscow	Russia	11737kc.	Nightly.
Singapore	Malaya	11735kc.	3.30-5.30 p.m.; 6 p.m.-3 a.m.
LKQ	Oslo	11735kc.	Closes 8 a.m.
KGEX	San Francisco	11730kc.	3.30-7 p.m.
PCJ	Holland	11730kc.	Mon. to Thurs., 7-8.30 a.m.; 12.30-2 p.m.; Sun., 1.30-3 a.m.
WRUW	Boston	11730kc.	News, 8 a.m.
WRUL	Boston	11730kc.	Latin service, 2 p.m.
GVV	London	11730kc.	
CHOL	Sackville	11720kc.	6.15-9 a.m.; 6.45-8.30 p.m.
CE1173	Chile	11720kc.	9.30 p.m.
Paris	France	11720kc.	1.40 p.m.
HE15	Berne	11715kc.	1 p.m.-2.40 a.m.; 5.15-6.45 p.m.; 1-2.30 a.m.
FGA	Dakar	11715kc.	4.45-6 a.m.; reopens at 5 p.m.
VLG3	Melbourne	11710kc.	5.45-6.45 p.m.; 6.55 p.m.-1 a.m.
WLWO	Cincinnati	11710kc.	8.45-10.15 p.m.; 10.30 p.m.-7.30 a.m.
WLWR	Cincinnati	11710kc.	10 a.m.-3 p.m.
SPW	Warsaw	11710kc.	9-10.20 p.m.
Moscow	Russia	11710kc.	Midnight.
SBP	Sweden	11705kc.	9.30 p.m.
GVW	London	11700kc.	7 a.m.-12.30 p.m.
HP5J	Panama	11690kc.	Opens at 9 p.m.; also 11 a.m.
XORA	Shanghai	11690kc.	8 p.m.
GRG	London	11680kc.	Opens at 1.30 a.m. to Africa.
XGAS	Changsha	11680kc.	11 p.m.
HCJQ	Colombia	11680kc.	9.30 a.m.
OTC	Leopoldville	11670kc.	2-6 a.m.
XPTA	Canton	11650kc.	11 p.m., News.
OTC	Congo	11645kc.	6.30-7.45 a.m.
Moscow	Russia	11630kc.	12.15 a.m., news.
PMB	Java	11570kc.	News, 10.30 p.m.
XMAG	Nanking	11540kc.	AFRS, 9.45 p.m.
XLRA	Hankow	11500kc.	10 p.m.
Batavia		11440kc.	12.30-1 a.m.
WCBN	New York	11145kc.	8 a.m.
WOOC	New York	11145kc.	Closes at 11 a.m.
CS9MD	Azores	11090kc.	Closes at 6 a.m.
YDH2	Samarang	11030kc.	Closing at 9.30 p.m.
CS2MK	Lisbon	11027kc.	Closes at 9 a.m.
YHN	Java	11000kc.	English, 9.45 a.m.
YHN	Java	10840kc.	Nightly.
SDB2	Sweden	10780kc.	1-3.30 a.m.
VQ7LO	Nairobi	10730kc.	10 p.m.-12.15 a.m.; 1.15-3.30 a.m.
Java		10640kc.	7.30 p.m.
Tananarive		10615kc.	2.30-3.30 p.m.; 6.30-8 p.m.; 1-2 a.m.
VPO3	Barbadoes	10605kc.	7.30 a.m.
ZIK2	Honduras	10598kc.	4.30-5 a.m.
PLS	Batavia	10360kc.	Closes midnight.
Moscow	Russia	10290kc.	Opens 4.30 a.m., in Russian.
Java		10280kc.	10 p.m.
XRRA	Peiping	10260kc.	9.30-10 p.m., English.
PSH	Brazil	10220kc.	9 a.m.
HH3W	Haiti	10130kc.	Best at 9 p.m.
SUV	Cairo	10550kc.	4.30-5 a.m.
WWV	Washington	10000kc.	24 hour service.

U.H.F. TECHNIQUES

(Continued from page 36.)

Automatic Frequency Control

For some applications automatic frequency control is desirable. A *discriminator* generates a d.c. voltage, whose value depends upon the shift of the local oscillator frequency from the desired value. This d.c. voltage is used to correct the frequency of the oscillator by means of a reactance tube or some such device. A.F.C. is particularly applicable to reflex klystron local oscillators.

Detectors

Diode detectors are common in U.H.F. receivers. If a double diode such as the 6H6 is employed, one half may be used as a source of A.V.C. voltage. It is common to employ the same type of valve as used for I.F. amplification connected as a diode, for the sake of uniformity in valves.

Another type of detector is the cathode follower or *infinite impedance* detector, which has the property of being more nearly linear than the diode. It also has the advantage of not loading the final coupling circuit of the I.F. amplifier. It consists of a triode with the output taken from the cathode resistor.

Video Amplifiers

For sharp pulses, amplifiers capable of covering a very wide range of audio frequencies are necessary after the detector. These are termed video amplifiers and consist of several resistance-capacity coupled stages. The fidelity or response is divided into three ranges of frequencies—

(a) **the middle frequency range, where effects of the coupling condenser and shunt capacitance are negligible;**

(b) **the high frequency range where the shunt capacitance causes decrease in gain; and**

(c) **the low frequency range in which the coupling condenser causes a decrease in gain.**

Poor high frequency response causes a rounding-off of the leading edge of the pulse, whilst bad low frequency response results in a sloping top on a square pulse, followed by an overshoot at the end of the pulse.

This overshoot is sometimes termed paralysis and tends to prevent the detection of small signals after strong ones.

If the video signals have to be transferred through a co-axial cable or any distance, a *cathode follower* is necessary to prevent a reduction in the high frequency response.

Indicators

In communication systems loudspeakers or earphones are used as indicators.

Field strength receivers and aircraft navigational aids employ meters to display the information received.

For radar and television, however, cathode ray oscillographs are necessary. The subject of indicators and associated equipment for these applications is extensive, but a few points may be mentioned here. Both employ some form of scanning of the cathode ray tube screen by means of a *time base* generated by appropriate circuits. Video signals are used to modulate the beam of the tube either in intensity or in deflection. The intensity is greater in television tubes, but for plan position indicators in radar, longer "persistence" is used than in television.

Aerial Duplexing

In radar applications, the same aerial is used for transmitting and receiving the short pulses of r.f. energy. The powerful pulses of the transmitter are prevented from reaching the sensitive receiver by means of a *duplexing* system or *transmit-receiver* (T-R) switch. The schematic layout of such a system is shown in Fig. 8. The switches consist of gas discharge tubes which break down and "close" under the influence of the transmitter pulses. Up to 200 Mc-s open wire lines are employed whilst at microwave lengths, co-axial or wave-guide lines with *rhumbatron* cavity discharge tubes are required.

The R-T switch is needed to prevent the received signals leaking into the transmitter.

Fig. 9 is a photograph of a 25 Cm. TR cavity with a co-axial line mixer coupled directly to it.

A.R.R.L.—AND THE AMATEUR

(Continued from page 37.)

★ **It secured a special ruling allowing portable-mobile operation during emergencies and on week-ends for testing of emergency gear.**

★ **It secured a special ruling covering temporary fixed-station operation under portable status.**

★ **It inaugurated the A.R.R.L. code proficiency programme designed to raise the general level of amateur code ability, thereby increasing the value of amateur radio to the nation as a potential reserve of trained operators.**

The radio world owes much to the A.R.R.L. From a very humble beginning it has grown to a stage where it dominates international opinion or certain aspects of amateur radio through its technical journals. Its work in the ultra high frequency spectrum and latterly on single side bad transmission is closely linked with the commercial field. It never wishes to compete with the commercial world being more content to work together to improve radio generally.

This policy will never change. One sees it in the old QST's of the 1920's when plate modulation was just coming into its own. It was again evident when the quartz crystal entered the electronic field first to stabilise the frequency of transmitters and some time later to act as an agent in sharpening the tuning of a receiver. Today that same sane view is taken with single sideband transmissions.

This article is not meant to be a free advertisement for A.R.R.L.—it needs none. It is simply a tribute to an organisation founded on the principles of democracy, fair play and justice. Amateur radio can do a lot in this world of strained international relations. If the A.R.R.L. has its way it will achieve this aim.

Technical BOOK REVIEW

LORAN-LONG RANGE NAVIGATION

Radiation Laboratory Series. Published by the McGraw-Hill Book Co. Inc. Stiff cloth cover, 476 pages. Price approx. 46/6, plus postage.

This volume is the fourth of the Radiation Laboratory Series now being published to record the wartime activities of the Massachusetts Institute of Technology. Written by eleven contributing authors, it is a comprehensive account of the design and use of the long range pulse navigation system known as *Loran*.

As pointed out in the preface, the aim of this book is "to describe the Loran system, its principles and its equipment as they existed at the end of the war, and to offer suggestions for their adaptation and improvement for civilion services in time of peace." This, it will be found, has been achieved in an admirable and interesting manner.

The volume is divided into two main sections. Part I headed "The Loran System" discusses such topics as History and Principles of Loran, Future Trends, Propagation Characteristics as well as including the methods of calculating Loran tables and charts. Part II—entitled "Loran Equipment"—is devoted to a discussion of Timers, Switching Equipment, Transmitters, Antenna Systems, Receiver-Indicators, Special Techniques and Measurements.

This book is undoubtedly the most comprehensive reference now in available on the subject, and whilst covering a specialised field, should be of interest to all engineers and technicians.

RADIO ENGINEERING

By F. E. Terman, Sc.D., Published by McGraw-Hill Book Co. Inc., Stiff cloth cover, 969 pages. Prices 54/3, plus postage.

This third edition of a leading standard text, which has an impressive record of widespread use in many colleges and universities for over 15 years, hardly requires any introduction to radio engineers. As in previous editions, this latest volume gives a comprehensive treatment of all phases of radio communication with emphasis being placed on fundamental principles rather than current practice.

Since the last revision in 1937, many advances have been made in the radio engineering field, and as a consequence the major portion of this text has been re-written to include details of these changes. In particular, emphasis has been placed on information relating to ultra-high frequencies, microwave techniques and pulse mode of operation, such as are now being encountered in television and radar systems.

Whilst it would be impossible to attempt to detail all changes and additions, it is interesting to note the inclusion of a complete new chapter describing circuits with distributed constants. This summarises the main properties of transmission lines, wave guides and cavity resonators, and serves to introduce the reader to microwave phenomena.

Whilst hardly a text for the "novice," the ambitious student will find it is an excellent textbook, as it presents a lucid, authorative approach to the ever widening radio and electronics field.

ANTENNA MANUAL

By Woodrow Smith. Published by Editors and Engineers Ltd. Stiff cover, 306 pages. Price approx. 29/-, plus postage.

The object of this book is to present in a single volume a comprehensive compilation of antenna, transmission line and propogation data of particular interest to all technicians associated with the more practical aspects of radio communications.

Since this book is primarily intended for the practical man it will be found that more emphasis has been placed on engineering approximations than trying to present a rigorous mathematical treatment of the subject. Consequently, for a complete understanding only an elementary knowledge of electric theory and radio communication is required by the reader.

Covering all aspects of antenna theory with numerous practical examples of design and construction, this book should prove invaluable as a reference text to all radio experimenters.

All copies made available by Angus & Robertson Ltd., 89 Castlereagh Street, Sydney.

The Mail Bag

J.B. (via Surat, Q'ld.) is a regular reader of RADIO SCIENCE, and is particularly interested in the constructional and experimenters' pages.

A.—Many thanks for your interesting letter and appreciative remarks about the magazine. We are pleased to hear of your successes with the small circuits. The lack of volume in the one valve receiver is probably due to a fault in the reaction winding. Firstly, you can try reversing the leads to this, as an incorrect connection would give the symptoms you mention. Failing this, you can try either adding additional turns or moving the winding closer to the grid winding, to increase the coupling. Actually, a combination of these two suggestions will usually result in improved operation. However, we would be pleased to hear if you are able to rectify the fault.

S.A.L. (Fairfield, Q'ld.) is interested in DX-ing, and suggests that special communications type receiver suitable for this purpose be described.

A.—Thanks for the suggestion, and it may be possible to include a receiver of this type in our future designs. No doubt such a set would be quite popular with many of our ardent S-W listeners. The mistake in addressing your subscription copies has now been rectified and you should have no further worries regarding this.

I.B.T. (Caulfield, Vic.) sends in some suggestions for future articles and these deal mainly with the subject of acoustics and audio equipment.

A.—Your suggestions have been noted, and it is hoped to include some special "sound" articles in the near future. Probably the Three Way Speaker system and article on Pickup Resonance effects in the September issue will be of interest to you. Your remarks about the magazine are appreciated.

TECHNICAL QUERY SERVICE

Readers are 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".

K.M.P. (Dapto, N.S.W.) frequently has difficulty in obtaining his copy of RADIO SCIENCE and asks if subscription are accepted.

A.—Yes, K.M.P., a subscription can be made direct to us if you wish. The rates are 12/- per annum, or 21/- for two years, in both cases, post free to your address. If you require any of the earlier issues, these are still obtainable at the price of 1/- each.

R.H.W. (Invermay, Tas.) in requesting some back issues, writes: "I noticed the June issue at my newsagents and bought same, and at once was very pleased with the articles and general data, etc. in your magazine. I managed to obtain the April and May issues, and have lodged an order for any future ones."

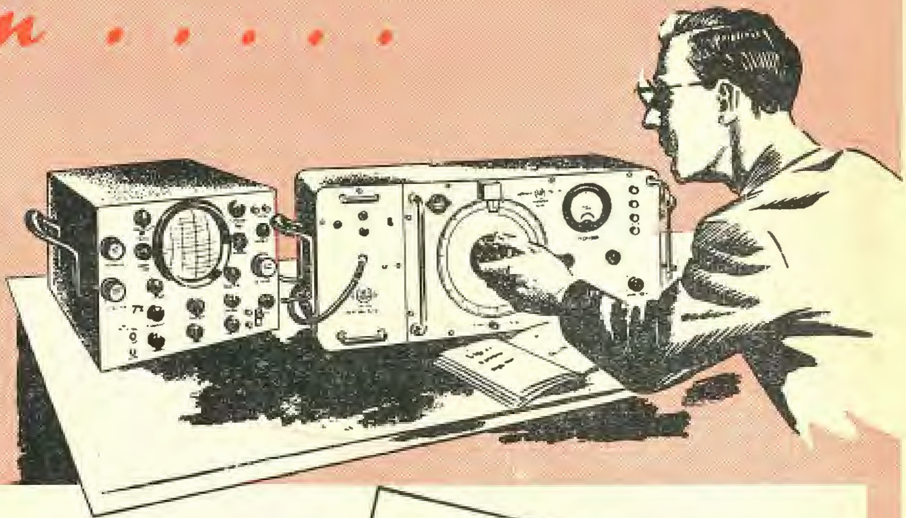
A.—The issues requested have been forwarded, and no doubt by now will have been received by you. We appreciate your remarks about the magazine and feel sure that you will find each issue even more interesting than the last. The circuits and equipment you mention will be featured in a future issue, but at the moment cannot say which issue this will be. We wish you luck with the "Ham" licence exam., and would be pleased to hear from you when you have the transmitter in operation.

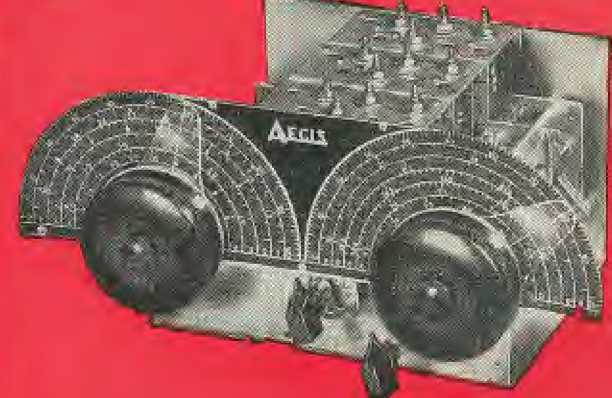
J.C. (Camberwell, Vic.) is interested in building up the "All Wave Battery Two", and asks whether a 1P5 and 1Q5-GT could be used in place of the 1T4 and 3S4 as shown in the circuit.

A.—Yes, J.C., the two valves you mention could be used in this circuit, providing allowance was made for their larger size. The present miniature seven pin sockets would need to be changed to the standard octal type, but the remainder of the component values would remain unaltered. We would be pleased to hear of your results with this small receiver.

D.W. (Auckland, N.Z.) intends building up the Miniminor Portable receiver described in the February issue of RADIO SCIENCE, and asks several questions regarding the aerial and earth.

A.—Here are the answers to your questions, D.W. Your first idea for mounting the metal plate at the bottom of the cabinet and connecting this to the earth terminal on the loop, is quite sound, and as you mention, would provide a simple external earth when the set is placed on the ground. An external aerial could be provided by sewing the wire around the carrying strap, and this should be connected into the circuit, via a standard aerial coil. This is necessary because of the fact that loop is now flexible and may assume different shapes, thus making it difficult to align it accurately. Also, the coil is necessary to prevent any serious detuning of the input grid circuit. However, a little experimenting with this idea should soon enable you to adjust things correctly. We are pleased to hear you enjoy reading the magazine, and thanks for the appreciative remarks.

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