RADIO SCIENCE

Vol. 1.—No. 10. Registered at the G.P.O., Sydney, for transmission by post as a periodical. NOV.-DEC., 1948

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*Maximum operating frequency	75 Mc/s
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editorial.

F.M.-Government Monopoly?

News that Frequency Modulation transmissions are to be solely confined to the ABC Stations is most disquietening, not only to the radio industry as a whole, but to the listening radio audience. The Government, however, is apparently unperturbed by the results of the recent public opinion survey which revealed that the present National network can only rate some 10% listener interest; and appears to be fully determined to carry on with its objective of creating a virtual broadcasting monopoly of this form of transmission.

Whilst this Journal is absolutely non-political in outlook, it unhesitatingly criticises the proposed action of the Government in denying the use of this form of broadcasting to the commercial stations and, in consequence, depriving the vast majority of the listening public from enjoying their own choice of radio programme on this improved form of transmission. It would be no exaggeration of fact to add here that the present high degree of development in broadcasting programmes is due, in the main, to the untiring and progressive efforts of these commercial stations. As the President of the Federation of Commercial Broadcasting Stations says: "Commercial radio pioneered broadcasting in Australia. We are deeply concerned that commercial broadcasting seems to be left out of this new field of broadcasting."

From the industrial point of view, the outlook is as equally disturbing. In a radio industry which is rapidly approaching saturation from the consumer point of view, and with the lag in sales of AM receivers, due to the public policy of "wait and see", the introduction of FM did appear to present a new sales angle. Most manufacturers have made and tested experimental FM receivers and were in a position to commence their large-scale manufacture as soon as the circumstances warranted such a move. However, the Government's announcement has completely negatived their hopes—the FM selling angle of "ABC Stations Only" is not sufficient inducement for the purchase of a higher-priced set of present doubtful entertainment value.

Despite some press claims to the contrary, there is no doubt that the FM form of broadcasting is superior to the present AM transmissions and has many advantages to offer the listening public. In addition to providing the much-needed additional broadcasting channels in an already overcrowded radio spectrum, it will provide the listener with non-fading signals, increased tonal range and a noise-free background. This latter feature will be most advantageous in the many country areas where it is proposed to erect low-power stations, as static-free reception will be a boon to all who have attempted to listen to AM stations during the summer months.

In the early stages of development, this system must necessarily be of an ancilliary nature, but for its general adoption the present policy of "political" control must be put aside if the Australian public is to be provided with the best possible broadcasting service. "Freedom of the Air" is just as essential as Freedom of the Press in a democratic country, and in this case it merely infers that the entire radio industry should be permitted to share in the benefits of any new technical development.

This Issue

Owing to the late publishing date of recent issues of this Magazine, due to circumstances beyond our control, it has been found necessary to date this issue November-December in order to regain our normal publishing date of the 1st of the month.

In this regard, all subscriptions have been advanced by one month, so that each subscriber will receive his full number of issues paid for in advance.

As our next issue will be January, 1949, we take this opportunity of wishing our many thousands of readers, our contributors and publishing staff . . .

A MERRY CHRISTMAS AND PROSPEROUS NEW YEAR.

RADIO SCIENCE

FOR THE ADVANCEMENT OF RADIO AND ELECTRONIC KNOWLEDGE.

Vol. 1.—No. 10. :: NOV.-DEC., 1948

EDITORIAL CONTENTS

OUR COVER:

Disc recording lathes and reproducing turntable in one section of the cutting room of the Australian Record Coy. Pty. Ltd. Master records are cut on these lathes, after which they are coated chemically with silver and electroplated. Th plating or "shell" is then stripped off and after nickelling and trimming, is used as a die to press the final record in Vinylite.

Photograph courtesy Australian Record Coy. Pty. Ltd.

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X-RAY THICKNESS GAUGE

By W. N. LUNDAHL
Westinghouse Electric Corporation

"How thick is it?" is a question always facing the production engineer wherever sheet metals are made. Electronics—in particular a combination of x-ray and photo-multiplier tubes—provides a gauge that gives a continuous, accurate indication of production thickness without moving parts.

A gauge for continuously indicating the thickness of cold rolled sheet steel, regardless of temperature, and without making contact with the sheet itself, has long been the dream of rolling-mill operators. Such a gauge has been developed by Westinghouse engineers and is applicable not only to sheet steel, but in hundreds of other cases where it is desired to compare the thickness of a material with that of a standard sample.

Principle of Operation

The gauge is based on the principle of x-ray absorption and takes advantage of the fact that the amount of x-ray absorption of any material is determined by the atomic number of the material and its thickness, and is independent of physical state, state of aggregation and temperature. Basically, two equal sources of x-rays are used, one for a standard sample and the other for the sheet under test. After passing through the materials, the x-rays strike fluorescent screens.

The amount of light produced on the screens depends on the absorbing properties of the materials being used. The illuminations of these screens are then compared by means of a phototube, and any variations in thickness of the sheet under test will be indicated on a suitable meter. The basic arrangement is shown in Fig. 1.

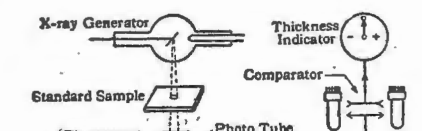


Fig. 1.—The thickness gauge uses two x-ray generators. The radiations from one pass through the sheet in question; those from the other through a standard. The surviving radiations fall, alternatively, on to the x-radiation sensitive screen surrounding a photomultiplier. The results are amplified, compared, and any difference applied to an indicator.

Several problems are immediately encountered in developing an instrument using these basic principles. The intensity of x-radiation from the two sources of x-rays must be kept constant, and drift due to unstable characteristics of the phototube and associated amplifier must be eliminated. The accuracy of the gauge must be satisfactory for the particular application, and the equipment must be readily adaptable to a wide range of thicknesses. How these and other problems have been solved will become apparent from the following description of the gauge.

The block diagram (Fig. 2) shows the basic elements of the system. The x-ray tubes are operated with A.C. on the plates and are operated 180 deg. out of phase, so that x-rays strike the pickup from only one unit at a time. A type 931-A photomultiplier tube is used to determine the illumination on the fluorescent screen of the pickup. Alternate pulses of light thus strike the phototube, one pulse due to x-rays passing through the standard sample and the other due to x-rays passing through the material under test. These pulses are then amplified, passed through a comparator, and then to an indicator where the difference in amplitudes is shown as thousandths of an inch variation in thickness.

Gauge Circuit

The gauge circuit is shown in Fig. 3. It consists essentially of a pentode detector amplifier, a duplex diode clipper and base line restorer, a pentode sawtooth converter and a pair of power amplifier pentodes used in a comparator circuit.

The output signal obtained from the anode of the photomultiplier is condenser coupled to a conventional stage of pentode amplification. The amplified signal from the first stage is coupled to the clipper section of the duplex diode, where a portion of the signal is conducted through to the following stage. The percentage of the signal amplitude which is conducted depends upon the bias maintained across the elements. As more of the lower portion of the signal is clipped, the percentage amplitude differential between the standard pulse and the pulse representing instantaneous pass, line thickness increases, thus increasing the thickness sensitivity. (Thickness sensitivity is defined as the percentage thickness differential between the standard sample and the instantaneous pass line thickness which will give a full-scale thickness indicator deflection.) A second function of the diode is to prevent damaging currents from flowing through the indicator's movement in the event of large thickness differentials or complete removal of the pass line strip.

The cathode of the clipper is coupled to a pentode saw-tooth converter which, in effect, adds area to the pulses. The average value of the signal is quite small, due to the short duration of the

Both x-ray tubes and their transformers are mounted in a single, oil-filled cast head. In this installation, the steel strip is shown passing between the lower x-ray generator and the pickup photomultiplier above it.

pulse. Thus, the additional area derived from the saw-tooth waveform materially increases the effectiveness of the following stage.

The saw-tooth conversion is followed by the 6AG7 pair in a comparator circuit. This circuit operates in a somewhat unconventional manner. The control grids of the two tubes are in parallel. The cathodes are carried to ground through a potentiometer balancer and the gauge selector rheostat which is mounted in the control panel.

The plates are carried through identical resistors to B+. The screen grids are connected to the opposite ends of the secondary of a transformer whose centre tap is grounded.

Assume that at a given instant pulse "A" has arrived at the control grid of the two tubes. At that same instant, the phasing of the A.C. potentials on the screen grids are such that the left-hand tube screen grid is at a positive peak. The right-hand tube screen grid is 180 deg. out of phase, and thus at a negative peak. Since a pentode will not conduct when the screen is at zero or at a negative potential, no plate current will flow in the right-hand tube.

However, the left-hand tube will conduct, the plate current being a composite A.C. wave, but instantaneously a current of a value depending upon the peak amplitude of the signal on the grid at that moment, the instantaneous A.C. potential on the screen and the tube characteristic. One-half cycle later, pulse "B" has arrived on the control grid. The right-hand tube screen has become positive and the left-hand tube screen has become the same value negative, and conduction occurs only in the right-hand tube.

Bridge Network

Thus, the tubes become selective; the left hand tube operating with the pulse "A" and the right-hand tube operating with "B" pulse. This circuit is, in effect, a bridge circuit in which the two plate load resistors and the two tubes act as the legs in the circuit. If a suitable instrument is placed between

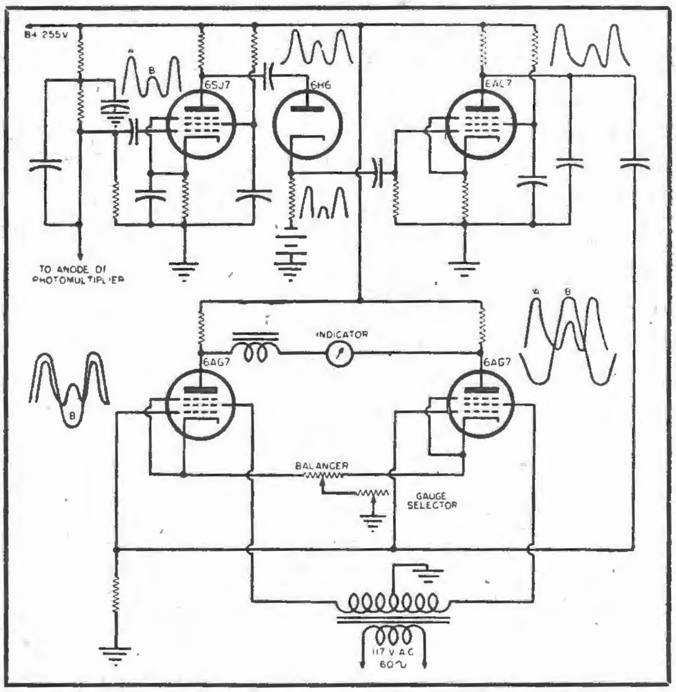


Fig. 3.—The gauge circuit used in the x-ray thickness gauge.

the two plates, any unbalance in the circuit will be indicated by a deflection proportional to the amount of unbalance. This unbalance, of course, will be caused by differences in amplitude of pulse "A" and pulse "B".

If the pulse amplitudes of "A" and "B" are equal, the voltage drops across the tube plate resistors will be equal. Thus, no D.C. potential will appear across the tube plates; however, if the pulse amplitudes differ, the plate currents of the two tubes will, of course, differ; thus, the voltage drop in the plate load resistors will differ and in effect, a D.C. potential will appear across the tube plates and be indicated by the deflection in the proper direction of the indicating instrument.

Eliminating Drift

Because of the characteristic *drift* of the phototubes employing the secondary emission principle, such as the 931-A used here, some form of stabilization is necessary. This is accomplished by automatically controlling the potentials on the last two dynodes so that the overall gain of the 931-A automatically compensates for any drift. The circuit for this stabilizer is shown in Fig. 4, and contains the following components—a photomultiplier tube, a standard pentode amplifier stage, a sharp cut-off pentode, a *pi* filter network, a bias supply for the sharp cut-off pentode, and a base line restorer.

A pulse from the 931-A is amplified by the pentode. This amplified pulse is applied to the grid of the stabilizer tube, which is the sharp cut-off pentode, through coupling condenser C_1. However, the stabilizer tube is biased far beyond cut-off, and consequently it will not conduct unless the signal pulse amplitude nearly equals the D.C. bias potential. If the stabilizer tube conducts the average IR drop across, R_L increases. Thus, the drop across R_1 and R_2 decreases. The pulse signal appearing across the tube is effectively filtered out by the pi network of C_2 R_3 and C_3.

At times, the signal amplitude increases to quite high values, due to thin test material or complete removal of the test material. This high signal amplitude will cause the grid to swing positive, throwing the response beyond the linear portion of the grid characteristics, with possible injury to the tube. The diode will tend to clip off the lower portion of the signal as seen by the grid of stabilizer tube, thus reducing the average A.C. value. Since the average A.C. value of the signal swings around the D.C. bias potential, the peak values will remain within the linear range. The base line reference is thus restored to its original position.

Calculations and experiments have shown that normal drift of any photomultiplier of the particular type under discussion can easily be compensated for by a maximum plus or minus variation of potential of 40 per cent. across the eighth and ninth dynodes. As shown in Fig. 4, the dynode potential application is so designed that the seventh element is grounded. A con-

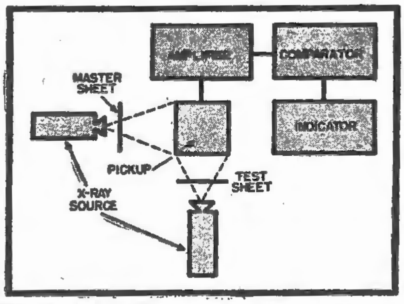


Fig. 2.—Block diagram of a one source-two pickup system.

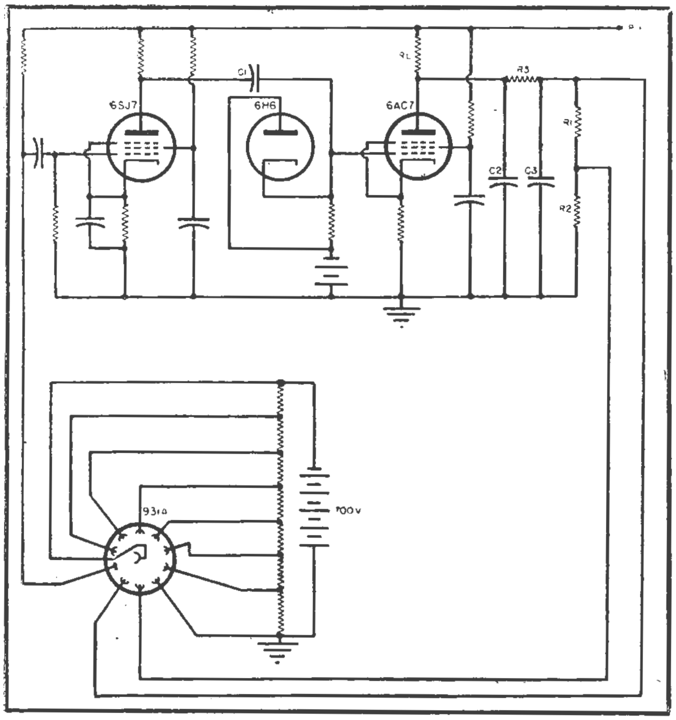


Fig. 4.—Basic circuit used for stabilising photomultiplier output.

stant high voltage supply feeds the bleeder from the seventh element to the cathode. The eight and ninth dynodes are fed from the divider R_1 R_2 and the anode is supplied through a resistor from the common B supply for the vacuum tubes and the gauge circuit.

The signal input to the phototube is set originally so that an optimum signal current flows through the stabilizer tube. This sets the voltage across R_1, R_2 in its mid-value. If the tube tends to drift down in amplification, the pulse on the grid of the stabilizer becomes smaller. The voltage increases on R_1, R_2 and also on the eighth and ninth dynodes. The amplification increases again until the compensator circuit reaches equilibrium.

Conversely, if the signal becomes too large due to a positive drift in 931-A, more voltage is *peeled* off the filter network. The eighth and ninth dynode potentials drop until balance is again obtained. Another desirable feature of this device is the fact that complete removal of the test sheet and the consequent subjection of high intensity radiation directly upon the pickup devide does not injure the photomultiplier. The instant the test sheet is removed, the stabilizer automatically drops the eighth and ninth dynode potentials to a value low enough to prevent damaging currents from flowing.

Stabilization of the two sources of x-rays is accomplished by means of an electronic device called the *tandem milliampere stabilizer.* This device maintains correct equality by using the current through one tube as a reference and having the current of the other tube follow.

The present device is designed to be used with steel sheet within a thickness range of five to fifty-thousandths

(Continued on page 46.)

Omni-Directional Radio Range

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

A recent development in radial track systems for aerial navigation is the v-h-f Omni-Directional Radio Range. This system gives indications all around the compass, and is in a frequency band substantially unaffected by difficulties encountered with many of the low frequency ranges.

In connection with the navigation of civil aircraft along air routes, a need has long been felt for a radio aid which would indicate to the pilot, in a direct and simple fashion, the bearing of his aircraft from some known ground point, and which would allow him to fly the aircraft along a straight track to or from such a point. Needless to say, it is an important requirement that such a radio aid should be inherently accurate and not affected by adverse weather conditions or other circumstances outside the control of the pilot.

Reasons for an Omni-directional Range

The need for an omni-directional track guide of such a kind has become more insistent in recent years, largely because of the very great increase in commercial air traffic in Europe, the U.S.A. and elsewhere. As is well-known, there have been available for many years, such radio track guides as the 2-course and 4-course radio ranges of various kind, providing a limited number of tracks as their descriptions indicate.

These track guides have been effective in the past and have rendered valuable service for many years. Radio range stations have been installed at intervals along major air routes in such a way that a continuous delineation of track is provided to aircraft flying the route. However, with increasing air traffic and the number of air services, there is a developing tendency for a large number of routes to converge at each major airport. The bearings of these routes vary, of course, through the entire 360 deg. and the 2-course or 4-course radio range is no longer adequate to provide track guidance in such circumstances.

What is needed is a system which will provide a large number of straight radial tracks emanating from any given ground point, and it is to fulfil this need that the omni-directional radio range has been developed.

It may be remarked that in addi-tional to allowing aircraft to fly a straight track to or from an airport, an omni-directional range will play an important part in the *control* of air traffic in the vicinity of the airport. Such a system which provides many radial tracks can, in conjunction with a system providing information on *distance* from the airport (such as the Distance Measuring Equipment now becoming standard in aircraft), allow the position of the aircraft within the control area to be completely defined, an essential requirement for satisfactory air traffic control.

Development of an Omni-directional Range

At about the commencement of the recent war, at least one industrial laboratory in the United States was working on the problems of an omni-directional range, and had developed the idea to the stage where experimental flights were being made. The principle underlying the range was that known as the *phase-comparison* method, which we shall describe shortly. During the war, not much progress appears to have been made in the further development of omni-directional ranges, due no doubt in part to the fact that in military aviation one is not so much concerned with air routes as with complete coverage of an area of operations, a requirement which is best met with a navigational aid providing a grid or lattice, such as *Gee*, *Loran*, and the like.

However, at the close of the war, and with the problems of air traffic density becoming increasingly pressing, particularly in the United States, the Civil Aeronautics Authority (C.A.A.) in that country, a body which supervises, amongst other matters, the safe operation of civil air traffic, intensified a development programme for the omni-directional range, the phase-comparison principles still being used. At about this time also, development of an omni-directional range along similar lines was commenced in England at the Royal Aircraft Establishment.

At the 1946 meeting of the International Civil Aviation Organization (I.C.A.O.) in Canada and the United States, three systems of short-range (i.e., 100 miles approximately) track guidance were under consideration, namely, the British *Gee* system, the Australian Mul-

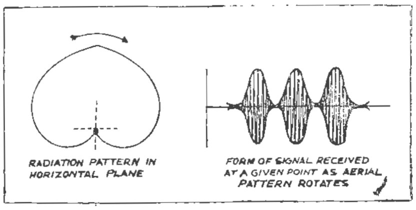


Fig. 2.—Illustrating a horizontal radiation pattern of cardioid form and the nature of the signal received at a given point as the aerial pattern is rotated.

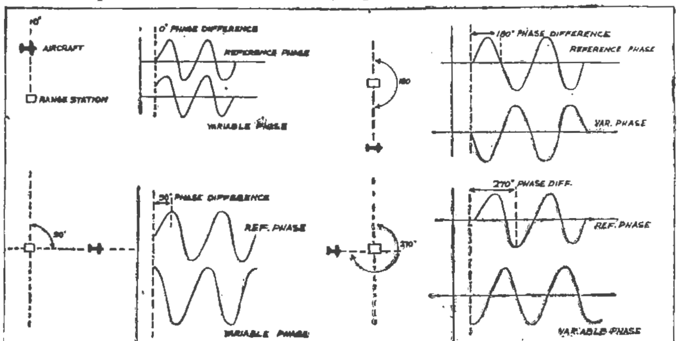


Fig. 1.—Illustrating the manner in which the phase difference between the "reference" and "variable" modulations changes with the bearing of the aircraft from the station.

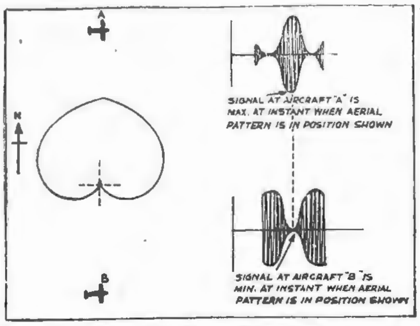
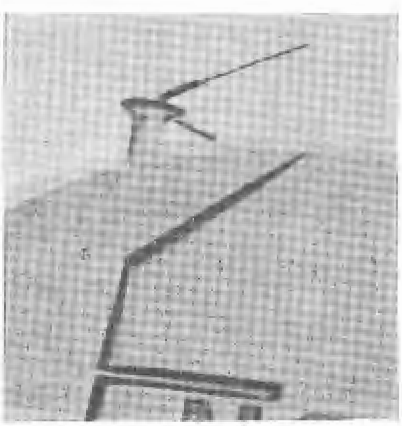


Fig. 3.—This diagram illustrates that the phase of the modulation due to arotating aerial pattern of cardioid form is dependent on the bearing of the receiver from the aerial.

tiple Track Radar Range (M.T.R.) and the C.A.A. Omni-directional (*Omni*) range. The last-named system was selected for standardisation as the international short-range track guidance system, but further development of track-guide aids was recommended, no one system at that time being considered entirely satisfactory.

Since the end of the war, development has been actively carried on in the United States by the C.A.A. and the stage has now been reached where experimental flights on a large scale have been made and a wide network of ranges has been installed. The ranges have not so far been used operationally by air lines. Development in Great Britain has been on a lesser scale, but experimental flights have been carried out there also.

It is proposed to operate the omni-directional ranges in the VHF band (about 112-118 mc.) so that the coverage to be expected is approximately *line-of-sight,* that is to say, about 130 miles at a height of 10,000 feet, since waves in this frequency band behave in a manner approximating optical waves. A high degree of immunity to interference from electrical noise is obtained by using this band.



CAA Omni-range coaxial V plane antenna.

The "Phase-Comparison" Principle

The principle of *phase-comparison* is that which has been generally adopted as a basis for an omni-directional range. Briefly, the method is as follows: Two independent aerials are provided at the range station. One aerial radiates *omni-directionally* a carrier modulated at a low audio frequency. This is known as the reference signal. The second aerial radiates a signal having the same modulation frequency, but the phase of the modulation *varies in accordance with the bearing of the receiver from the station,* this phase being measured with respect to that of the reference signal.

The principle will be more easily

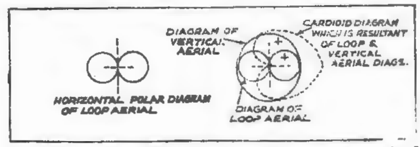


Fig. 4.—A combination of loop and vertical aerial polar diagram results in the cardioid diagram.

understood by reference to Fig. 1. It will be seen that an aircraft on a given bearing from the station will observe a difference in phase between the two modulations, and this difference measured in electrical degrees (i.e., one cycle equals 360 deg.) is the bearing of the aircraft from the station. Hence the basic equipment required in the aircraft is merely a receiver or a phase-difference meter, the output of the latter

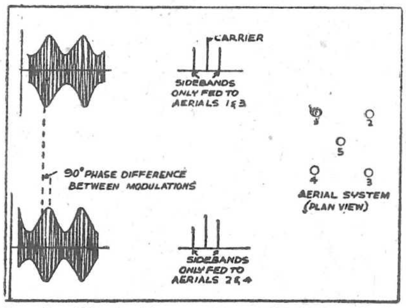


Fig. 5.—Illustrating nature of sideband signals fed to the four outer aerials of the radiating system.

giving the bearing of the aircraft to the pilot.

If it is desired to fly a straight radial track to or from the station, it is merely necessary to fly so that the bearing remains constant. Since any bearing may be selected on which to fly, it is clear that the system constitutes a truly omni-directional track guide. A noteworthy advantage of the system is that a single site is required for the station, as against two or more spaced sites for the so-called *hyperbolic* navigational aids; this is of importance from the aspects of installation, operation and maintenance.

Methods of Producing the Desired Radiation

We shall now consider how signals carrying the desired modulations (i.e., fixed and variable) may be obtained. Clearly, the reference modulation can be radiated from a single aerial in the usual way as a modulated C.W. carrier. The variable-phase modulation requires a more complex arrangement.

To understand the necessary radiation pattern, reference should be made to Fig. 2, which represents the polar diagram of an aerial in the horizontal plane. The particular diagram shown is known as a cardioid. The length of the radius vector from the centre to any point on the figure indicates the relative intensity of signal radiated in that direction.

Now, imagine the polar diagrams rotated about its centre at a definite rate, and consider the effect on a receiver at a distant point. It is clear that for every revolution of the aerial pattern the signal intensity at the receiver will pass through an entire cycle, e.g., from a minimum to a maximum and back again. As the aerial rotates, therefore, the effect at the receiver will be that of a modulated carrier (see Fig. 2).

Furthermore, and this is important, it will be seen that *at any particular instant* the phase of the signal will depend on the bearing of the receiver from the cardioid aerial. For example, suppose that at a given instant the cardioid maximum is directed due north. A receiver north of the station will be receiving minimum signal. Reference to Fig. 3 shows that the modulations at the two points are then 180 deg. out of phase.

Hence, a rotating cardioid aerial pattern meets our requirements for the variable-phase signal, namely that the phase of its modulation relative to a reference phase is proportional to the bearing of the receiver from the station. The manner in which the rotating cardioid is produced, as well as the reference signal, will now be considered.

Means of Producing a Rotating Cardioid Aerial Pattern

It will be advantageous first to consider how a stationary aerial diagram of cardioid form may be produced, and later to investigate methods for rotating it.

It is well-known that a loop aerial can be used for radio direction finding, the usual application being to rotate the loop about a vertical axis of symmetry until the received signal, of which it is required to determine the direction of the source, is at a minimum or zero value. The polar diagram of such a loop aerial in the horizontal plane is of the familiar *figure-eight* form, shown in Fig 4. It is clear from an examination of this diagram that there are two orientations of the loop, 180 deg. apart, for which a minimum signal is received.

In radio direction finding this characteristic of the loop aerial introduces an ambiguity in determination of the bearing of the distant transmitter, and there is a long-established technique for resolving this ambiguity. The procedure is to determine with the loop the bearing of the transmitter or its reciprocal, and then to add to the loop voltage (by connecting in series with it) the output of a simple omni-directional vertical aerial.

Reference to Fig. 4 shows that the addition of loop and vertical aerial voltages, taking due account of the sign of the voltages, results in a polar diagram for the combination having only one minimum, a diagram which is in fact, the cardioid which we are interested in producing. (In direction finding, the fact that the cardioid diagram has only a single minimum, allows the ambiguity in bearing to be resolved.)

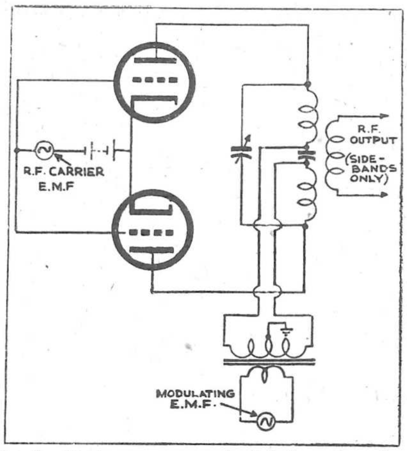


Fig. 6.—Basic arrangement of balanced modulator.

We have, therefore, in the combination of loop and vertical aerial, a means of producing the required cardioid diagram. An alternative to the loop aerial is to use a horizontal dipole, since such an aerial also has a *figure-eight* radiation diagram in the vertical plane; the difference then is in the polarisation of the aerial, which is horizontal instead of vertical. (Polarisation will be considered further at a later stage in this article.) Or again, in place of a horizontal dipole, a pair of laterally-spaced horizontal loops may be used, since this has the desired omni-directional radiation pattern in the horizontal plane. For such a loop the polarisation is horizontal.

We must now consider possible means of rotating the cardioid aerial pattern. It is clear that it will be sufficient to cause the *figure-eight* component of the diagram to rotate, since if this is done, the pattern as a whole will rotate.

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Fig. 7. — Simplified block schematic circuit of omni-directional range transmitter, using fixed aerials and balanced modulators. (Monitoring arrangements not shown).

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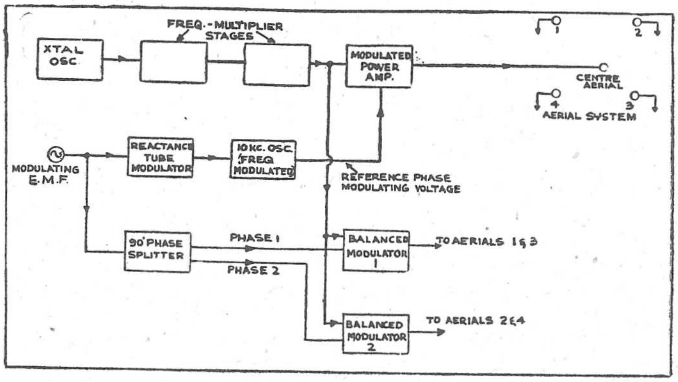

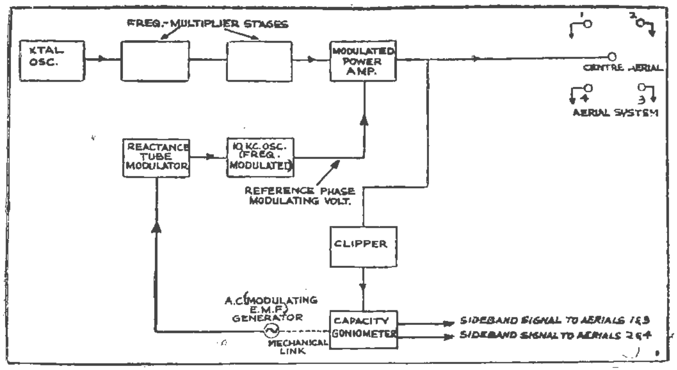

Fig. 8. — Simplified block schematic circuit of omni-directional range transmitter using fixed aerials and capacity-goniometer.

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A straightforward method of approaching the problem would appear to be to set up a *figure-eight* aerial of one of the types just described, to apply a C.W. carrier to it, and to rotate it about a vertical axis by means of a motor at a speed corresponding to the modulation frequency it is desired to produce at the receiver. At the same time, the C.W. carrier would be fed to an omni-directional aerial which is stationary and mounted co-axially with the rotating aerial.

This direct method of producing a rotating cardioid pattern has been the subject of considerable development work, which now appears to have reached a successful outcome. There have, however, been a number of problems to overcome in the development, not the least of which has been that of satisfactorily constructing a pair of horizontal loop aerials (this is the form of aerial finally fixed upon) in such a way as to resist the mechanical stresses imposed when the aerial is rapidly rotated. Since a modulation frequency of 60 cycles per second is a typical figure, corresponding to a rotational speed for the aerial of 3600 revolutions per minute, it can be seen that the forces involved will be considerable.

Fixed Aerial System

Difficulties in the construction of a satisfactory rotating *figure-eight* aerial have led to much development work being done on other aerial systems which will produce the same result. An ingenious technique has been devised by which it is possible to produce a rotating *figure-eight* diagram from a fixed aerial system, thus circumventing the mechanical difficulties of the rotating aerial.

The technique involves the use of four fixed aerials located at the corners of a square, the dimensions of the latter being of the order of one wavelength at the frequency used. At the centre of the square is located a fifth aerial. Each individual aerial has an omni-directional horizontal radiation pattern, and takes the form of a horizontal loop.

To the centre aerial is fed a C.W. carrier and to each diagonal pair of aerials is fed a signal *comprising the sidebands only* of a modulated carrier, the modulation frequency being that which it is desired to produce at the receiver. The sideband signals fed to the two diagonal pair of aerials differ in that the phases of the corresponding modulations differ by 90 deg. Reference to Fig. 5 will assist in making clearer the nature of the signals fed to the outer aerials.

It is difficult to give a clear physical picture of the effect of the sideband signals radiated from the four outer aerials. However, by analysing mathematically the resultant field at a distant point due to the aerials, it is found that the effect is precisely the same as would be produced by the actual mechanical rotation of a *figure-eight* aerial. In other words, due to the arrangement of the four aerials the nature of the signals fed to them a *rotating field* is produced, having a *figure-eight* form. This field combines with the omni-directional radiation from the centre aerial to produce a rotating cardioid in the same way as previously discussed.

To date, two methods have been used to produce the sideband signals which are fed to the four outer aerials. The first method is to use the well-known principle of the balanced modulator, of which a basic circuit is shown in Fig. 6. A voltage at the carrier frequency is applied in parallel to the grids of two similar amplifiers, while the anodes are fed in push-pull from the modulating source. With this arrangement the carrier is balanced out in the output, but the sidebands appear at their normal amplitude.

Two balanced-modulation pairs are required, one to feed each pair of diagonally-opposed aerials.

Capacity Goniometer

This method of producing the necessary sidebands has the advantage of being purely electronic, but there are serious difficulties in maintaining the proper relationship between the amplitude and phases of the signals in the four aerials and also of these signals with respect to that of the centre aerial. Accordingly, an alternative method has been developed, in which the sidebands are produced electro-mechanically by a device known as a *capacity goniometer*.

This consists of two rotating semi-cylindrical plates and two pairs of stator plates. The latter plates are specially shaped, and the rotor can move within them. When an unmodulated R.F. voltage is applied to the rotor plates, voltages appear (due to capacitive coupling) on the two pairs of stator plates, the relative amplitudes of these voltages being dependent on the orientation of the rotor. If the rotor is now driven around at an angular speed corresponding to the desired modulation frequency, the voltage on the two pairs of stators vary in amplitude, and each has precisely the form of a sideband signal of the kind required. Each sideband signal is then fed to the corresponding pair of aerials.

So far, we have dealt with several methods of producing the rotating cardioid diagram necessary to provide the variable-phase signal. It will be recalled, however, that it is also necessary to radiate a signal omni-directionally of which the modulation provides a reference phase not dependent on bearing from the station. Use is made of the centre aerial of the fixed-aerial system to radiate this reference phase, and in the case of the system with a mechanically-rotated *figure-eight* aerial, use is made of the fixed aerial to radiate the reference phase.

Reference Phase Modulation

The reference-phase modulation is carried out in the following way: The audio-frequency modulating signal (which in the case of the spinning *figure-eight* aerial and *capacity-goniometer* system is derived from an A.C. generator coupled to the shaft of the spinning aerial or goniometer, and in the balanced- modu-

(Continued on page 46.)

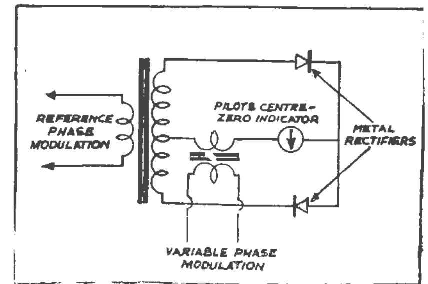

Fig. 9.—Simplified circuit of phase discriminator.

MODERN

Atom Smashers

By B. Y. MILLS, B.Sc., B.E.

In this second article, the author completes the discussion of modern atom smashing equipment by describing the operating principles of the Linear Accelerator, Microtron and the Betatron.

In the accelerators described so far, high energies have been obtained by successive accelerations, while the ions have been constrained to move in circular orbits by means of a magnetic field. Historically, however, this method was preceded by that of linear acceleration, or acceleration along a straight line. The principle is illustrated in Fig. 8, which is a diagram of the earliest form of this accelerator, called the Sloan-Lawrence accelerator, after its inventors (Lawrence was later to invent the cyclotron).

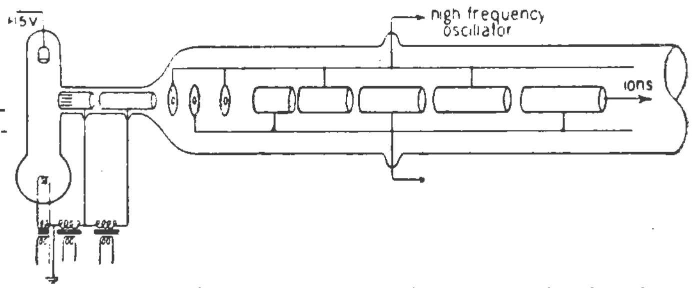

Fig. 8.—The Sloan-Lawrence Linear accelerator tube.

Mode of Operation

Positive ions, in this case of mercury, are produced by the low-pressure discharge on the left and directed by the two elements of an electron gun along the axis to the right. The accelerator proper consists of a series of tubes of increasing length, called drift tubes, between which a high intensity R.F. electric field is maintained.

The ions are accelerated by the field, and the lengths of the tubes are so arranged that the ions take a time equal to a half-period of the RF oscillation to traverse them, resulting in the field always being in the correct direction to accelerate them when they are crossing the gaps. As the ions speed up the drift tubes must be made longer.

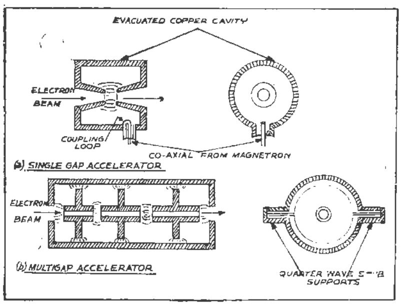

Fig. 9.—Linear Accelerators using resonant cavities for micro-wave operation. In the case of the multi-gap accelerator (b), the adjacent cavities are coupled together by the electric field at the edges of the baffles. The baffles are effectively insulated from the body of the cavity by quarter wave stub support.

Heavy mercury ions had to be used in the original accelerator because the frequencies required for the light fast ions most useful for atom-smashing could not be produced at that time. In fact, it is only since the revolutionary development of high power micro-wave oscillators during the war that such a method has shown promise for the acceleration of protons and electrons to very high energies.

Some of the earliest post-war work along this line was carried out in Australia by the Radiophysics Laboratory, C.S.I.R. There, by using a resonant cavity of the type shown in Fig 9a, fed by a 25 cm., 500 K.W. magnetron, electrons with an energy in excess of one million volts have been produced across a single accelerating gap. Some success has also been achieved by connecting several cavities in series as shown in Fig. 9b.

Multi-gap Connection

In this, the adjacent cavities are coupled together by a low impedance capacity coupling in the form of a gap around the rim of the separating plates. Power is fed into the cavity at one end of the chain and the coupling is made very tight, with the result that the cavities all have the same peak voltage and a phase difference of 180 degrees between successive gaps as in the Sloan-Lawrence accelerator.

Here the length of successive drift tubes does not increase so rapidly, however, as the relativity effects restrict the increase in electron velocity. Experimental work has not been carried further than the four gap accelerator shown in the diagram.

When the very high energies required for modern nuclear research must be produced, the engineering problems of this technique become too formidable.

Proposed Accelerator

In Fig. 10 is shown the essentials of a 40 M.E.V. proton accelerator under construction at the University of California. It consists of a 40ft. long cylindrical steel vacuum tank with a lining of copper to conduct the high frequency currents. Copper drift tubes are suspended in the centre of the tank and R.F. power is supplied by 30 radar transmitters operating at a frequency of 200 megacycles and arranged along the length of the tank.

The radar transmitters are controlled by a master oscillator which determines their phases. Again, a change of phase of 180 degrees per gap is employed. Because the phases are controlled externally there is no danger of exciting unwanted modes in the accelerator and all the baffles between adjacent cavities may be removed.

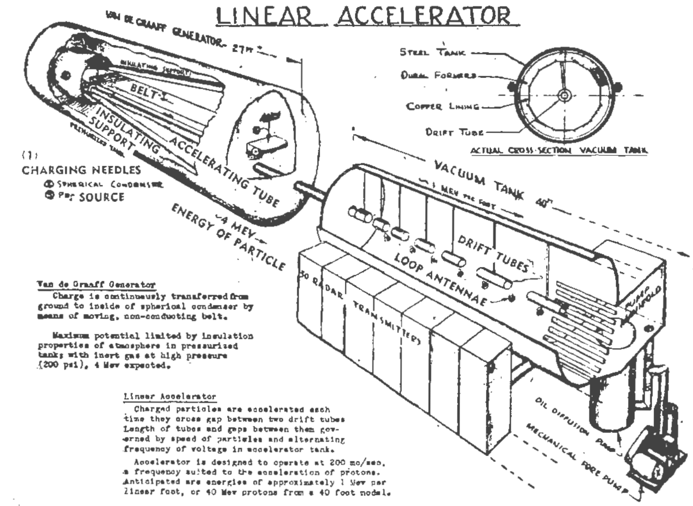

Fig. 10.—This diagram shows the main features of the Linear accelerator.

This does not affect the principal resonant frequency of the systems, as the currents on either sides of a baffle are 180 degrees out of phase and therefore cancel.

Protons are injected with an initial energy 4 M.E.V. produced by a Van de Graaf electro-static generator.

One great advantage of an accelerator of this type is that once it is working satisfactorily, it is a comparatively simple matter to increase the output energy by adding further sections similar to the first. To produce an energy of 1,000 M.E.V., such a machine would have to be approximately 1,000ft. long.

Travelling Wave Type

Another type of linear accelerator which, however, can only be used for electrons is the travelling wave accelerator. It also has resulted from war-time advances in micro-wave techniques. Like the electron synchrotron, it depends on the velocity of electrons remaining practically constant and nearly equal to the velocity of light when accelerated beyond a few M.E.V. The principle is illustrated in Fig. 11.

A high-power magnetron feeds a wave-guide, down which a wave with the field configuration shown (the TM01 wave) is propagated. The wave velocity is maintained at slightly less than the velocity of light by *loading* the wave-guide with corrugations. The wave has a strong electric field in the direction of motion, and therefore electrons injected at high energy in the same direction and travelling at the same velocity as the wave remain in the longitudinal accelerating field, and have their energy continually increased. Work on this type of accelerator is proceeding principally in England and it is hoped eventually to obtain an energy in the region of 1,000 M.E.V.

The Microtron

Still another accelerator made possible by the high power micro-wave oscillators

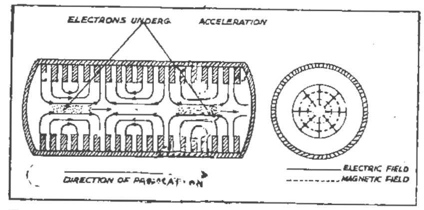

Fig. 11.—The Travelling wave accelerator. A TMo1 wave is propogated down a "loaded" waveguide and travels at the same velocity as the electrons it is accelerating.

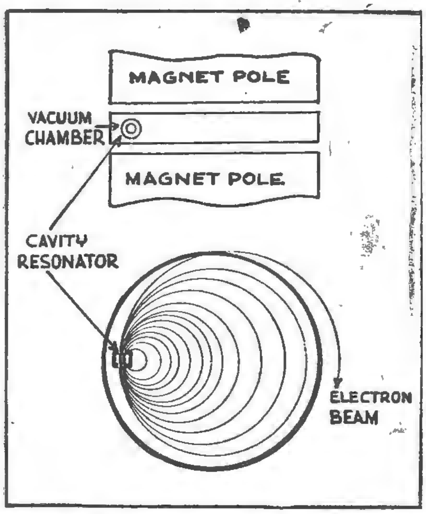

Fig. 12.—The basic details of the Microtron.

developed during the war is the microtron. It employs a fixed magnetic field and a single cavity resonator, as shown in Fig. 12. The cavity is fed by a 10cm. magnetron, which produces an R.F. voltage of about 500 K.V.—1 M.E.V. across the accelerating gap. Electrons accelerated across the gap travel in a circle in the magnetic field and return to the gap in time to be accelerated again, the successive orbits having the form shown in the diagram.

The principle on which it depends was, like the synchrotron, also discovered by the Soviet physicist, Veksler, and while apparently similar to that of the cyclotron, actually has a considerable difference. Owing to the mass of electrons increasing as they increase in energy, each successive circle in the magnetic field takes longer than the last, but the accelerating voltage is chosen so that the increased time is equal to the period of the R.F. oscillation. The electrons, therefore, always arrive at the same phase in the R.F. voltage, and are continually accelerated. While no very high energy machines of this type are reported under construction, an energy in excess of 1,000 M.E.V. is theoretically possible.

The Betatron

The final high energy accelerator of interest is the betatron, an electron accelerator capable of producing energies up to about 200 M.E.V. Although many early attempts had been made, it was not until 1940 that the first successful machine was constructed. By now large numbers of betatrons with energies ranging from 2 to 100 M.E.V. are in operation throughout the world.

Until the advent of the synchrotron, it was the only method available for accelerating electrons to high energies. Nowadays it can be considered as superseded, but as a large number have been already constructed, and as the betatron principle is commonly used for the initial acceleration in the synchrotron, it is still of considerable interest.

Although quite different in principle, it is similar in appearance to the synchrotron. The essential components are shown in Fig. 13. The electrons are constrained to move in circular orbits within a vacuum doughnut by the guiding magnetic field at the edges of central magnet poles. In this case, however, there are no accelerating electrodes, but the magnetic field is increased very rapidly, producing a circumferential electric field by electro-magnetic induction. It is this circumferential field which accelerates the electrons. The principle is the same as that which causes a voltage to be inducd in a transformer coil when there is changing flux in the core.

It can be shown that the electron orbit will be at a radius where the magnetic field is exactly half the average value of the magnetic field enclosed by the orbit. Therefore, unlike the synchrotron, a large central magnetic field is required. The orbit radius is quite independent of electron mass, so that there is no limitation in energy due to relativity effects.

Low Energy Input

Electrons are injected at a low energy by a small electron gun mounted close to the orbit, and after acceleration the orbit radius is changed, usually by means of additional coils, so that the electron beam strikes a target suspended within the doughnut, giving rise to high energy X-rays. Like the synchrotron, the varying magnetic field is produced by applying a low frequency alternating voltage across a resonant system comprising the magnet coils in series with a bank of condensers.

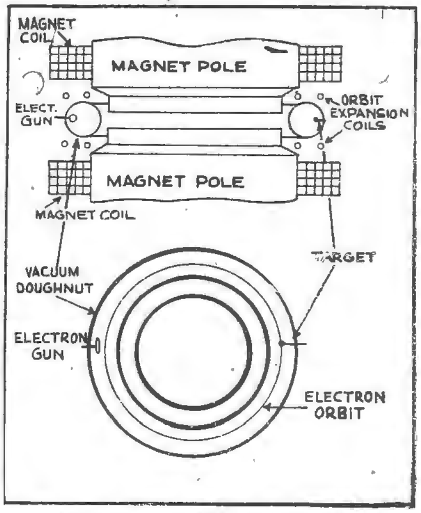

Fig. 13.—The essential components of a Betatron.

It is apparent that there is a great deal of similarity between the betatron and the synchrotron, and, in fact, in all synchrotrons there is some betatron effect, due to the magnetic field enclosed by the electron orbit. The betatron, however, requiring a much larger magnet, and therefore also a much larger condenser bank, turns out to be considerably more expensive to make in all but the smallest sizes. Also, the maximum energy attainable in a betatron is limited to about 200 M.E.V. by electron radiation, a factor which is not of importance in the synchrotron.

To give an idea of the size of a large betatron, a photograph of a 100 M.E.V. machine is given in Fig. 14. This is the largest machine which has been constructed, the magnet weighing some 130 tons. Compare it with the 70 M.E.V. synchrotron shown in Fig. 6 of last month's article.

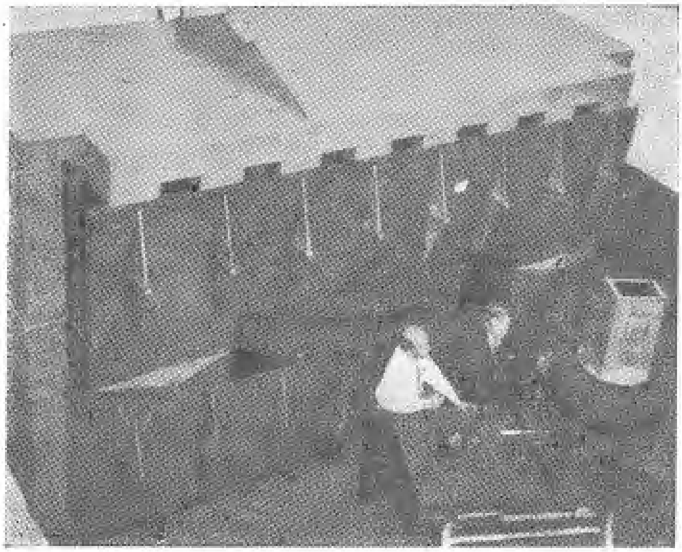

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Fig. 14.—A close-up view of the 100 MEV Betatron.

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A Technical Survey of Latest Overseas Developments

NEW LONG PLAYING RECORDS

The new recording system recently developed by Columbia, enables an ordinary six-record album to be recorded on a single disc.

The new recording system achieves a six-fold increase in recording time per disc by combining 33 1/3 r.p.m. transcription-standard turntable speed with an extremely fine pitch of approximately 260 grooves per inch. The decrease of 78 r.p.m. introduces a time factor of 2.35, while the larger number of grooves, compared with 85 to 100 per inch, typical of conventional home records, provides an additional factor of 2.6 times.

The net result is that as much as 50 minutes of recording time can be accommodated on the two sides of a 12 inch disc, compared with 8 minutes on the older type. These new records are known as LP—for long playing.

Vinylite Discs

The success of the new system is due mainly to the use of Vinylite plastic for the pressings, the development of a new, efficient, lightweight reproducing arm and cartridge and mechanical refinements in the turntable driving mechanism. A special pre-emphasis characteristic was introduced to achieve high signal-to-noise performance, as well as other unconventional techniques—mainly in the degree of overcutting.

Fig. 1.—Peter C. Goldmark of CBS microscopically examines one of the long playing discs.

The grooves are about 0.003 inch in width—that is roughly one-third the size of a standard record groove, and consequently it is not possible to record at as high a level if the cut were held proportional to the groove width. Although the recorded level is about 4 db below the usual reference, the use a lightweight pickup in conjunction with the low noise properties of the Vinylite enables a highly acceptable noise level to be achieved.

The groove shape has an included angle of about 90 degrees, and the tip radius is under 0.0002 inch. Accordingly, it is not possible to reproduce the new pressings with a standard 0.003 inch stylus. The special stylus developed for the system, employs a semi-permanent metal stylus lapped to a tip of 0.001 inch radius, and has a groove pressure of only one-fifth of an ounce. To keep distortion at a low level, the diameter of the innermost groove has a minimum value of 5¾ inches, which is almost two inches greater than that of conventional commercial domestic 78 r.p.m. pressings.

Pre-emphasis Necessary

The practice of pre-emphasis has been standardised in the new records, using the characteristic shown in fig. 1. Above 200 cps, the curve is identical with the standard NAB transcription characteristic, reaching 16 db pre-emphasis at 10,000 cps., relative to 900 cps. value. Below 200 cps. the characteristic is higher than the NAB being about 7 db

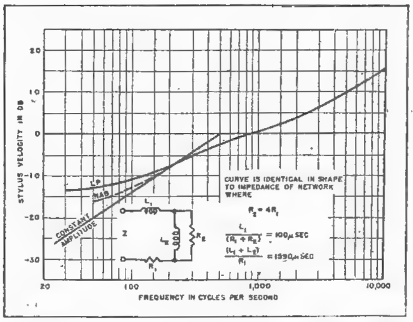


Fig. 2.—This graph shows the relative characteristics of the Long Playing, NAB transcription and Constant Amplitude records.

above constant amplitude at 50 cps. The similarity of these two curves makes it possible to use the LP recordings on standard broadcasting transcription tables with no change in equalising.

The early release of these new records consists of re-recordings from masters in the Columbia files. More than usual care is taken to exclude dust and any other foreign matter at every stage of manufacture, in view of the difficulty in securing freedom from blemishes for a 25 minute period (one side) as compared with the usual 4 minutes for the ordinary record.

The results to date, as judged by technical and non-technical listeners are excellent. In frequency range, dynamic range, and distortion, the LP records out-distance shellac pressings and with the possible exception of noise surpass 78 r.p.m. Vinylite pressings.

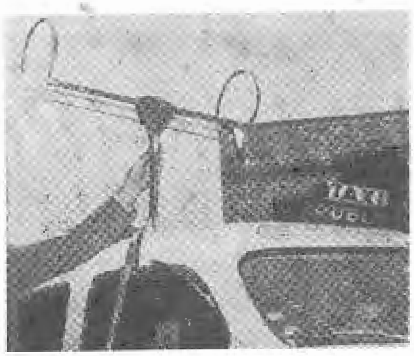
—*Courtesy Electronics.*

TELEVISION IN TAXIS

Taxi television may become as commonplace as radio, if experiments now being carried out in Chicago are successful. Field tests were recently performed with a receiver specially converted for taxi installation.

Results indicated that (1) on low frequency channels a satisfactory signal is received in most parts of Chicago and at distances up to 30 miles away; (2) higher channel signals seem to have more standing waves and ghosts. Standing waves are greatest near a large metallic object such as a bridge, although the signal may be perfectly stable under a bridge. In flat, open country signals are quite stable; (3) slight ghosts appeared in a few flat, open country areas where there were no overhead wires or other objects to cause reflections (!). The reason for this effect is not known yet; (4) The video and audio signals seem to have different standing wave patterns.

It was also found that in any given locality the dipole antenna should be roughly normal to the station direction to minimize standing wave, ghosts, and other interference effects. In this test a modified all-band antenna, with its ends cut off and a revised cut-down centre section was found to operate fairly well on both high and low channels.



A view of the special aerial fitted on the roof of the taxi.

No special shielding had to be added to the receiver circuits, but the use of ignition suppressors and additional generator filters were found to be desirable.

In operation, it was found important to maintain adequate heater voltage in order to stabilize synchronisation, and it is also important to have low set and low car noise during minimum signal in the standing wave pattern. The converted receiver requires 70 watts of power.

Courtesy "Tele-Tech."

The transmitter will produce an effective radiated power up to 25 kw., and with this power engineers will be able to carry out field strength surveys of a 500 mc. broadcast service under all conditions and over all kinds of terrain. Should the experiments prove these frequencies are practicable for television, it is intended to provide a simple adapter for present television sets to enable them to receive programmes broadcast on the higher frequencies.

Moon Affects Radio Transmission

Although it is well-known that radio propagation is affected by various solar disturbances, it is only recently that the moon has been found to affect transmissions. According to a National Bureau of Standards report, the moon affects radio transmission at certain times in various parts of the world. For example, at Huancayo, Peru, where the effect is very pronounced, maximum usable short wave frequencies averaged 1.7 mc. lower three or four days after the new moon than was the case after the first or last quarter.

One explanation advanced for this phenomena is that the moon produces tides in the atmosphere and in the ionosphere, somewhat analogous to the manner in which it raises tides in the ocean. However, as this data is still deemed inconclusive by itself, further investigations are still being carried out.

New "G" Ionospheric Layer

For many years the ionosphere has been considered to consist of several radio reflecting layers, commonly referred to as E1, E2, F1 and F2, this latter layer being the highest with an elevation of some 175 miles and an indicated temperature of 1000 deg. C.

Now, according to recent evidence based on radar-reflection measurements, it appears that a "G" layer exists above the F2 layer at about 250 miles. The temperature in this region is considered to be even far in excess of 1000 deg. C. One theory ascribes the production of this "G" layer to the sun's ultra-violet rays stripping electrons off nitrogen atoms and so electrifying them. The G layer thus establishes itself as another radio sieve passing extremely short waves but turning back relatively longer waves—as do the lower layers, each with its own critical frequency.

UHF Experimental TV Station

A new experimental station being erected in Washington by RCA, will be used to explore radio frequencies above 500 mc. as a medium for the expansion of commercial T-V services. It is intended to transmit on 510 mc. and be used in conjunction with station WNBW on 67 mc. The simultaneous operation of the two stations will enable engineers for the first time to compare the service possibilities of UHF frequencies with those of the present lower-band commercial frequencies.

New H-F Valve

American scientists have produced a new magnetron valve which radiates as much energy as the largest American standard broadcast station at the extreme high frequency of 1,000,000,000 cycles per second. With a power output of 50,000 watts, this is the highest power yet produced at the billion cycle frequency.

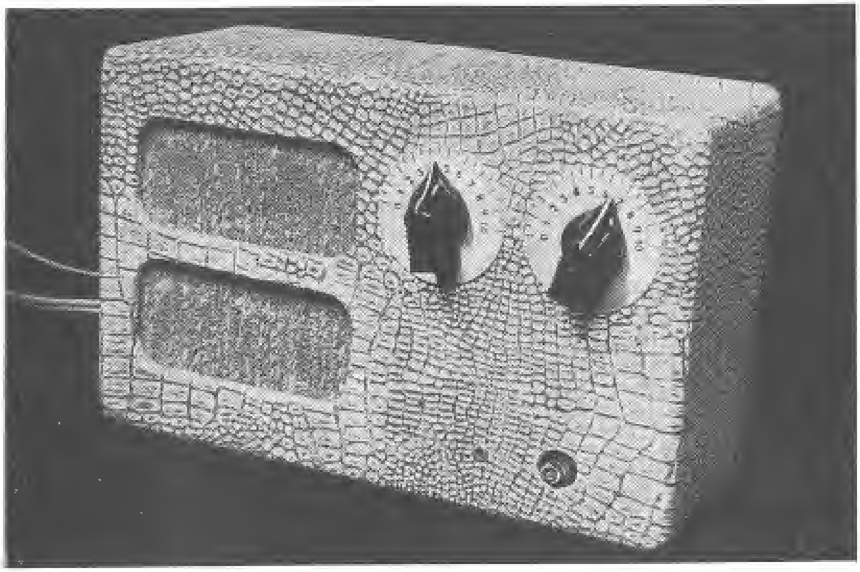
The magnetron is water-cooled, and unlike most conventional vacuum tubes, an unheated cathode is used. This is made to emit electrons by high speed bombardment, each speeding electron causing three or four electrons to be emitted from the cathode.

Scientists are still experimenting to find out how much power can be produced at this high frequency and the limits apparently are not yet in sight.

Presenting the---

Miniminor 'Companion'

3 Valve Mantel Receiver



Here is the ideal "second" set for the home. Housed in an attractive leatherette cabinet and requiring only three valves, this low cost receiver will provide excellent listening on all local stations.

Nowadays, it is generally conceded that more than 90% of the radio listening time is spent on the local stations. Only a small minority ever trouble to tune in to country or interstate stations, and apparently even less worry about the short wave bands. As a result, we find there is always a steady demand for small receivers, especially if these can be built up at a reasonable cost, to provide such local listening.

Although most mantel receivers these days use the superheterodyne type of circuit, mainly from the point of view of selectivity and sensitivity, there are many who consider such an arrangement either too costly or too elaborate for their "second" set needs. What they require is a low-cost receiver that will enable them to listen to their favourite local stations and nothing more.

To cater for the needs of these readers, the mantel receiver described this month should provide the results required. This small set will be found ideal around the home, as the second set, to be taken into the bedroom or kitchen, and in fact, its compact size will enable it to be conveniently used practically anywhere there is AC power available.

Comprising three valves including the rectifier stage, this small receiver is capable of a really fine performance. Realising the limitations on reception imposed by such a simple circuit, several air tests were carried out in different localities and in each case there was no difficulty in receiving all local stations using only a few feet of wire as aerial. At night with a larger aerial, many country as well as several of the stronger interstate stations were received at good loud speaker strength.

From the circuit point of view, there is little choice in the design of a receiver of this type and it is difficult to provide any radical departure from what may be considered standard practice. The main improvements are brought about by the use of more efficient components.

In this particular receiver, the recently released Mullard ECC35 has been used in the first stage. This valve is a twin triode type having separate cathodes, making it admirably suited for use as a combined regenerative detector and audio amplifier. The gain of this valve is considerably higher than the more commonly used 6N7, 6C8G types etc., and was found to provide ample amplification for most needs.

The tuning coil is a factory wound Reinartz type, comprising the usual Aerial, Grid and Reaction windings. Although a home wound coil could have been used in this position, it will be found that the commercial unit is easier to handle and far superior from the point of view of efficiency and gain. This coil is available in several well-known brands, any of which is suitable for this circuit. In some cases, an iron core type is available, and it will be found that the increased performance of this is a possible advantage under some listening conditions. In the receiver, an air core type was used initially and this gave satisfactory results in the suburban areas.

Regenerative Detector

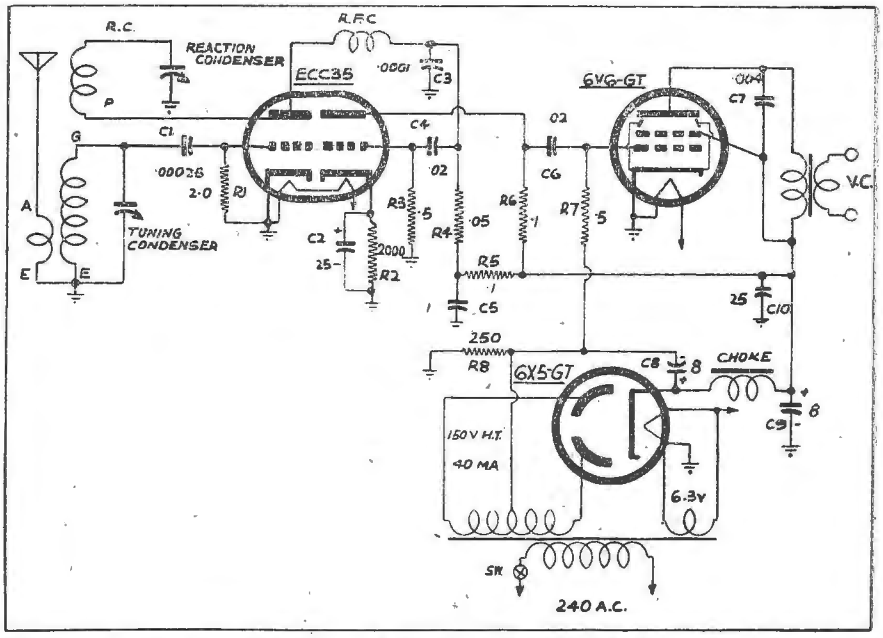
The first triode section of the ECC35 is wired up as a regenerative detector and the circuit constants specified call for little comment. For those who like experimenting, it might be mentioned that the values of C1 and R1 are not critical and can be varied over fairly wide limits. In the case of R1, values can vary from .5 to 5 meg, whilst C1 can be any value from .0001 to .0005, the actual choice of values being those which give the best results in each individual case.

The tuning condenser is the midget single gang FN type—probably the smallest condenser at present available, and in view of the limited space is admirably suited for our purpose. This condenser differs from the usual type, in that a solid dielectric is used. Whilst this construction introduces certain circuit losses when compared with the air dielectric type, this slight disadvantage is more than outweighed by its compact size.

The reaction winding of the coil is connected in the plate circuit as shown, with the regeneration being controlled by means of the reaction condenser connected between one end of the coil and earth. The amount of energy feedback is effectively controlled by varying the capacity of this condenser—the greater the capacity the greater the feedback.

It is important to ensure the connections to this winding are made correctly. If, by any chance, these connections are reversed, then regeneration will not take place and it will be impossible for the valve to operate efficiently.

The plate of the detector is also returned to the B plus line through the RF choke, and a .05 meg resistor in series with a .1 meg resistor. The RF choke is necessary to confine the RF currents in the plate circuit whilst the bypass condenser C3 is used to prevent any RF signal that may pass through the RF choke from reaching the audio output. Its inclusion also tends to provide smoother reaction control.



This circuit requires only three valves and should present little difficulty to the constructor. It is capable of excellent results on all local stations.

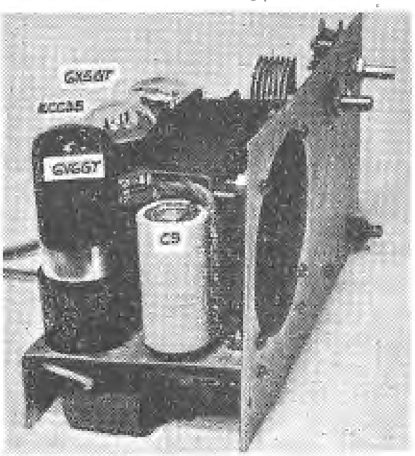
Low Detector Voltage

For efficient operation, it is essential that the detector section operates at a relatively low plate voltage (approx. 50-70 volts) and for this reason the resistors R4 and R5 are used to reduce the high tension voltage to the correct value.

The output from the detector is taken to the grid of the second triode section by means of the .02 mfd condenser. The necessary bias for this stage is supplied by the 2000 ohm cathode bias resistor.

This stage is then resistance-coupled to the 6V6GT output valve, the component values once again calling for little comment. For simplicity, the bias voltage for this valve is obtained by means of the back bias system thus enabling the cathode to be earthed. The 250 ohm resistor connected between the power transformer centre tap and earth provides the necessary bias voltage by virtue of the total receiver current flowing through it.

The power supply is conventional, comprising a 6X5-GT rectifier and a 30 ma power transformer. The transformer is a midget FN type, and should any other make be used it may be neces-



This photograph clearly shows the mounting of the second filter condenser (C9) alongside the speaker.

PARTS LIST

- 1 Chassis as detailed.
- 1 Cabinet to suit.
- 1 Tuning Condenser.
- 1 .0001 mfd variable condenser.
- 1 Reinartz Coil.
- 1 3in. speaker.
- 1 Filter choke.

Condensers

- 1 25 mfd electrolytic.
- 2 8 mfd electrolytic.
- 1 .1 mfd tubular.
- 2 .02 mfd tubular.
- 1 .004 mfd tubular.
- 20.0001 mfd mica.

Resistors

- 1 2.0 meg ½ watt.
- 2 .5 meg ½ watt
- 2 .1 meg ½ wott
- 1 .05 meg ½ watt
- 1 250 ohm 3 watt wire wound.

Valves

ECC35, 6V6-GT, 6X5-GT.

Sundries

- 1 R.F. choke, 2 tuning knobs and plates, 1 midget switch, 3 octal sockets, power cord and grommet, hookup wire, nuts and bolts.

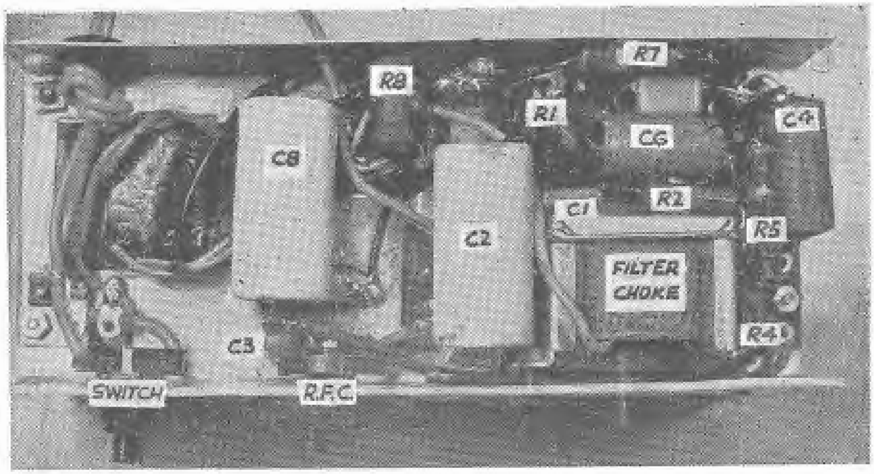
sary to amend the chassis cutout shown on the drawing.

Two 8 mfd condensers and a filter choke complete the smoothing section and this combination will be found to effectively remove any hum. It should be noted that the negative lead of the first filter condenser is connected to the power transformer centre tap and not to earth.

Chassis Layout

The general layout of the receiver can be seen from the various photographs, and a layout diagram is included for those who intend making their own chassis. The chassis is made up from two pieces of aluminium—the front plate measuring 7¾ in. long x 4 3/8 in. deep, whilst the main base is bent up from a piece 7¾ in. long x 5 3/8 in. deep. Each piece should be marked out as shown, leaving all cutting and drilling to be done after the main bends have been made. After removing any burrs, etc., the two pieces should be rivetted together, using small Eyelet type rivets.

It should be pointed out that the layout shown is based on the use of certain components, and should other brands be used it may be necessary to amend this. The main components affected are the power transformer and tuning condenser, and it is suggested where possible, the FN types specified be used. The speaker used is the 3in. Kingsley, although the 3in. Rola is also suitable. The main point here being to ensure that there is adequate clearance between the back of the speaker and the three valves mounted along the back of the chassis. Also, if this latter speaker is used, it will be necessary to slightly enlarge the speaker cutout on the front panel.



This underneath chassis shows the location of most components and should be used as a guide when wiring up. The numbered components refer to those shown in the circuit diagram.

The remainder of the components used are standard. Other than the back bias resistor, all the resistors can be of the ½ watt types, whilst the smallest types of condensers should be used. Unless this point is watched, there is the chance you may have difficulty in fitting the various components in the restricted space.

Mounting the Components

In mounting the parts, the power transformer fits on the right-hand side, being flush with the back and side edges of the chassis. Next insert the tuning and reaction condensers in their respective holes, making sure they clear the power transformer.

The speaker is bolted direct to the front plate using four nuts and bolts, whilst the filter choke is mounted immediately below, under the chassis, fitting up into the cutout provided. The three valve sockets, which incidentally are the manufacturer's type and held in place by means of the snap ring, are mounted along the back edge of the chassis. Care should be taken to orientate the socket to ensure the shortest possible leads.

The Reinartz coil fits into the space between the speaker and reaction condenser, but before bolting it into position, remove the metal can and solder a length of wire to the grid pin. This is then brought out through the top of the can to provide the grid connection to the tuning condenser.

The small ON-OFF power switch is mounted in the hole provided, with the adjacent hole being used for the indicator light, if required.

With the parts in position, the next step is the wiring in of the various components. If done in an orderly manner, this should not prove very difficult and as a guide, the underneath chassis photograph has been coded to indicate the position of the main components.

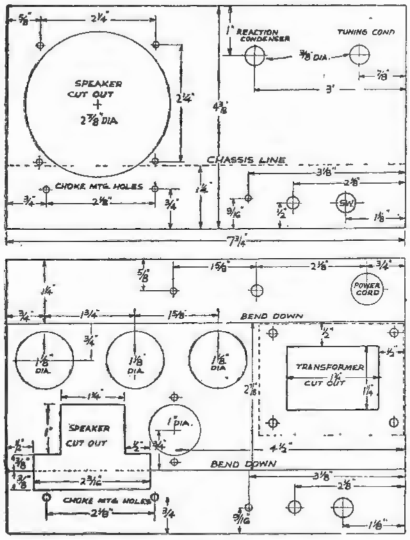
First of all wire up the rectifier socket. The leads from the power transformers are clearly marked, and it is simply a matter of soldering each lead to the correct pin on the octal socket. If you are doubtful of these, then reference should be made to the small panel giving these connections.

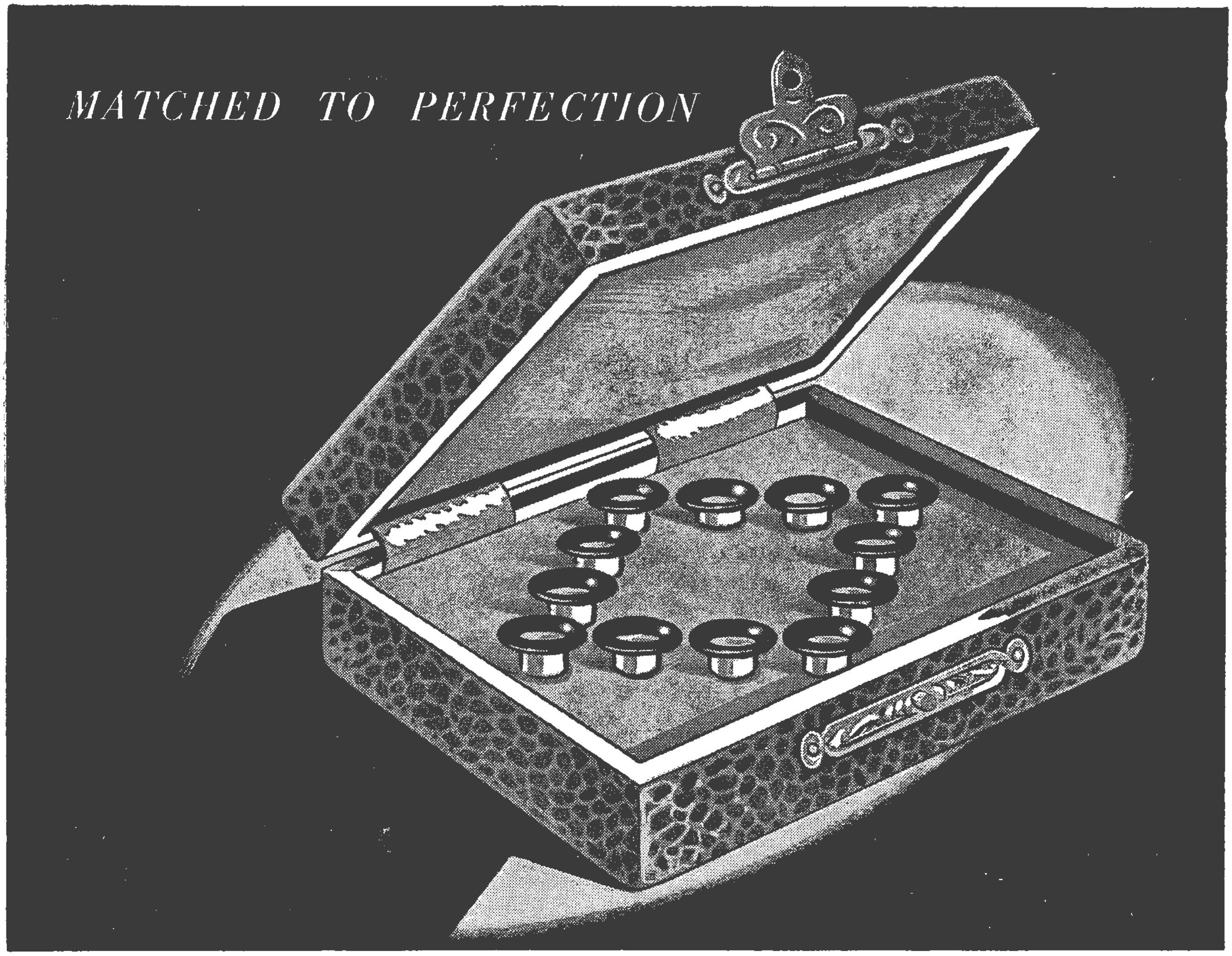
One filter condenser is mounted underneath the chassis and care should be taken to ensure the negative lead of this is connecteed to the power transformer centre tap and NOT to earth. The second filter condenser is mounted alongside the speaker, the positive lead connecting to one terminal on the speaker output transformer, and the negative lead being earthed by means of a solder lug under a bolt.

The heater should be wired in next, making sure one side of this is earthed. The connections from the ECC35 to the tuning coil should be kept short and direct, taking care to keep the plate and grid leads well apart to prevent any feedback.

A small mounting lug on the back of the chassis allows the conections for the back bias system to be conveniently made. The remainder of the details can be readily seen from the photographs and these should be used as a wiring-up guide.

Chassis Details




MATCHED TO PERFECTION

SOCKET CONNECTIONS

	ECC35	6V6-GT	6X5-GT
Pin 1	Grid 2	No Connection	No Connection
Pin 2	Plate 2	Heater	Heater
Pin 3	Cathode 2	Plate	Plate
Pin 4	Grid 1	Screen	No Connection
Pin 5	Plate 1	Grid	Plate
Pin 6	Cathode 1	No Connection	No Connection
Pin 7	Heater	Heater	Heater
Pin 8	Heater	Cathode	Cathode

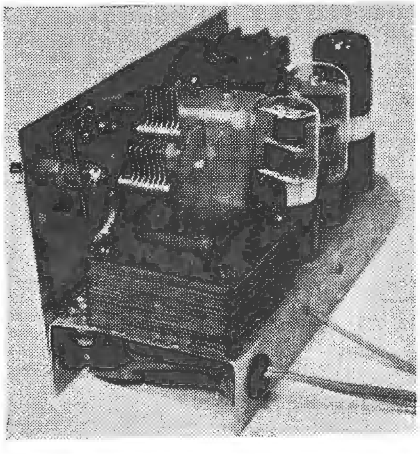
The various socket connections are given in this table. In each case the socket should be viewed from underneath with the key slot towards the user and No. 1 pin is then the one to the left of the keyway.

When connecting up the tuning condenser, make sure the moving plates are earthed by soldering a small pigtail to the small nut at the back of the condenser. This will ensure these plates are securely earthed instead of having to rely on the mounting spindle.

Switching On

After the wiring has been completed and re-checked for any errors, plug in the ECC35 and the 6V6GT and switch on. Within a few minutes the heaters should be seen alight, indicating the heater circuit is correct. Next, plug in the rectifier, watching for any short circuits, etc. If all is in order, there should be heard a slight humming in the speaker, and as the reaction condenser is rotated, the usual squeal should be heard. Tune across the band and if all connections are correct, it should be possible to hear the local stations. For best reception the reaction condensers should be backed off until the valve is just on the verge of oscillation.

The receiver has been designed to fit into the original Miniminor cabinet, supplies of which are readily available. The only modification necessary in using this cabinet is to enlarge the two control holes because of the slightly altered position of the tuning and reaction condenser spindles. This slight enlargement is effectively covered by the circular dial plates.



Another view of the receiver showing top chassis layout.

For the dial, two small circular 0-10 scales with pointer knobs were fitted, and these were glued on the cabinet in position shown. If desired, the small Efco dialplate is also suitable, except that it will be necessary to cut this in halves and mount each section separately in position, using the small screws provided.

To obtain maximum performance from a small receiver of this type, some consideration must be given to the choice of aerial length. Whilst generally speaking, a long aerial will give increased signal pickup and consequently greater output, it has a loading effect on the tuned stage, tending to broaden the response. In other words, the longer the aerial, the less selective the receiver, and so difficulty may be experienced in strong adjacent stations. This may be particularly noticeable in some suburban areas.

Because of this, it is necessary to affect a compromise on aerial length, and determine by experiment the best length for your particular locality. As a guide, about 6-10 feet should be ample for most suburban areas, whilst those living further out where selectivity is not so important, can use a longer aerial.

Under good operating conditions, we think you will be amazed at the performance of this little receiver, and we expect many enthusiastic letters regarding its performance. So make sure you write in and let us know the results you obtained with it.

SUBSCRIBERS, NOTE!

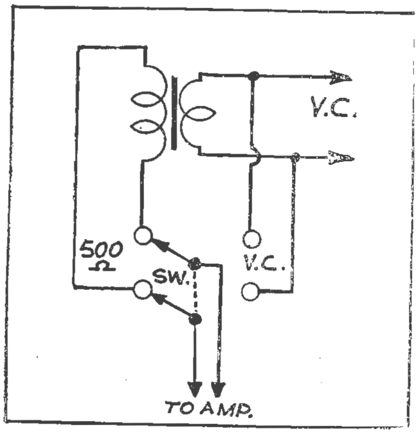
In order to regain our normal publishing date of the 1st of the month, this issue has been dated November-December. All subscriptions, therefore, have been automatically increased by one month, thus assuring all subscribers will receive the full number of copies paid for in advance.

FOR THE EXPERIMENTER

By A. H. NICHOLLS, VK2NI

Changing Speaker Output

In some public address systems it is necessary, at times, to use the speaker on 500 ohms or voice coil. A double pole double throw switch mounted on the speaker frame—or case, if it is in a cabinet—allows connections to be made directly to the speaker or through the output transformer.

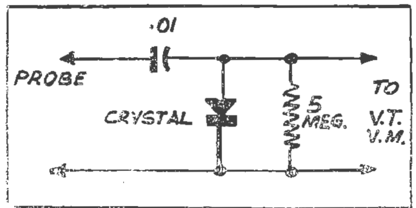


The use of a double pole-double throw switch enables the speaker connections to be changed.

Germanium Crystal Probe

Here is a worthwhile idea for using one of the miniature crystal diode units. If a V.T.V.M. is set up to read negative volts, 1.5v AC will give 1.5v DC. The unit may be housed in a pen-lite torch case for convenience.

Care should be taken to ensure that not more than 50v r-m-s is applied to the crystal, otherwise damage will result.



Circuit of the simple diode probe using a germanium crystal.

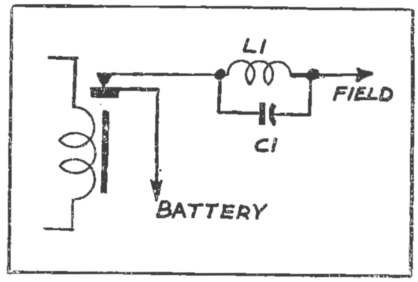
Emergency Soldering

Clip a small dynamotor brush in an alligator clip and connect to 6v. filaments, or a 6v. battery. The other lead from the supply connects to 3-4 ins. of solder. Bring the carbon on to the tip of the solder at the point to be soldered.

Regulator Filter for Mobile Equipment

With the increasing activity in mobile equipment nowadays, various annoying sources of interference becomes prevalent. Among the top-ranking types of "hash" generator is the car's dynamo regulator.

This unit switches the field circuit continuously when heavy intermittent battery drain is employed. A .5 mfd condenser frequently used for suppressing interference should not be placed across the field regulator contacts, as this will cause burning and pitting. Instead, a simple choke as shown in the sketch should be employed, and it will be found that this is satisfactory for most cases.



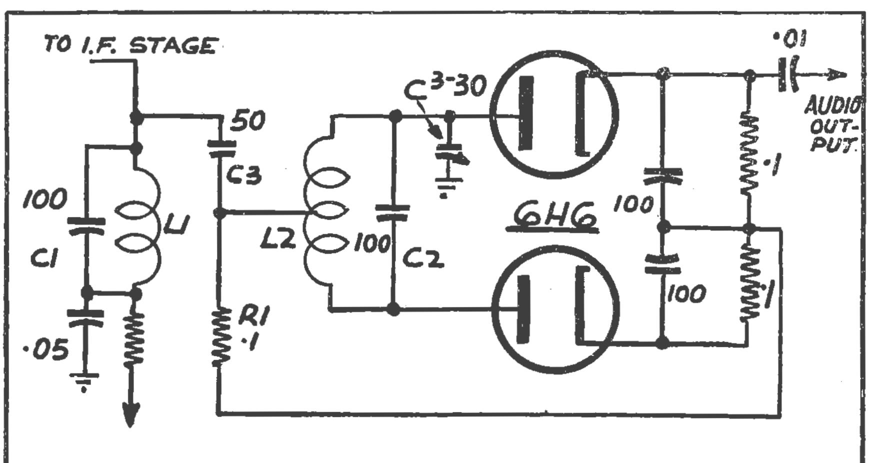
Details of the regulator filter. The coil, L1 consists of 25 turns, 22 SWG enam. wire, ⅜ inch dia., ¾ inch long. The condenser C1, is a standard 455 kc. padder.

L-F Discriminator Transformer

Many amateurs have receivers that tune to 28 mc. or even 60 mc., and these can be easily adapted for narrow-band F-M operation by the addition of a suitable discriminator transformer as shown in the accompanying circuit.

In this circuit, L1 and L2 are "pies" from any 455 kc. I-F unit. The bandwidth control—C—is a 3-30 mmfd condenser. The coils should have no magnetic coupling and should be mounted in separate cans.

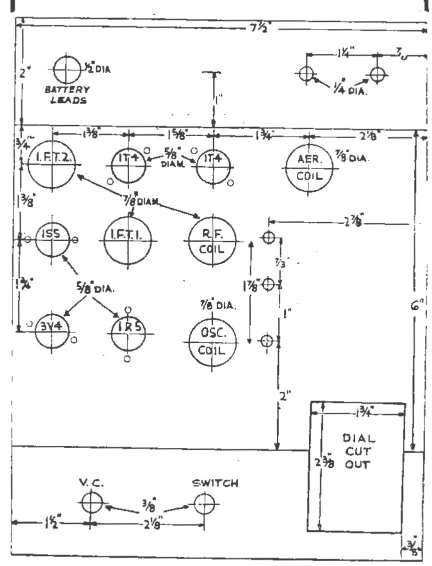
The unbalance provided by "C" causes current to flow in the secondary of the same phase as would be supplied by magnetic coupling. Thus, to change the bandwidth, merely change "C". Tune C1 for maximum A-M output and C2 for minimum A-M output. A few trial settings should give the desired bandwidth.



This diagram shows the changes necessary to add a discriminator section permitting narrow band F-M reception.

COUNTRYMAN'S FIVE . . .

As requested by many, here is the chassis layout for the five valve battery receiver described last month.



Basic Electricity and Magnetism

By A. L. THORRINGTON, A.S.T.C.

A thorough knowledge of fundamental electrical and magnetic phenomena is essential for the complete understanding of the action of many radio circuits. This is the first of a series of articles, specially written for the radio beginner, which aim at explaining electricity and magnetism in an unusual way.

Many electrical text books start at the end of the story of early electrical development. Reading them is like starting a novel at the last chapter. If they seem incoherent it is because authors of electrical literature assume that we know what has gone before; that we know the history of mathematics and physics. We know of Oersted, Ohm and Faraday; we read about Ampere, Franklin and Maxwell but we are told little or nothing about Euclid, Newton and Laplace, whose mathematical and physical theories are the basis of our magnetic and electrical concepts.

Many Deterrents

The lack of historical background is only one of the factors which deters us from seeking electrical knowledge beyond our practical requirements. There are other deterrents.

THE AUTHOR

Albert L. Thorrington holds a credit Diploma in Electrical Engineering, Sydney Technical College. Founded the Express Instrument Coy. in 1930, which was the first to manufacture electrical measuring instruments and radio testing equipment on a commercial basis in this country. Took out several patents, which were later used overseas.

During the initial stages of the War, assisted in the development of aircraft instruments.

Holds Diploma and was a member of the Wireless Institute of Australia as well as being a foundation member of the Institute of Radio Engineers.

One of them is the curious tradition which insists that the pursuit of knowledge and the pursuit of pleasure are diametrically opposed activities. The writer of a technical treatise does not feel obliged to inform and entertain at the same time; the ideal thesis is as devoid of inspiration as the telephone directory. You would probably insult the author of a text book if you told him it was inspirational and entertaining.

Another deterrent is the necessary use of mathematical expressions, and diagrams. If you are repelled by their presence in technical literature it is because you are not familiar with mathematical symbolism. Mathematics is neither mysterious nor clever. If you regard mathematicians as clever because the symbols they use seem formidable, you should likewise regard the French as clever if you have never learned their language.

Only mathematics can precisely express scientific ideas. It is therefore essential to be familiar with mathematical symbolism. As these articles develop, electrical and magnetic theories must, of necessity, include algebraical expressions, graphs, and vector diagrams. The shock of their appearance will be cushioned by an explanation of the technique used to shift from ordinary to mathematical language. The artifice is cunning and simple, and whilst you may be surprised, you will not be mystified.

Is Electricity Mysterious?

Many people regard electricity as mysterious because of its intangible nature. Were they consistent they would be equally awe-struck at the sight of boot black and battleships, since both consist of matter and any honest scientist will tell you that he has no idea as to the nature of matter.

He knows numerous laws which govern the behaviour of matter; as to what

Dr. William Gilbert, an Elizabethan physicist, who compiled the first book dealing with studies in magnetism. From his numerous experiments he discovered that many other substances in addition to amber had a similar property of attraction after being rubbed. Also, he is credited with giving electricity its name, calling the attraction "electric force" and bodies possessing this power, "electrics", after "elektron" the Greek word for amber.

precisely obeys these laws he has no knowledge. Science has no knowledge as to the exact nature of electricity, but this does not endow electricity with mysticism. Science has amassed considerable information about the effects of electricity and the conditions which promote these effects.

The Birth and Growth of Electrical Theories

A theory may be defined as: *a hypothesis which consistently correlates all known data relating to a particular phenomenon.* This definition is only partly true, mainly because the man or men who postulate a theory are influenced by the technical trends and the social developments of their period. Theories are modified because knowledge expands and social influences are continually changing. Scientific research is not always inspired by curiosity; it gets its greatest stimulus during wars, and wars are not started by anything scientific. Science reflects the state of the nation as well as its own progress.

Early electrical experimenters advanced the theory that electricity existed as an invisible fluid in all materials that could be electrically charged. The *fluid* theory adequately explained the interplay of mechanical forces apparent when charged bodies were near each other. It could also account in a less adequate way for the spectacular phenomenon of electrical discharges.

Because of the knowledge we have today, the *fluid* theory is scientifically insignificant and technically unimportant. What is important is the fact that electrical technology has inherited the terminology which the fluid theory logically and naturally inspired. This inheritance distorts the meaning of the broader and deeper concepts which have replaced the *fluid* theory and this distortion, in turn, gives rise to the difficulties you may have in understanding advanced electrical theories.

These difficulties disappear if we discard distorted meanings, and to get rid of distortion we must endow such terms as *current* and *flow*, *circuit* and *condenser* with adequate meaning and significance, and further, we must so use them that their modified meanings are apparent.

These modifications will become obvious as these articles develop. Before we discuss them it is useful to enquire as to *how* the idea of an invisible fluid, as intangible as the electrical stuff it professed to clarify, could possibly advance electrical research, and *why*, out of an infinite number of alternatives, the *fluid* concept was chosen.

It is highly improbable that men like Franklin and Faraday regarded electrical *fluid* as real. For the purpose of their concept it was immaterial as to whether the *fluid* was real or not.

The early experimenters grappled with the problem of expressing their spectacular observations in mathematical language; of stating what they saw with symbols, and numbers. If you can recall your own early difficulties of translating everyday language into algebraical formulae you will understand their problems. Bearing this in mind, consider the undefined word, *electricity*, and see if you can express it mathematically. The absurdity of the suggestion emphasises the necessity and purpose of *definitions*.

Need for Definitions

The purpose of definitions is not necessarily to describe; definitions are devices for shifting from words to symbols. You can define electricity in an infinite number of ways and any sensible definition will enable you to switch from everyday language to mathematical language as soon as you know the trick of doing it. The catch is that your definition will not be sufficiently expansive to include all mathematical statements you want to make about electricity; when this happens you discard it and get a better one.

The primary purpose of the *fluid* concept was to provide a means whereby purely qualitative and indeterminate statements about electrical phenomena could be translated into the quantitative and precise language of mathematics. This step elevated electrical research to the status of an exact science. This does not mean that any branch of science which uses numbers is an exact science; it simply means that any branch which uses them is more exact than the one which does not use them. It is more likely to advance.

When enquiring as to *why* the *fluid* theory was chosen, we should remember that all the theories are the products of the technical and social trends of the period in which they are postulated. At the time when men regarded electricity as a fluid there was intensive research into the properties of water and steam as sources of energy.

Dr. G. S. Ohm, who is accepted as the announcer of the law which now bears his name, was primarily interested in the flow of heat, and heat, at the time, was regarded as a fluid. Ohm enunciated no specific law; he simply stated his deductions about the behaviour of the electric circuit and Ohm's idea of a circuit was a single conductor connected across a galvanic cell. He never dreamed that the word, *circuit* would include the complex networks which are commonplace today.

Ohm, in his original paper, used terms and concepts associated with hydraulics and thermo-dynamics. He is not to be censured for this. He expressed his ideas in the scientific idiom of his day, and he is not to blame if we endow the terms he used with the limited meanings which originally sufficed.

The Energy Concept

In 1831, Faraday discovered that the relative movement between a magnetic field and an electrical conductor induced an e.m.f. in the latter. His discovery made possible the commercial utilisation of electricity and before long electricity began to compete with water and steam as sources of energy. As a result, it became necessary to express the phenomenon of electricity in terms of energy.

During the generation before Faraday's discovery, science directed its attention to the technological problem of getting as much work out of machines as possible. The invention of the steam engine meant that dead matter acquired potential energy or the possibility of doing work which need no longer be done by men and horses. Men were less interested in what matter was, as what it could be made to do.

The word *energy,* or capacity of doing work, became increasingly important in the vocabulary of science. Energy became the common basis of measurement between the physical sciences, chemistry and biology. When electricity became available in commercial quantities it became industrially important to put it on the same common basis of measurement as the other sciences.

The importance of being able to calculate the electrical equivalent of energy to and from other forms is easy to understand. Our prime interest in electricity is in what it will do. When we know what it does we then want to know how much of it is required to do any particular task.

Unlike other forms of energy, electricity does not exist naturally; it must be converted from mechanical, thermal or chemical forms of energy. To get the requisite amount of electrical energy for a specific task we must convert a definite amount of mechanical, thermal, or chemical energy into electrical energy. After we have established these basic energy relationships, we can easily compute the size of the engine, the quantity of coal, or the capacity of the battery needed to supply the electrical energy required.

If the desirability of regarding electricity as a form of energy is apparent to you then it will be equally obvious that electrical terms should have meanings which directly or indirectly imply the energetic character of electricity.

Use of Analogies

If we accord electrical terms with the limited and narrow meanings usually accorded them by popular expositions of electricity we will naturally have difficulty in following the arguments in the more advanced text books. The writer of a "popular" text uses *water circuits,* complete with hydraulic motors and water pumps as a means of explaining the nature of electricity, and his definitions of electrical terms seldom, if ever, imply that electricity is a form of energy. On the other hand, the writer of the more advanced text thinks and writes in terms of energy and his definitions of electrical terms signify this fact.

Michael Faraday (1791-1867). His investigations in magnetism and electricity resulted in the discovery of the principles of electromagnetic induction on which depend the operation of the electric motor and dynamo. The unit of capacitance was named the Farad in honour of this eminent English scientist.

We will obviously never understand the energy concept if we think about electricity as a fluid.

Now, the water analogy is perfectly legitimate provided that we regard the water merely as a medium for transmitting energy; if we look upon water in motion as a manifestation of kinetic energy, and water stored at a height and at rest, a manifestation of potential energy. Once we see the water analogy in this light there will be no inference with potential energy, and no electrical current with kinetic energy.

It is necessary to warn you here that the term, *potential difference* and the term, *potential energy* are NOT synonymous; neither are the terms, *current* and *kinetic energy* synonymous. Slight differences between the terms exist, but these will be apparent when we analyse them later.

The Significance of the Energy Concept

Power is defined as: *the time rate of energy displacement,* or expressed another way, *the time rate of doing work.* Clearly, if electricity is a form of energy, then electrical power must be the time rate of electrical energy displacement or transformation. When electrical energy is utilised for lighting a lamp then electrical energy is being

(Continued on page 46.)

STRATOVISION—New T-V System

Stratovision, a system for serving large ground areas by rebroadcasting from transmitters in aircraft, may prove to be much more than a highly imaginative idea. From the results of recent tests it now appears, technically, that the system is entirely practical.

The beginning of the Stratovision system of broadcasting dates from December, 1944, when a Westinghouse electronics engineer, suggested the possibility of employing an aircraft as a flying antenna for commercial television and F-M broadcasting. The idea was to receive signals from a station below and then recast them over an area many times larger than would be possible using a ground antenna.

Early experiments in conjunction with the Glenn L. Martin aircraft company were successfully carried out using a simple tone transmitting apparatus. These tests reached the stage where transmissions of actual television pictures were required, and for this purpose a modified B-29 bomber was acquired.

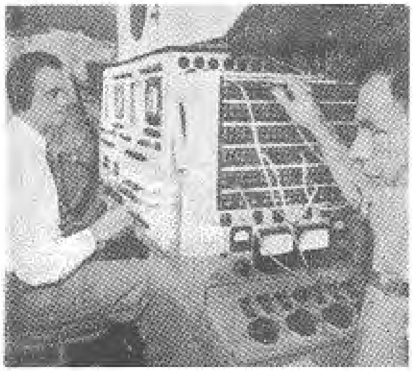
★

The modified B-29 for Stratovision operation carries the transmitting aerial at the front of the aircraft and the audio and video receiving antenna on an 8ft. mast mounted on the tail.

★

Press Preview

During the past few months this pressurised B-29, equipped with F-M and television apparatus has made frequent flight tests over a wide area. Recently members of the press gathered in Zanesville, Ohio, saw by television the nomination of Republican candidates in Convention Hall, Philadelphia. This was not ordinary television, but a Stratovision transmission. The programme was telecast from Washington and picked up by the experimental plane circling at 25,000 feet in Western Pennsylvania, 160 miles away. This in turn relayed the programme on a new frequency over a circle of some 250 miles radius, which included Zanesville, 130 miles further west.



This view shows the video monitors (left) and the audio monitors with plane-ground "cue" circuits on the right.

The fact that television and F-M signals could be picked up by a moving antenna at altitudes of 25,000 feet and re-broadcast on different channels with good coverage in a 500-mile diameter circle was indicated by earlier mathematical calculations and flight tests. In addition, further demonstrations have proved the ability of the system to pick up a telecast signal from a ground station below, and place in receivers 250 miles distant pictures of quality and strength comparable to those delivered by a primary telecast station within its limited range.

Main Advantages.

The essential objective of this Stratovision system is to increase the area in which signals on the customary F-M and television bands can be received. The approximate limit to an earth-bound antenna operating at these ultra high frequencies is a line-of-sight of approximately 50 miles, whereas a plane flying at say, 25,000 feet, has a practical reach of some 25 times greater area than the primary transmitting station below.

Another technical advantage in favour of this airborne system is that much less broadcast energy is required. For example, with the plane flying at its usual height of 25,000 feet with a 1-kw transmitter, it can place in a 500-mile circle, a signal equal in strength to that of a 50-kw land transmitter in a 100-mile circle.

Interference Problems

As to be expected, many problems of interference were encountered with this system, mainly due to the great receiving range and extensive service area. This can be readily understood when it is realised that the service area of a T-V ground station is perhaps only 12,000 square miles, compared to some 200,000 square miles for the Stratovision station. With only 12 low band channels available, frequency assignments to ground stations are repeated within such relatively short distances, that the plane's receiver is almost certain to pick up two or more stations operating on the same frequency. Similarly, the transmitter is also likely to interfere with one or more ground stations.

Whilst this situation virtually rules out commercial Stratovision operation in the lower frequency bands, it does not eliminate the system as a practical

(Continued on page 46.)

TROUBLESHOOTING RECEIVER DISTORTION

In this second article, further common causes of receiver distortion together with methods of location and elimination are treated in some detail.

Most modern receivers utilise degenerative, or negative, feed-back circuits to hold distortion to a minimum. Negative feed-back tends to reduce both harmonic and frequency distortion. One or two, or even three, stages are involved in the feed-back chain. There are many methods used. A portion of the voltage may be fed back from the voice coil circuit, or the plate circuit of the output stage to a preceding stage, as in Fig. 1, or in some cases degenerative feed-back in one stage is accomplished merely by omitting the cathode by-pass condenser across all or a portion of the cathode resistor, as shown in Fig. 2.

Regardless of the method used, the improved tone quality which results is obtained at the sacrifice of amplification. A material loss of gain will result with excessive degeneration. Likewise a marked increase in distortion will result if for any reason the degenerative feed-back circuit should case to function.

Phase Inversion

In the case of a resistance-coupled push-pull stage, there will be some means of phase inversion in order that the signal voltages fed to the two output grids will be opposite in phase.

If the distortion is to be held to a minimum, the voltages must not only be opposite in phase, but equal in amplitude. In checking the operation of the phase inverter, a modulated signal from a signal generator may be fed into the r-f input of the receiver, or into any r-f or i-f stage for that matter; or an audio signal may be fed into the input of the audio amplifier of the receiver (see Fig. 3). The audio voltages that will consequently appear at the two output grids may be checked and compared by either the use of an oscilloscope or a V.T.V.M. that is equipped with a r-f probe. These voltages should be of the same magnitude. A material difference between these readings may indicate a defective tube in the phase inverter socket, or a change in value of a load resistor in the phase inverter circuit.

Separate phase inverter tubes are not always used. Sometimes the driver stage serves as the phase inverter by having one of the output grids coupled to its plate and the other to its cathode, as shown in Fig. 4. This serves the purpose of phase inversion, because the voltages at the plate and cathode of a vacuum tube are essentially 180 deg. out of phase.

In such a case, any difference in the values of the plate load resistor and the cathode load resistor will result in one of the output grids receiving a stronger excitation voltage than the other, causing distortion. A difference in the values of the grid load resistors of the output stage or the coupling condensers can have the same effect. In some phase inverter circuits, the grid load resistors are purposely of different values in order to apply equal signal excitation voltages to the two grids. Such a circuit may be found in cases where phase inversion is acquired by coupling one of the output grids to the screen-grid of the other stage, as in Fig. 5. In any case, the signal voltages at the two control grids of the output stage should be equal.

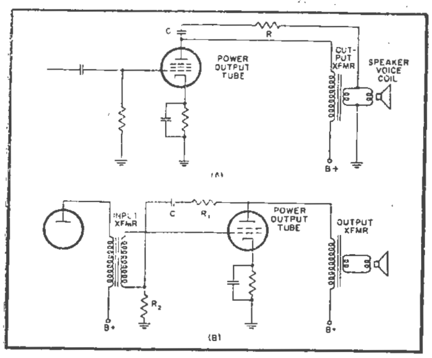


Fig. 1.—The circuits above illustrate two common methods employed to obtain regenerative feedback. In A, resistor R and capacitor C constitute the feedback circuit. In B, resistors R1 and R2 and capacitor C constitute the feedback circuit.

Midget Receivers

In some midget receivers a grid resistor of from 10 to 15 megohms will be found in the first a-f amplifier stage.

This grid resistor can be quickly located by first locating the coupling condenser which will be connected to the arm of the volume control potentiometer. The other end of this condenser will be connected to the grid of the first a-f amplifier and also to the grid resistor, R1 in Fig. 6. When these receivers are tuned to a strong local signal, there will be an unpleasant time lag, accompanied by distortion, when the volume control is advanced for louder volume. Sometimes the value of resistor R1 will increase and become of such a high value that the distortion is always present. This time lag can be eliminated and the tone quality often improved by substituting a resistor of from 2 to 3 megohms.

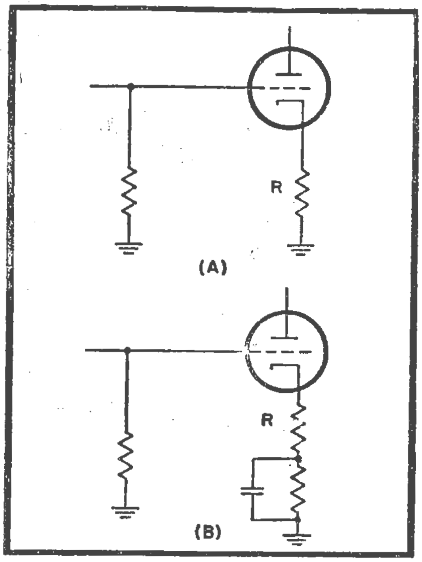
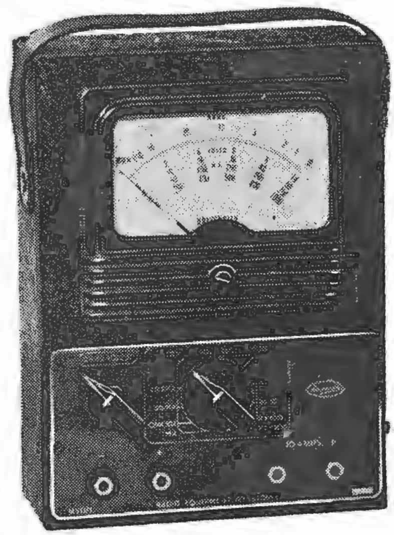


Fig. 2.—Negative feedback voltage may be developed across the cathode resistor of an amplifier by omitting the bypass condenser as shown in (A) or by placing the bypass condenser across only part of the cathode resistor as shown in (B).

A symptom sometimes encountered, especially in a receiver with resistance coupled audio stages, is a static-like noise due to the use of a resistor with too small a wattage rating. The wattage rating given to a resistor is based on the power necessary to raise the temperature of the resistor to 250 deg. C. A resistor should



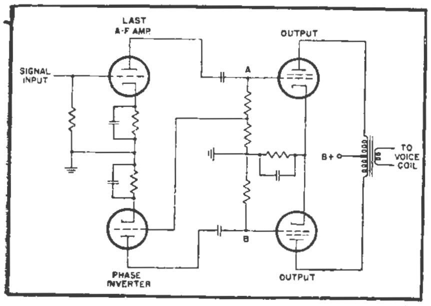


Fig. 3.—Push-pull output stage and phase inverter. The operation of the phase inverter may be checked by comparing the voltages present at points A and B as described in the text.

be used which has a wattage rating of approximately twice the actual power that it must dissipate.

Bass Compensation

Most receivers employ some sort of bass compensation associated with the volume control circuit in order to compensate for the relative low sensitivity of the ear to the bass frequencies at low volume. A varying percentage of feed-back takes place at different volume control settings. The lower the setting of the volume control the greater the amount of feed-back, resulting in a greater amount of bass emphasis. The volume control resistor will be tapped at one or more points. It is extremely important, therefore, that this control be of the correct value, and have the proper tapering, and when replacement is necessary it must be replaced with an exact duplicate of the original control.

The presence of an excessive amount of regenerative or positive feed-back associated with one or more stages in a receiver is often the source of considerable distortion. Regenerative feed-back may be due to many causes. The most common cause in the audio section is undesired coupling between stages due to lack of voltage regulation in the common voltage supply.

The higher the gain of the audio stages, the more troublesome feed-back becomes. The feed-back may be great enough to cause sustained oscillations. Oscillation resulting from poor regulation will produce a sound in the speaker resembling the sound of a motor-boat. Consequently, such oscillation has inherited the name *"motor boating."*

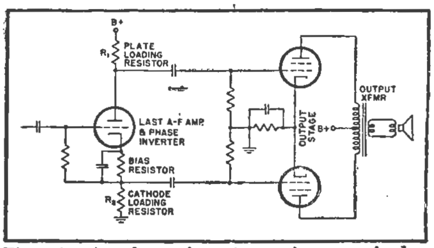


Fig. 4.—A phase inverter using a single triode. In order for the phase inverter to operate properly, resistors R1 and R2 must be of equal value.

Curing Motor-boating

The installation of a r-c filtering, or isolating, networks in the individual B + lead of one or more stages will often remedy this condition, if such networks are not already incorporated in the circuit (see Fig. 7). In installing these networks, the resistor should be kept as low as possible to prevent unnecessary lowering of the plate voltage. All of the by-pass condensers and power supply filter condensers should be checked first, as the trouble usually lies in an open or partially open condenser which is already incorporated in the receiver. Any component which is capable of causing poor voltage regulation in the receiver can be the source of the trouble. The voltage regulation may be checked by tuning the receiver to a strong signal and taking voltage readings at various points along the distribution line with a V.T.V.M. The voltage at any point should be constant. Any fluctuation of the meter reading will indicate poor regulation.

If the power transformer has been replaced by a transformer with too low a rating, it may be necessary to replace it with a heavier transformer before good regulation can be acquired. One indication of an overloaded transformer is an excessively high temperature after the receiver has been on for some time. This may be checked by placing one's hand upon the transformer. The temperature should never become great enough to cause discomfort to the hand.

Any filter choke that is associated with the power supply is as important in keeping the voltage regulation under control as are the filter condensers. If a choke has been replaced with one that is too light or with one of too low a reactance, poor regulation may result.

Oftentimes distortion will originate in the i-f stages as a result of excessive regeneration due to stray coupling between the grid and plate leads. This trouble is common with midget receivers. Sustained oscillations will usually result when a station carrier is tuned in, especially on the low frequency end of the dial. Proper dressing of these leads will usually remedy this condition.

Loose shield cans often become a source of trouble. The symptoms are many and varying, such as squealing, howling, static noises and other intermittent disturbances. An undergrounded or poorly grounded i-f can and will also affect the alignment. Misalignment of the receiver will result in distortion. A marked frequency distortion will also result with the sharp tuning of i-f transformers that are designed for flat-top characteristics.

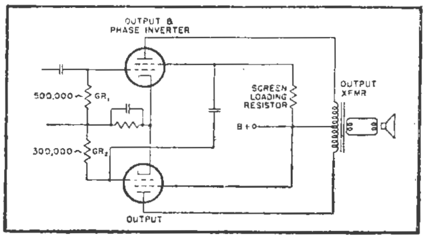


Fig. 5.—Push-pull output stage and phase inverter combined.

The factory instructions should be followed in every detail when aligning a receiver.

Oscillator

Frequently drift and instability of output voltage of the local oscillator may be the source of distortion in a superheterodyne receiver. The oscillator output will vary with the frequency in most receivers, and in the case of the small midgets this variation may approach a ratio of about 2 to 1. In the better receivers, however, the output is almost constant.

A simple method of checking this variation and the general stability of the oscillator is by connecting the r-f probe of a V.T.V.M. to the oscillator grid resistor (Fig. 8) and observing the output voltage while rotating the tuning condenser through the tuning range. The oscillator frequency will be lowered when the r-f probe is attached to the grid resistor and therefore it will become necessary to re-tune the oscillator slightly, if it is desired to observe its output at any specific frequency setting.

The stability of an oscillator is generally improved with a high value of grid resistor, but should this value become too great, oscillation may become intermittent or cease entirely. The wiring and other components associated with the oscillator circuit must be rigid and care should be exercised to avoid disarranging any of these from their original position. This is especially important in the case of high frequency oscillators. Displacement of any of these components may

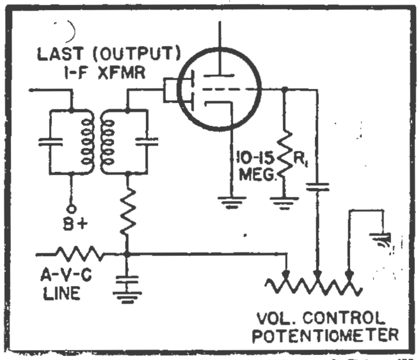


Fig. 6.—An increase in the value of R1 will cause distortion as described in the text.

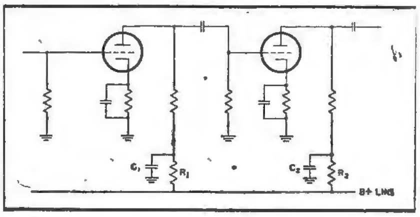


Fig. 7.—The installation of resistors R1 and R2 and condensers C1 and C2 will often remedy "motor-boating".

result in absorption of some of the oscillator output at certain frequencies, due to the proximity of other circuits which may resonate at these frequencies.

Distortion sometimes originates in the mixer stage. A trouble sometimes encountered is that of image effects resulting from oscillator harmonics beating with the incoming signal and producing and interfering i-f signal.

Reducing the a.v.c. voltage that is applied to the mixer stage will usually remedy this trouble. It must be remembered, however, that the a.v.c. time constant should not be upset in the process of installing a voltage divider.

The oscillator voltage which is induced into the control grid circuit of the mixer tube, should not become equal to the grid bias voltage of the mixer. If this condition should exist when the grid bias is normal, the oscillator output may be reduced by reducing the oscillator plate voltage or by installing a lower value of grid resistor.

There are other factors not associated with the chassis proper which may contribute to distorted reception, such as incorrect phasing of multiple speakers, microphonic action and acoustic feedback, and even the cabinet itself may contribute its share of trouble. Buzzing and rattling noises are often caused by sympathetic vibrations of loose cabinet panelling or loose grill work located in front of the speaker.

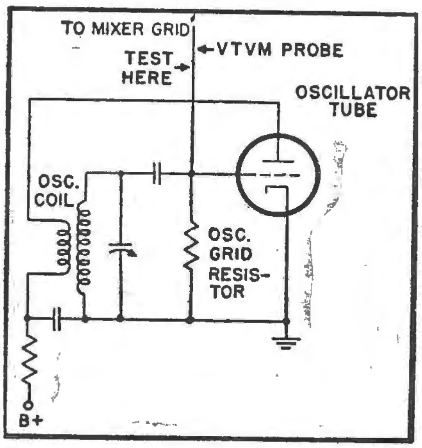


Fig. 8.—An oscillator may be checked for output variation by placing the R-F probe of a V.T.V.M. at point A and rotating the tuning condenser throughout its range.

Speaker Phasing

The phasing of twin or multiple speaker voice-coils may be checked by connecting a source of low d.c. potential such as a 1½-volt dry cell in series with the voice coil circuit (Fig. 9) and placing the fingers lightly on the speaker cones as the circuit is closed. At the instant contact is made, the cones will make a decided movement in either the inward or outward direction. When properly phased they will all move in the same direction. The direction of movement of any individual speaker cone is changed by merely reversing its voice coil leads.

Some vibrations which are transmitted from the speaker to the chassis will sometimes cause certain components on the chassis, such as the tuning condensers or oscillator coil, etc., to vibrate in unison with the speaker cone, resulting in sustained oscillations which usually introduce a roaring or howling sound into the output. The installation of rubber cushions under the chassis, if these are not already employed, will often remedy

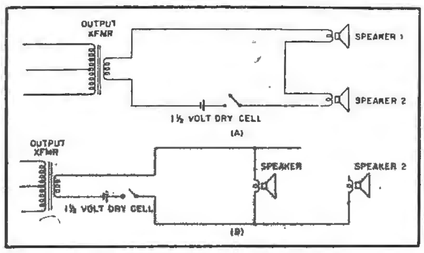


Fig. 9.—The method used to check speaker phasing. A is for series speakers and B is for parallel speakers.

this trouble. The installation of rubber washers between the speaker and the cabinet will also often help to effect a cure.

In some cases a tube with microphonic qualities will be the chief source of trouble. In such cases it is only necessary to replace the tube. It is suggested that if a tube cannot be found that will be insensitive to the vibrations, that several layers of friction tape be wound around the base of the tube so as to dampen out the induced vibrations.

A torn or otherwise damaged speaker cone will usually produce *rattling* and *buzzing* sounds. Should the speaker voice coil be out of alignment, so that the voice coil rubs against the pole pieces, a rasping *tinny* sound will result which will be especially pronounced at low volume, and at the lower audio frequencies.

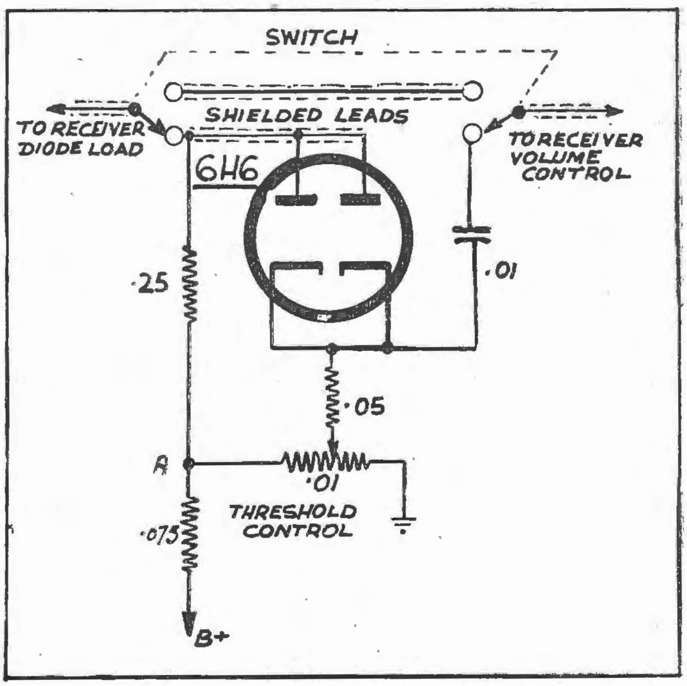
The possibilities of distortion are many and varied, but an attempt has been made to give the reader a basic outline from which to start, along with several service hints on actual cases.

Reprinted courtesy "Radio Maintenance."

Effective Noise Limiter Circuit

Noise impulses can often prevent clear reception of many stations on the S/W Bands. Here are details of an easily-constructed unit which can be used to effectively reduce many forms of interference.

After disregarding the usual valve and circuit noises, much of the noise interference experienced in short wave and other high frequency receivers can be traced to radiation from nearby electrical equipment or car ignition systems. Since, in most cases, this interference is of an amplitude modulated nature, a considerable reduction in noise level can often be obtained by using an amplitude limiter in the audio section of the receiver.



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The necessary connections for adding the noise limiter to any circuit are given in this diagram. The whole unit can be mounted on a small metal chassis, or if preferred mounted direct to the receiver chassis.

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Typical Circuit

A typical series type valve noise limiting circuit is shown in the accompanying diagram, and in operation this simply cuts off noise peaks above a certain level, pre-determined by the setting of the "threshold" control. The effectiveness of such a unit naturally depends on the type of noise interference, and consequently it should be mentioned that this unit will not eliminate all forms of interference.

In actual tests it was found to be quite effective in silencing nearby car ignition interference, enabling weak code signals to be clearly copied. It will be found that the limiting action tends to keep the audio output at a constant level—and this is very advantageous when copying a weak signal through any QRM. In cases where the noise was of a continuous nature, the unit had little effect, but since this form of interference is not encountered very often, the unit will still be found a worthwhile addition to any receiver.

One point to be remembered is that the audio gain of the receiver will be reduced when the unit is switched into the circuit. However, since most modern receivers have ample reserve power, this disadvantage is not serious and can be easily overcome by simply turning up the volume control.

Operation of Unit

The operation of the unit is simple to understand. The valve is adjusted to "chop" or limit noise peak levels at the second detector output by becoming non-conducting above a certain level, pre-determined by the *"threshold"* control.

The audio signal from the second detector modulates the steady diode current, and consequently conduction takes place whilst the diode plate is positive with respect to the cathode. This condition is assured by giving the diode a positive bias voltage of approximately 30 volts. When the signal becomes sufficiently large to swing the cathode positive with respect to the diode plate current cut-off will occur, resulting in non-conduction and the elimination of that portion of the applied signal in the audio output. The point at which this cut-off occurs is variable, and can be adjusted by the use of the threshold control.

The circuit uses a 6H6 as a diode limiter, and this should be wired up as shown. The components can be mounted on a small aluminium chassis —in our case this measured 3 x 3 x 2, or if there is sufficient room, on the receiver chassis. The current requirements of the unit are quite small and these can be obtained from the main receiver.

Receiver Connections

To connect the unit into the receiver, first locate the audio coupling condenser. This is usually connected from some point on the diode load to the "hot" side of the volume control. This lead is opened and the necessary connections made to the double pole double throw switch which serves as the limiter ON-OFF switch. All leads should be made with shielded wire, with the outer braiding earthed.

The .075 meg resistor in the B plus line is only approximate and may have to be varied until the bias is approximately 30 volts positive with respect to earth. An easy way of adjusting the threshold control is to advance it until the modulation sounds slightly distorted, then back it off until just above this point. This will then prevent any noise impulses from overriding the incoming signal. The threshold control should be of the wirewound type, as a carbon unit will often become noisy after being in operation a short while. The other resistors can be of the ½ watt type.

For your note book

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

Shorting Condenser Vanes

Cases of short circuiting gang condensers are fairly common both to the amateur and the professional serviceman. Whilst the task of finding the cause of the scraping noise usually presents little difficulty even to the comparative novice, the real problem is how to remove it.

Apart from vanes bent through accidental damage, the trouble may be due to "whiskers" of metal adhering to one or more of the plates. Although these can be removed by inserting a thin strip of card, it has been found from experience, that this method is not always successful.

Consequently, the handy tool specially suitable for this purpose can be easily made. It consists merely of a length of 16 gauge wire, with one end curled onto a loop for holding or hanging purposes, and the other flattened into a thin blade to a length of about three inches by hammering it on a flat surface.

The "feeler" so formed can be inserted firmly between the vanes whilst the handle can be bent to suit any particular condition.

Wirewound Potentiometers

Certain types of wirewound potentiometers often become noisy in operation, due to the adjacent turns of the resistance element moving when traversed by the rotating contact arm.

A potentiometer which gives trouble of this nature can generally be put right by varnishing the windings with two or three coats of celluloid cement. Allow ample time for each coat to dry before the next is applied making sure, of course, the actual contact surface is kept free of cement.

The celluloid cement can be made by dissolving scraps of celluloid in equal parts of acetone and amyl acetate.

Non-slip Dial Cables

If the cord friction cable which drives a tuning dial has been stretched, or if the cable or pulley has been worn smooth, there will often be slippage, resulting in a great deal of annoyance when tuning the receiver.

This trouble may be overcome by rubbing some powdered rosin on the section of the cable that travels over the drive pulley and also on the traction surface of the pulley. The effect of this rosin is to increase the friction of the system, thus assuring more positive movement.

Cleaning Lead-acid Batteries

Unless proper care is taken of the lead-acid type of accumulator, the terminals will become corroded. If this happens, here is a simple method of cleaning the corroded parts.

Make a solution of Sodium Bicarbonate (ordinary baking soda) with water, and pour this solution on the battery where there is corrosion. Let it stand for 3-5 minutes and then clean off with clean water. For most cases, a tablespoon of soda in a cup full of water should be satisfactory, although a slightly stronger solution will give quicker results. By frequently repeating this process and applying petroleum jelly to the terminals, batteries can be kept in good condition.

Parasitic Oscillation

Parasitic oscillation is most common in the output stage where it manifests itself as an almost complete cessation of signals combined with a heavy increase in plate current. The oscillations usually take place at a frequency determined by the inductance of the wires running to grid and plate in conjunction with interelectrode and other stray capacities acting as a tuning condenser.

The cure for this condition is based on the use of a "grid stopper". A non-inductive resistor of about 5000 ohms or higher is connected in series with the signal path to the grid of the valve and mounted right up against the respective valve socket terminal.

The combination of this resistance in conjunction with the grid-filament capacity of the valve makes a fairly effective filter preventing high frequency voltages from developing on the grid.

RADIO FREQUENCY MEASURING EQUIPMENT

By ALAN WALLACE

The subject of frequency measurement is of prime importance to every amateur. In this series of articles, the author will discuss the operation, use and construction of suitable measuring equipment for frequencies above 30 mc.

It is necessary, whenever considering the subject of measurement of alternating electrical quantities, to consider three factors, namely, the order of the frequencies involved, those measuring instruments which are operable at those frequencies and, last but not least, the order of accuracy required. It is the purpose of this series of articles to deal with the measurement of the various quantities associated with radio frequencies in the H-F and V-H-F portions of the spectrum, i.e., from 3-300 mcs.

Types of Wavemeters

One of the most important factors concerning an RF wave which must be known with a high degree of accuracy, is its frequency (or **wavelength**) and to this end, various ***absorption wavemeters*** and ***heterodyne frequency meters*** have been developed. Of these two instruments, the *wavemeter* can only be relied upon for approximate frequency indications, at the frequencies under consideration, so that for all accurate measurements a heterodyne frequency meter should be employed, whilst for extreme accuracy, a crystal calibrated *secondary standard* frequency meter must be used.

However, notwithstanding its limitations, the absorption type wavemeter is a very convenient instrument for rough frequency measurement and R-F indication. In addition, it is suitable for such purposes as the identification of harmonics, field strength measurements, and the detection of stray R-F fields. As a consequence, the scope of this first article will be restricted to describing the operation of various varieties of this instrument, the factors determining its accuracy and sensitivity, together with some consideration of the more accurate means of frequency measurement.

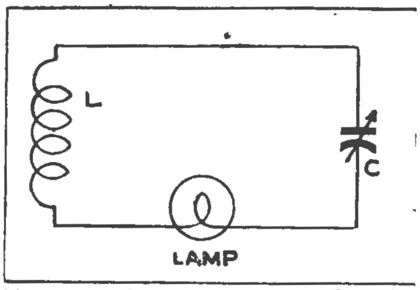

Fig. 1.—The basic circuit for an absorption type wavemeter.

Basic Circuit

The basic circuit of any absorption type wavemeter is that shown in Fig. 1. This has a resonant circuit loosely coupled to the source of R-F energy, and is provided with some device, e.g., a pea lamp, for indicating when the circulating current is at a maximum. In practice, the wavemeter will be loosely coupled to a transmitter, or other source of R-F energy, and the circuit capacity varied until a maximum response is obtained in the lamp.

Alternatively, if the wavemeter is coupled to a metered circuit such as the final stage of a transmitter, an indication may be obtained by noting the point at which the plate current increases, as the condenser is rotated, thus indicating that energy is being absorbed by the wavemeter. The frequency of the radiation may then be used, either from a directly calibrated condenser scale, or from a calibration chart.

Since the resonant frequency of such a circuit is given by the familiar expression $Fo = \frac{1}{2\pi\sqrt{LC}}$, it will be obvious that linear changes of capacity will not cause linear changes in frequency. In fact, such linear changes of capacity will produce a frequency scale which is crowded at the high frequency end of the range.

Consequently, in order to facilitate the reading of frequencies at this end of the scale, a condenser having a ***straight** line frequency* or *log-law* characteristic is often used. However, the prime requirement for accurate measurement, and the maintainance of calibration is that the unit should be constructed in a very rigid manner, preferably with shielding to minimise the effects of band and stray capacities. Of course, it will also be realised that it is of utmost importance that the loosest practicable coupling should always be used with any absorption type wavemeter, in order to minimise the loss of selectivity, double humping, and change of resonant frequency which occurs when two circuits are coupled too tightly.

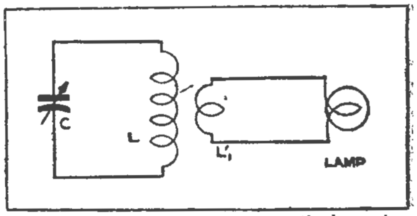

Fig. 2.—(a) This is a more practical version of the circuit shown in Fig. 1.

More Useful Version

A more practical variation of this circuit is shown below, in Fig. 2, wherein the tuned circuit is more isolated from the indicating device which is connected to a loop mutually coupled to the tuned circuit, and may comprise either a pea-lamp as above or a more sensitive indicating device, such as an R-F milliameter. Alternatively, a 0-1 m.a. D.C. milliameter, in conjunction with a suitable rectifier such as a crystal detector, may be employed, as in Fig. 2a. In this circuit, it is possible to achieve quite good sensitivity, and with proper selection of components it may be arranged to have a continuous coverage up to about 60 mcs.

These basic forms of the absorption type wavemeter circuit may also be adapted for frequencies in the range

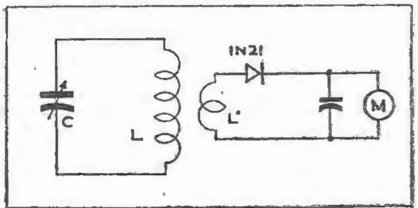

Fig 2.—(b) By replacing the indicator lamp in Fig. 2 (a) with a rectifier and meter combination, a more positive indication is obtained.

60-300 mcs. by simply arranging the tuned circuits in such a manner as to have low losses at these frequencies. The inductance will then become a small loop comprising one or two turns of wire, whilst the capacitance will have a value between 3 and 15 uuF. Of course, it will be appreciated that, owing to the reduced efficiencies experienced in this region, a more sensitive indicating device, e.g., a 0-100 uA D.C. meter, is necessary to achieve the same overall sensitivity.

It is quite usual, in order to obtain a greater sensitivity and provide greater flexibility, to employ a triode valve as a detector, with the indicating meter in its anode circuit. This enables changes in plate current to be noted as the applied voltage is increased, thus giving a very accurate indication of changes in the strength of the R-F field. However, as all such circuits have been dealt with very fully elsewhere, no practical data for their construction will be given here, such information being readily available from the published handbooks.

Heterodyne Frequency Meter

To achieve an accuracy of frequency measurement of an order sufficient to comply with International and P.M.G. Regulations, it is necessary to use some form of heterodyne frequency meter. In this instrument, the incoming signal is mixed internally with a locally generated oscillation of known frequency which may be either fixed or variable, depending upon the circuit arrangement employed.

One system, as employed in Service wavemeters, G61-G62, is to beat the incoming signal with a selected harmonic of a sub-standard crystal oscillator, amplifying the resultant beat note and measuring its frequency with an *absorption type* interpolating wavemeter. This arrangement is shown in block form in dia. 3, and for the purpose of explanation, consider the incoming signal to be at a frequency of 7,100 kcs.

Now, by means of the *Thousands Selector,* the sixth harmonic (corresponding to a dial reading of 7,000 kcs., although actually having a frequency of 6,000 kcs.) of the 1,000 kcs. crystal oscillator is selected and fed, with the incoming signal, to the Balanced Mixer. From this mixer the resulting beat note of 1,100 kcs. is amplified and fed to the interpolating wavemeter which has a range from 1,000-2,000 kcs., corresponding to dial readings of 0-1,000 kcs.

The dial of the interpolating wavemeter, when adjusted to give maximum response in the meter provided, will now read 100 kcs. Thus the frequency, as read on the instrument would be the sum of the "Thousands Selector" and

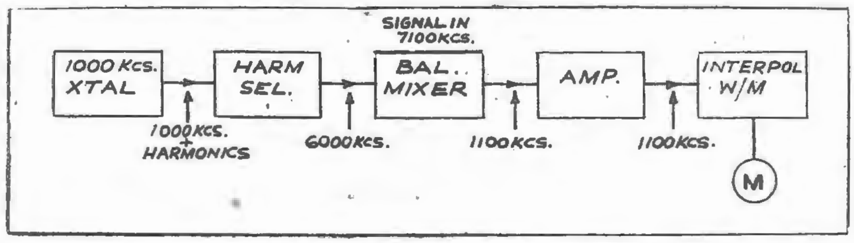

Fig. 3.—Block diagram of one form of Wavemeter.

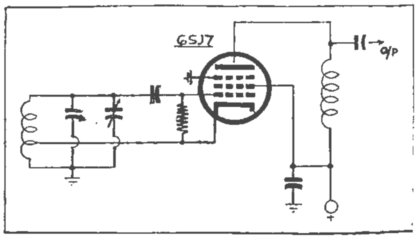

Fig. 4.—The electron-coupled circuit provides good electrical stability.

"Wavemeter" dial readings, i.e., 7,000 plus 100 equals 7,100 kcs.

This system, however, whilst capable of quite reasonable accuracy is normally far too cumbersome to be either constructed or operated by the average amateur. Consequently, a far more popular variety of the heterodyne frequency meter is that in which the output of a highly stable, acurately calibrated, variable frequency oscillator is mixed with the incoming signal to give a zero beat, the corresponding frequency then being read directly from the calibrated dial of the oscillator. The prime requirement of such an oscillator is that it should be extremely stable, both mechanically and thermally, as any variation in the frequency of its output will be manifest as an equivalent error in the reading obtained.

The requirement of mechanical stability is not normally too difficult to fulfil, providing due care is exercised in the mounting and support of all components associated with the oscillator circuit, although the use of variable condensers having a closer spacing than normal should be particularly avoided. Electrical stability is best achieved by the selection of a suitable oscillator circuit, such as the familiar election coupled oscillator as shown in Fig. 4, and by the use throughout of ceramic insulations and coil forms. Any thermoplastics or other materials likely to change their physical dimensions or dielectric properties with variations in temperature should be avoided.

It will be apparent that plug-in coils are out of the question, and it is preferable that any range changing which may be necessary should be accomplished by switching of tappings upon a single fixed coil, such that a low L/C ratio is maintained at all times. It is also very desirable, in the interests of stability, that the voltage supply to the oscillator should be regulated, and the output loading be the minimum amount required to satisfactorily drive the mixer stage.

For amateur purposes, it is sufficient in most instances to have a frequency meter which covers only the amateur bands. Hence, a suitable oscillator would be one which tuned from 1,750-1,800 kcs., or from 1,750-1,950 kcs., depending on the ranges desired, and utilising harmonics of the oscillator to cover the higher frequency bands.

Highly Useful Instrument

An instrument incorporating such an oscillator is of unlimited usefulness in the ham shack, as, apart from its primary purpose of checking the frequency of the local transmitter, its output may be used for such purposes as checking of receiver calibrations and the direct measurement of the frequency of incoming signals. In addition, by the provision of suitable buffer stages, it can be used as a very stable frequency controlling circuit for the transmitter.

The mixer circuit employed in a normal heterodyne frequency meter may be quite conventional, and can take the form of either an electronic mixer, i.e., 6GL, 6SA7, etc., or of a convenient detector circuit, the signals being mixed externally. However, it is quite possible with some sacrifice in audio output, to utilize a conventional pentode. e.g., 6SK7, 6AC7, EF50 as a mixer/detector, by using the suppressor as an injector grid.

A circuit using such a pentode is shown in Fig. 5, in this case the output being taken from the cathode, in order to improve the output when operating into a low-impedance load. This arrangement, at present in the experimental stage, shows considerable promise, in view of the large numbers of amateurs in possession of low impedance headphones which normally give unsatisfactory performance without special circuit arrangements.

Of course, it will be realised that no matter what precautions are taken with the design of the variable frequency oscillator, it cannot be relied upon for absolute accuracy unless some means are provided for the checking of its calibration before using. A convenient means of checking calibration is to provide a simple crystal oscillator, operating at some known frequency, e.g., 100, 1,000 or 3,500 kcs., and to use its output as a standard reference point for the calibration of the oscillator.

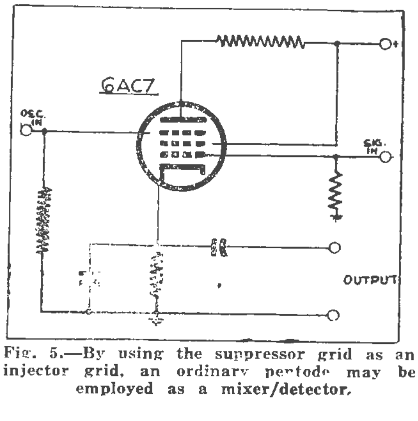

Fig. 5.—By using the suppressor grid as an injector grid, an ordinary pentode may be employed as a mixer/detector.

The instrument then becomes of a sub-standard nature, if the calibrating crystal itself is of sub-standard accuracy and resultant frequency measurements may be relied upon to within 1 part in 100,000, with greater accuracy at those frequencies where direct comparison may be made with the sub-standard crystal oscillator.

However, where greater accuracy is required, of the order of one part in 1,000,000, it is necessary to employ a secondary frequency standard. The circuit arrangement of this is such that constant comparison is provided between the incoming signal and the output of a secondary standard crystal oscillator, provision being made to simultaneously compare the output of this secondary standard with the standard frequency signals radiated by WWV or some other frequency standard.

In view of the many factors entering into the design of such an instrument, however, further description of this equipment will be deferred until the next issue, when it is hoped to include also, full constructional details of a simple heterodyne frequency meter, with provision for crystal calibration.

Amateur NEWS and VIEWS

CW vs PHONE

The time-aged argument of CW versus Phone on the amateur bands has once again come into prominence. The points advanced for and against both sides weigh fairly evenly and consequently the following W.I.A. recommendations have been decided by vote. This is only a gentleman's agreement, and whilst not legally binding, it is considered all amateurs will agree with the allocations.

The CW portions of the bands are now as follows:—

80 metres—3500 kc. to 3600 kc.
40 metres—7000 kc. to 7500 kc.
20 metres—14000 kc. to 14150 kc.
10 metres—28000 kc. to 28150 kc.

The remaining portions of the band are to be set aside for Phone use only.

This decision does not mean to say that CW cannot be used on the rest of the band, but simply that the "Phone Men" are asked to leave these channels clear for the CW man.

QSL CARDS

Do you QSL? If not, why not? The incoming QSL cards for Australia exceeds the ratio of 3 to 1 over outgoing cards. Some day you may want a WAC, WAZ or DX Century certificate and will not have the necessary QSL cards to prove your qualifications, simply because some amateur forgot to send his QSL. So remember to send your QSL cards out for all contacts made, as this may be the very one to complete that amateur's score.

While on the subject of QSL cards, a stamped, addressed envelope sent to VK2YC, 78 Moloney Street, Eastlakes, N.S.W., will obtain any overseas or Australian cards to your credit.

VHF BANDS POPULAR

An ever-increasing popularity is being experienced for the VHF band, especially on 144-148 mc. Up-to-date, well over 50 stations have been heard on this band, with the "regulars" totalling over 25. Some of the well-known calls on this band include VK2's ABZ, AJA, FK, ND, IY, DP, AZ, AIL etc. who can be heard on most nights.

It is expected that the band will be heavily populated over the contest period, with more than 60 stations in Sydney alone being on the air. Activity on the 288 mc. band has started in VK2, with VK2's ND, portable and ABZ, LZ, ADT heard regularly. It is expected, from what is heard on the VHF bands, that there will be about 15 men on 288 mc. in the near future.

Concerning the 577-585 mc. band, a start has been made with VK2's ND portable and QW, with at least six others anticipated to be in operation within the next few weeks.

Dropping down to 50 mc., the WIA broadcasts on frequency of 51.7 mc every Sunday at 8 p.m. After this broadcast, the Gladesville Radio Club gives CW practice for any listener who is interested in obtaining his ticket. Congrats, Gladesville!

This new monthly feature, "of, by and for" the amateur will be conducted by Ken Finney, VK2AIL. All amateurs and radio clubs are invited to co-operate in ensuring the success of these pages by forwarding along any items of interest, either personal or technical. All letters should be addressed to: Box 5047, G.P.O. Sydney, marking the envelope, "Amateur Notes".

SP●T NEWS . . .

- Wollongong boys have worked some excellent DX which includes W, G, C, ZL, I, OZ, OA, F, UA, SM, J, KH, CM, in about 6 months. This includes all states of U.S.A. Australia and all counties of England.
- Well-known call signs of the South Coast such as VK2MT, Chas. Hedley; VK2LA, Lyle Adams; VK2AMD, Howard Booth; have been heard working some fine DX. VK2MT works a G every morning on schedule, and while waiting often bowls F's 1, and GM's over in fine style.
- VK2DK (Arthur McCarthey) of Narrabri was seen in Sydney this week getting Eddystone Gear for his new rig. Arthur runs 6 watts to a ½ wave single wire, and has been heard in Texas, U.S.A. on 'phone, so certainly has efficiency as his watchword.
- VK2SB (Ray Chapman) is the man who took a chassis, ½ doz. 6N7, and 807 and a handful of resistors and condensers and, presto! 40 watts. Has been trying a vertical 8JK on 20 metres, working a J2AGA, and C1BC in fine style.
- VK2JJ (John Jones) has migrated to 144 mc. John runs 100 watts to an 813, VFO, on 40, 80, 20, 11, 10, 6 metres and 25 watts on 144 mc. A transmitter to end all others is almost finished, and is indeed a dream transmitter.
- VK2SW (Sid Ward) heard on 40 metre phone 7172 kc., with 60 watts of carrier quite nicely filled with audio and good xtal quality was heard working the "outside the state boys." See you on 7010 kc. some time!
- VK2IT (Tom Cahill) has fallen down in to the "DC" bands once again, migrating from 144 mc. to 20 metres; looks like he will be staying there, too, with a revamped command set on 40 and 20 metres.

CLUB NOTES

WOLLONGONG AMATEUR RADIO CLUB (VK2AMW)

President: H. Booth (Ex G2AS).
Secretary: R. Waters.

This Club meets every Friday evening, although the Club is open at all times to members. The present membership is 51 members, 9 of whom are licenced, and a cordial welcome is extended to any new members.

The transmitter is a 6V6 Crystal Osc., 807 Doubler, and push-pull 807's, running 60 watts input. The transmitter was built by G2AS (now VK2AMD), and operates mostly on 20 metres.

EXPERIMENTAL RADIO SOCIETY OF N.S.W.

Greenwood Hall, Liverpool Road, Enfield, N.S.W.

President: R. A. Blades, VK2VP, 4 Service Avenue, Ashfield.

Secretary: B. Taylor, 35 James St., Lidcombe.

The Society has acquired new club rooms at the above location, and meetings are held on alternate Thursday nights. Apart from the regular business of the Society, interesting lectures and discussions are held. The club transmitter, VK2LR will be operating on 7 mc., and at a subsequent date a transmitter will be operated on the higher frequencies.

Visitors are welcomed, as are any intending new members, and we can assure them of an interesting evening.

Club meetings for December are on the 9th and 23rd.

Approximate Great Circle Bearings from Capital Cities

Country	Melb.*	Sydney	Brisbane	T'sville	Adelaide	Perth
Canada (North)	030	030	030	040	030	085
Canada (South)	050	050	045	050	045	040
U.S.A. (North)	060	060	055	060	065	052
U.S A. (Central)	070	070	065	070	070	060
U.S.A. (South)	090	075	070	080	082	070
Panama	115	100	100	120	105	130
South America (North Half)	130	130	125	130	130	170
South America (South Half)	160	150	155	155	160	180
South America (East Coast)	170	165	160	165	170	185
Pacific Islands (General)	040	070	060	080	070	070
Japan	355	350	345	345	352	015
Burma	310	310	300	300	308	340
India (North)	300	300	295	290	310	325
India (South)	290	290	285	280	300	312
Europe	295	320	310	300	320	315
U.K.	310	330	330	325	330	320
Africa (North)	270	270	260	260	280	290
Africa (South)	230	280	220	220	235	250

*Bearing given as from Melbourne are sufficiently accurate for normal use in Tas.

World-wide Call Sign List

Certain countries are divided into "call areas", which enables the identification of a station to be carried not only to the country of origin, but to the "state" or district of that country. Listed below are the countries affected by this system of definite call areas and it is suggested this chart be kept as a handy reference.

ARGENTINE:

The first letter following the prefix numeral indicates the district, i.e., LU1AA is in the city of Buenos Aires. A.B.C.—Buenos Aires. D.E.—Buenos Aires province. F.G.—Sante Fe. H.—Cordoba. J—Entre Rios. K.—Gucaman. L.—Corrientes and Gob Misiones. M.—Mendoza. N.—Santiaga del Estero. O.—Salta. P.—San Juan. Q.—San Luis. R.—Catamarca. S.—Sa Rioja. T.—Jujuy. U.—La Pampa. V.—Rio Negro. W.—Chubut. X.—Santa Cruz. Z.—Islas Orcades (South Orkneys).

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AUSTRALIA:

VK2—N.S.W. VK3—Victoria. VK4—Queensland and Territory of Papua. VK5—South Australia. VK6—Western Australia. VK7—Tasmania. VK8—Central Australia. VK9—Territory of New Guinea.

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BRAZIL:

PY1A-PY1L—Rio de Janiero (city). 1M-1V—Rio de Janiero (state). 1U—Espirito Santo. 2A-2T—Sao Paulo. 2U—Goias. PY3—Rio Grande de Sul. PY4—Minas Gerais. 5A-5P—Parana. 5Q-5Z—Santa Catarina. 6A-6PL—Bahia. 6Q-6Z—Sergipe. 7A-7F—Pernambuco. 7G-7K—Algoas. 7L-7P—Puraibo. 7Q-7U—Rio Grande de Norte. 7V-7Z—Ceara. 8A-8F—Para. 8G-8L—Amazovas. 8M-8Q—Marankao. 8R-8V—Piaui. 8W-8Z—Territoria do Acre. PY9—Matto Grosso.

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CANADA:

VE1—Nova Scotia, New Brunswick and Prince Edward Is. 2—Province of Quebec. 3—Province of Ontario. 4—Province of Manitoba. 5—Province of Saskatchewan. 6—Province of Alberta. 7—British Columbia. 8A-8L—Yukon Territories. 8M-8Z—N.W. Territories. VE9—Experimental Stations.

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CHILE:

CE1—Provinces of Yacna, Tarapaca, Antofagarto and Atacavia. CE2—Provinces of Valparaiso, Aconcaqua and Coquimbo. CE3—Provinces of Santiago, O'Higgins and Colchague. CE4—Provinces of Curico, Talca, Linares, Maule, Vuble and Concepcion. CE5—Provinces of Blo Blo, Arauco, Malleco, Cantin and Valdivia. CE6—Provinces of Slanqulhue and Cluloe. CE7—Territory of Magallanes.

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COLOMBIAN REPUBLIC:

HK1—Barranquilla, Cartageria, Cienaga, etc. 2.—Santa Marta, Cucuta, etc. 3—Bogata. 4—Medellin, Caldas. 5—Cali, Buenaventura, Popayan. 6.—Manizales, Pereira, Ibague. 7.—Bucaramanga. 8—Caqueta.

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COSTA RICA:

T12—San Jose. T13—Cartago. T14—Heredia. T15—Grecia, Alajuela. T16—Port Linion. T18—Puntarenas.

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CUBA:

CM1/CO1—Province of Pinar del Rio. CM2/CO2—Havana. CM5/CO5—Province of Matanzas. CM6/CO6—Province of Las Villas. CM7/CO7—Province of Camaguey. CM8/CO8—Province of Oriente. CO9—Experimental broadcasting stations.

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CZECHOSLOVAKIA:

OK1—Bohemia. OK2—Moravia. OK3—Slovakia.

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ECUADOR:

HC1—Quito. HC2—Guayaquil. HC3—Loja. HC4—Portoviejo. HC5—Ciudad Cuenca.

JAPAN:

J2—Tokio and Nagoya. J3—Osaka and district. J4—Hiroshima. J5—Kumanioto district. J6—Sendai district. J7—Sappavo. J8—Korea (Chosen). J9—Formosa (Taiwan).

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MALAYA:

VS1—Straite Settlements. VS2—Fed. Malay States. VS3—Non-Fed. Malay States.

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MEXICO:

XE1—Central Mexico. XE2—Northern Mexico. XE3—Southern Mexico.

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NEWFOUNDLAND:

VO1—City of St. John's Is. VO2—All other stations south of lat. 49 deg., and east of longitude 56 deg. VO3—North of latitude 49 deg. and east of longitude 56 deg. VO4—South of latitude 49 deg. and west of longitude 56 deg. VO5—North of latitude 49 deg. and west of longitude 56 deg. VO6—Labrador.

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NEW ZEALAND:

ZL1—Auckland district. 2—Wellington district. 3—Canterbury district. 4—Otago district.

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NICARAGUA:

YN1—Managua. YN2—Granado. YN3—Leon.

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PERU:

OA1—Negrites. OA3—Huanuco. OA4—Lima. OA5—Huanto. OA6—Arequipa. OA7—Puerto Maldonavo.

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UNION OF SOUTH AFRICA:

ZS1—Cape Province. ZS2—Cape Midland and Eastern Cape. ZS3—S.W. Africa. ZS4—Orange Free State and N.W. Cape. ZS5—Natal and East Griqualand. ZS6—Transvaal and Bechuanaland Protectorate. ZS7—Bechuanaland. ZS8—Basutoland. ZS9—Swaziland.

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U.S.A.:

W1—States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. W2—States of New York and New Jersey. W3—States of Pennyslvania, Delaware, Maryland, Virginia and the district of Colombia. W4—States of Alabania, North Carolina, South Carolina, Georgia, Florida, Tennessee. W5—States of Mississippi, Louisiana, Texas, Arkansas, Oklahoma and New Mexico. W6—States of California, Nevada, Utah and Arizona. W7—States of Oregon, Washington, Idaho, Montana and Wyoming. W8—States of Michigan, Ohio and West Virginia. W9—States of Illinois, Indiana, Wisconsin and Kentucky. W0—States of Colorado, Iowa, Kansas, Minnesota, Missouri, Nebraski, North Dakota and South Dakota.

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URUGUAY:

The first letter following the prefix numeral indicates the "call area." A.B.C.—Montevideo. O—Canelones. E—San Jose district. F—Colonia. G.H.—Soriano. I.—Poysandu. J—Salto.. K—Artigus. L—Florida. N—Durazuo. O—Tacuarembo. P—Riviera. R—Maldonado. S—Lavaleja. T.—Rocha. U—Trenita and Tres. V—Cerro Largo.

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VENEZUELA:

YV1—Maracaibo, Trujillo. YV3—Barquiserneto, San Felipe. YU4—Valencia, Maracay. YV5—Caracas. YV6—Barcelona, Bolivar. YV7—Cumana, etc. YV8—Maturin, Quiriquire, etc.

Amateur Radio Emergency Network

"There is no greater work than helping the needy"—an old saying that applies right throughout life, it embraces amateur radio as much as any other section of the Australian way of life.

During the last few months amateur radio has played a prominent part in an emergency. In Maffra, Victoria, three amateur radio operators helped in the successful search for a missing boy, while in the north coast of New South Wales, communications were restored when floods rendered normal channels useless.

Their excellent work recalled the heroic jobs done by a handful of Victorian radio amateurs on "Black Friday", February 13, 1939, when disastrous fires wiped out many of Victoria's bush towns. Their efforts saved many lives and gained the praise of the nation. Unfortunately, the incident was quickly forgotten, due to the war starting six and a half months later.

These men set an example all could follow. Without soliciting any reward they placed their apparatus and time at the disposal of the authorities ready to do a first-class job. Their only reward was the satisfaction of a job well done.

Much Time Wasted

Listening around the amateur bands in Australia, any day or night, one hears many conversations which are just a waste of time. The owners of these stations, due to their selfish nature, have no desire to give their services to the community. Their only interest is to chat incessantly, never even considering how they could place their specialised knowledge to better serve the community.

But the same cannot be said for those mentioned in the introductory paragraphs. These men put their spare time to better use. Week-end after week-end they perfected their portable, battery-powered transmitters and receivers. Although they sincerely hoped they would never have to use it, they wanted it on hand so that when an emergency did strike, no time would be wasted. They remembered the frequently-quoted saying in QST: "When disaster strikes, it strikes quickly".

Aware of the need for an organised emergency network, the Wireless Institute of Australia has solicited the aid of every radio amateur in an emergency organisation. It intends preparing a comprehensive list of all stations ready to help in an emergency. Accurate files will keep an up-to-the-minute record of all portable equipment, home station equipment and telephones of the operator (both business and home), so he can be contacted with little waste of time.

There the matter stands. It will need the full support of every licensed radio amateur in the country if it is to be successful. Emergency work offers unlimited scope for experimenting. This, coupled with the knowledge that a service can be rendered to the community, should arouse every loyal Australian radio amateur to register his services with the W.I.A.

By
ROTH JONES
VK3BG

Special frequencies have been allotted to facilitate traffic handling. This will allow incorporation of crystal control in the transmitter, ensuring stability. The question frequently asked is what is the perfect portable emergency set-up. First paramount point in the design of the apparatus is minimum power drain and weight with maximum efficiency. The large number of small genemotors now available at a reasonable price through disposals stores offer an excellent source of high-tension supply. Considering their output, weight is remarkably light. Most genemotors will give between 30 and 50 watts—more than sufficient for any emergency transmitter and receiver. Provision could be made for telephony with little loss of transmitter output.

As the primary source of power will be 6- or 12-volt car battery, some modification will be necessary, as most generators are designed for 24-volt aircraft supply. This is not a difficult job.

Failing use of genemotors, dry batteries can be used effectively as high-tension supply, but due to the lower voltage and current drain, the transmitter output and range will be limited.

Other Equipment

Another important piece of equipment for emergency portable work is the antenna which should be packed with the transmitter and receiver. Most convenient and efficient is the co-axial-fed doublet cut accurately to the emergency frequency.

Lengths of wire and rope should also be included in the kit, so that a connection can be made to an adjacent tree or pole. This same antenna will also be excellent for receiving. Unless an antenna relay is available (they are a scarce item in this country), a double-throw, double-pole switch, preferably mounted on a ceramic base, should be placed near the transmitter tank coil.

As the transmitter's stages must be kept to a minimum for the conservation of power, beam-powered tubes are almost an essential. An 807 as a straight crystal oscillator is efficient, compact, reliable and easy to adjust. For those who prefer a separate oscillator ahead of the 807 P.A., a Pierce oscillator would conserve power.

Although the T.R.F. receiver is still popular for portable-emergency work, the small superhetrodyne, using double-purpose tubes, is more reliable and selective—a very important factor when there's trouble.

Many amateur radio operators who purchased portable disposals equipment have their problems fixed. The Type 3 Mark II receiver-transmitter is excellent for either portable or fixed use, being able to operate from batteries or A.C.

The field is now open for every Australian radio amateur to be ready for an emergency. The W.I.A. is using no compulsion; it is all voluntary. Let every member capable of rendering assistance back the scheme to the full.

Around The Industry

ULTRA MODERN PORTABLE RECEIVER

A recent addition to the Mullard "Thousand" series of receivers is Model MBS 1050—a five valve portable set for operation from either self-contained or external dry batteries.

Housed in an attractive satin-finished aluminium case with moulded plastic ends and handles, this compact receiver measures 13 ins. long, 9½ ins. wide and 5½ ins. deep. The weight, including batteries, is 15 lbs.

The tuning range is from 530 kc. to 1620 kc. and a universal frequency scale with local station indicators is fitted. The dial shutter which covers the dial whilst the receiver is in transit, also acts as the main battery switch. A special quick-release type of hinge permits the ready changing of batteries and service attention. Extension leads are contained in the case so that external batteries can be used when required.

This receiver is now readily available from any Mullard distributor, whilst additional technical information can be obtained by writing direct to Mullard-Australia Pty. Ltd., Box 2118, G.P.O. Sydney.

RADAMETA VALVE AND MULTITESTER

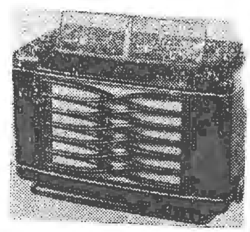
This instrument, which combines a mutual conductance valve tester and an AC-DC multimeter is capable of testing all components in the modern radio receiver.

The valve tester section is suitable for checking all valves, including the recently-released miniature button based type. The reliable mutual-conductance and gas test is employed to indicate the condition of the valve under test. In the case of rectifiers and diodes, an emission test is used. The scale reading is calibrated directly in Ma/V.

The multimeter ranges are: Volts, AC, DC and Output, 0-10-50-250-500-1000, Current 0-1-10-50-250 ma, Ohms, 50-500-50,000-10 meg., Capacitance, 1-50 mfd electrolytic and paper, .01 to .5 mfd paper and .001 to .05 mfd paper. In addition, the latest model reads Inductance 200mH to 50 henries, and Impedance, 65 to 15000 ohms.

The complete unit is housed in a black leatherette carrying case and is available in either AC, DC or vibrator-operated models. Additional information can be obtained by writing direct to the manufacturer, Radameta Test Equipment, Fowler Road, Guildford, N.S.W.

Three new models—the 113, 115 and 116 are the latest additions to the Philips Radioplayer range.



The model 113 is a five valve dual wave table model housed in an attractively moulded plastic cabinet. The frequency ranges are: B/C, 530-1620 kc.; S/W, 5.9-18.4 mc.

Fitted with the new Inclinator dial, this receiver also features an inbuilt aerial, gramophone pickup terminals, low level audio compensation and negative feedback. The ON-OFF switch is combined in the tone control.

Model 115 is similar in appearance to the 113, except that it covers the broadcast band only, frequency range being 530 to 1620 kc.

The Tablegram — model 116, is a five valve broadcast receiver and record player, housed in a streamlined timber cabinet. End control for ON-OFF switch being combined with the tone control. A Garrard record player is standard equipment, and this is suitable for either 10 or 12 in. records.

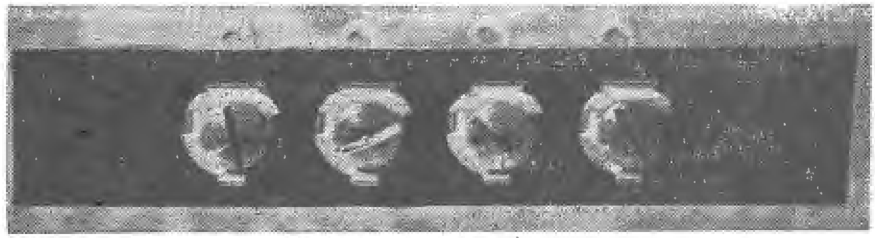
These receivers can now be seen at any Philips distributor, or further information can be obtained by writing direct to Philips Electrical Industries, Clarence Street, Sydney.

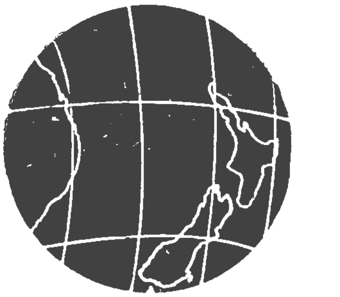
F.N. RADIO PRODUCTS

A screw-type of terminal strip intended for use in intercommunication systems and other applications where semi-permanent connections only are required is now available from F.N. Radio.

Consisting of heavy gauge plated lugs rivetted to a bakelite strip and fitted with screwdriver type of machined screws, this strip provides an easy means of making connections to leads fitted with spade lugs. It can be supplied in

For the small set enthusiast, this firm can now supply a midget two valve all-battery receiver using the latest 1.4 v. valves. This is housed in an attractive leatherette-covered cabinet measuring only 4½ x 5 x 3 inches, and comes complete with batteries and high quality headphones. The price is £8.17.6 plus postage. Further information can be obtained from F.N. Radio and Electronic Co., 265 Military Road, Cremorne, N.S.W.





TRANS-TASMAN DIARY

By J. F. FOX
(Special N.Z. Correspondent)

"RADIO NEW ZEALAND"—NEW S-W TRANSMITTER

On New Zealand's Dominion Day, September 27, Radio New Zealand, the Shortwave Division of the N.Z. Broadcasting Service began the first overseas service from this country.

The Prime Minister, Mr. Fraser, said in the inaugural broadcast that this was a notable occasion for the New Zealand Broadcasting Service, and that the purpose of the station was to present an accurate picture of life in the Dominion to the rest of the world. Although the power of Radio New Zealand is not strong compared with overseas stations, he hoped that the new service would do much to extend a mutual understanding with the peoples of other countries, as well as strengthening still further New Zealand's enduring comradeship with Australia and the Pacific Islands.

The Minister in Charge of Broadcasting, Mr. Jones, sent greetings to listeners in Australia and the Pacific. He said that many New Zealanders listened to the strong signals from Radio Australia and tonight, the New Zealand Broadcasting Service was able to reciprocate in the field of shortwave broadcasts. A further message was broadcast on behalf of the Maori people by the Hon. E. T. Tirikatene.

The National Orchestra conducted by Andersen Tyrere, and featuring the brilliant New Zealand pianist, Richard Farrel was heard in the opening programme. The first part of the broadcast was relayed by stations of Radio Australia.

The policy of the Shortwave Division is to provide a programme with the maximum entertainment value. Approximately three-quarters of the time on the air will be given to musical programmes, while the remainder will consist of talks and newscasts. A weekly session by the Tourist Department is designed to catch the ear of those who intend to visit this country.

For the first month, Radio New Zealand will be transmitting over ZL3, 11780 kcs. in the 25 metre band, and ZL4, 15280 kcs. in the 19 metre band. The other station likely to be used is ZL2, 9540 kcs. in the 31 metre band.

New Zealand readers are invited to contribute any items concerning radio, broadcasting, DX-ing and amateur rodio 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.

SOFAR Distress Aid

The Minister of Defence, (Hon. F. Jones) has announced that the United States Government had agreed to make available to member States of the International Civil Aviation Organisation (ICAO), in the South Pacific Region, technical data on a position-fixing device, known as SOFAR, which is now under development.

By means of this device, it will be possible to establish, almost immediately, the exact position of an aircraft or ship in distress at sea. Aircraft and ships at present depend on the reception of a distress message sent by radio, but this method is not always reliable.

SOFAR is a device based on the theory that there exists in the temperate latitudes of the Pacific Ocean a sound velocity structure such that the velocity decreases with depth to approximately 350 fathoms, and beyond that it increases with depth. In accordance with the laws of wave refraction, this plane of minimum velocity forms a natural sound "channel" over the entire area of the ocean. Due to this channelling effect, sound originating at or near the depth of minimum sound velocity is detectable at very great distances.

A "SOFAR Network" consists of at least three widely-separated hydrophone installations bordering the ocean area to be covered. The hydrophones are anchored at the sound channel depth and connected by cable to monitoring equipment on the shore.

To determine the position of a vessel in distress, a special type explosive acoustic signal, designed to explode at approximately 350 fathoms, is dropped overboard. When it reaches the approximate depth of the sound channel, the pressure detonator sets off the main charge and the resulting sound proceeds from that point in all directions.

Due to the channelling effect, the sound is more or less concentrated in one plane through the ocean, and is therefore detectable by the sensitive hydrophones at very great distances. When the sound reaches each of the listening hydrophones on which a continuous watch is maintained, it is recorded and timed very accurately. The time of arrival for each station is transmitted by radio to a plotting centre, where an accurate fix is then made on the source of the distress signal.

The Change Over

On Wednesday, September 1, the change over of frequencies and call signs of New Zealand radio stations took effect. Engineers and technicians of stations throughout the Dominion were engaged on the preparatory work for the change over some weeks prior to the beginning of the month.

At Makara, technicians of the Post and Telegraph's radio station measured the stations' accuracy on their new frequencies with special equipment. The accuracy of the checking instruments are correct to one part of 5,000,000. If there is the slightest variation in frequency, the station concerned is notified and adjustments are made. One unannounced change was 1YD, Auckland, which changed from 1250 kc. to 1280 kc.

It is too early yet to ascertain whether the change will be an improvement. However, Southland listeners have complained of heavy interference from across the Tasman to New Zealand national stations. Other centres in the Dominion seem to be satisfied with the change, though at first some difficulty was experienced by listeners in finding stations on the new frequencies.

Coinciding with the frequency changes, the usual cuts imposed on radio broadcasting were lifted, and the normal hours restored. This was the first time since March 1944, that radio stations have had an uninterrupted transmission from morning to night.

Radio Controlled Taxis

Two cars of the Wellington Co-operative Taxis Ltd., now have mobile radio telephone sets installed for communication with their head office. This marks the first taxi service in New Zealand to adopt radio telephone. An official of the company announced that it was the company's intention to equip all of the 100 cars of the fleet, which would cost approximately £19,000.

The Post and Telegraph Department recently demonstrated to the Wellington Free Ambulance Board with mobile radio telephone. Test runs were carried out in a departmental car through streets of the city and suburbs. The Hutt Valley, Trentham and Silverstream districts were also included in the tour. Communication was maintained with the Wellington East Post Office throughout, except when the car was in the Haitaitai tunnel. It is reported that the Wellington City Council is now considering installing radio telephone in some of their vehicles.

The Wellington service operates through two fixed stations on high points on either side of the city. The conversation is taken by landline to these stations, where it is broadcast on ultra high frequencies, and picked up by the vehicle as it moves through the streets of the city or suburbs.

New Club Formed

At a meeting of Otago and Southland amateur radio hobbyists held at Invercargill recently, it was decided to form a new organisation—the New Zealand Radio DX League. The league is controlled by a board of 10 members, five in Dunedin, who constitute the administration committee, and five in Invercargill comprising of the magazine committee. This organisation will ensure the closest co-operation between the two respective bodies who will meet bi-annually.

The league's magazine which was named The New Zealand DX Times, will exchange news with overseas radio clubs and magazines by radio and air mail. A new type of reception report form has been printed along the lines of the American forms. Membership will be open to anyone interested in long-distance radio reception.

The following are the office-bearers: **Dominion president**, Mr. L. E. Warburton (Invercargill); **vice-presidents**, Messrs. A. M. Branks (Invercargill) and J. F. Fox (Dunedin); **secretary-treasurer**, Mr. D. L. Lynn (Dunedin); **board of directors**, Messrs. K. A. Mackey, J. I. Martin, P. Thorn (Dunedin), A. J. Allan, D. J. Carter and A. T. Cushen (Invercargill); **administration committee**, Messrs. Fox, Lynn, Mackey, Martin and Thorn; **magazine committee**, Messrs. Branks (editor), Cushen, Carter, Allan and Warburton.

ON THE BROADCAST BAND

BRITISH ISLES TRANSMITTERS

Reception of broadcasting stations operating from the British Isles on the normal broadcast band frequencies is possible at many locations in this country during the summer months.

At present, the best time to listen for these stations appear to be around 5 a.m., when signals can be heard for approximately two hours. Since the British Isles are, of course, in the Greenwich Mean Time zone, 5 a.m. AEST corresponds to 7 p.m. in England—daylight saving being in use during the British summer months only since the end of the war.

"Home" Service

The British Broadcasting Corporation provides several services for listeners "at home", as well as their international short wave services. The network known as the "BBC Home Service" emanates from the following transmitters using the frequencies listed:

877 kc. The London area is served by a 100kw. transmitter located at Brookmans Park, near Hatfield, Herts.

1013 kc. Midlands district served by a 60 kw. transmitter at Droitwich, Worcestershire, and a 1 kw. transmitter at Norwich, Norfolk.

1348 kc. West of England, Clevedon, Somerset, 20 kw. and Bartley, Hampshire, 10 kw.

Stations in the above Home (or regional) network frequency are all linked for programmes, but stations have many programmes scheduled which are broadcast by the originating station only.

Light Programme

The light programme, an alternative service to the above (with broadcasts of light entertainment, sport, etc.) operates as follows:

200 kc. A powerful 150 kw. station operates on this long wavelength from Droitwich.

1149 kc. (alternative channel) transmitters at Brookmans Park, 60 kw. Burghead, 20 kw. Moorside Edge, 60 kw. Lisnagarvey, 10kw. Westerglen, 60 kw. Stagshaw, 10 kw Redruth, Cornwall, 2 kw. Redmoss, 2 kw. Plymouth, Devonshire, 1 kw. and Londonderry, 1 kw.

977 kc. West of England, Start Point, S. Devon 100 kw.

804 kc. Wales, Washford, Somerset, 60 kw., Fenmon, Anglesey 10 kw., and Wrexham, Denhigh 1 kw.

668 kc. North of England, Moorside Edge, Near Huddersfield, Yorkshire 100 kw.

1050 kc. North of England and Northern Ireland, Lisnagarvey, Co. Antrin (N. Ireland) 100 kw., Londonderry, Co. Derry 1 kw., Stagashaw, Northumberland 100 kw.

767 kc. Scotland, Burghead, Morayshire, Scotland 60 kw., Redmoss, Near Aberdeen 2,500 w. and Westerglen, near Falkirk, Stirlingshire, 60 kw.

Third Programme

The BBC "Third Programme" carrying the more serious type of presentations (opera, serious talks, orchestral concerts, etc.) operates also on two frequencies:

583 kc. Droitwich, 20 kw.

1474 kc. A series of some 22 transmitters operating from cities throughout the U.K. on low power, which is dependent on the size of the city and surrounding district to be serviced.

Medium wave transmissions beamed to Europe from England go out on:

1112 kc. from a 60 kw. transmitter at Crowbridge, on the Sussez coast.

637 kc. A 100 kw. job in Norden, N.W. Germany is used at present.

167 kc. (Long Wave) Ottringham, near Hull, 50 kw.

These usually present programmes in European languages, with English occasionally.

Although at first glance it may appear strange that very high powered transmitters are used in such a comparatively small area as the British Isles, it should be realised that large numbers of transmitters operate from the European continent. Since these transmitters cause a great deal of interference, the high power is necessary to ensure good, interference-free signals of local stations in any part of the British Isles.

The BBC pioneered a system of broadcasting whereby several transmitters running the same programme operated on the same frequency, providing good reception in selected districts, while an alternative frequency is available to listeners in districts where interference prevents good reception on the former channel.

By
ROY HALLETT

HISTORIC NOVEMBER

The month of November appears to be quite an historic month, as far as broadcasting is concerned, as it was on November 22nd, 1922, that station 2LO London first began regular broadcasting from Marconi House. This was operated by an organisation which eventually became the British Broadcasting Corporation.

However, two years earlier, on November 2nd, 1920, broadcasting as we know it today, really began when station KDKA Pittsburgh, Pennsylvania, U.S.A., broadcast an election result service. This is generally considered as the first pre-arranged public broadcast in the world. The idea occurred to employees of the Westinghouse laboratories, formerly engaged on wartime radio work, that radio entertainment on a large scale may be a good plan, after they had entertained friends by playing records over a small transmitter.

KDKA is still in operation these days, with a power of 50 kw. and using ultra-modern equipment. The station operates on 1020 kc. and has been heard under favourable conditions by a few Australian listeners, particularly on the Queensland coast.

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

RECENT VERIFICATIONS

Mr. Art Cushen, Invercargill, has just received his verification of reception of All India Radio's Cuttack station, and has been told he was the first N.Z. listener to report their reception. Located at Cuttack, some 250 miles south of Calcutta, this station reported back in our July issue as a new station (thanks largely to Mr. Gillett), took the air only on January 28th last. It operates with the call sign, VUK2, on 1355 kc. and, which makes Mr. Cushen's reception the more remarkable, with a power of only 1 kw.

We have already received much interesting news of Indian broadcasting affairs from Mr. Sanyal, in Sydney, and Mr. Pande, in Canberra, and look forward to hearing from their offices frequently in the future.

Other new arrivals at Arthur's address include replies from such Europeans as Hanover, Germany, 1330 kc., Lyons, France, 1339 kc., Milan, Italy, 1222 kc., Venice, Italy, 814 kc. and the new Aussie, 6CI Collie. These Europeans will be others to watch for around 5 a.m. AEST during coming weeks. This reader is hearing interesting signals from North America around 5 p.m. our time, and so other readers across the Tasman are advised to listen at this time. Art is also hearing CFRN, Edmondton, Alta, Canada, at present on 1260 kc. and KTMS, Santa Barbara, California, 1250 kc., both till 5 p.m. (7 p.m. in N.Z.).

IRISH STATIONS

From Eire, we find the following stations at present in operation:

565 kc. Athlone, 100 kw.
1348 kc. Dublin, 2 kw.
1240 kc. Cork, 1 kw.

While it is most unlikely that the above, and other low-powered transmitters in this list may be heard in this country, readers in particularly favourable locations for DX may be fortunate enough to log some of them.

Denmark's "World Radio Handbook" suggests addressing mail for the last-mentioned stations to "Radio Eirrann", c/o. G.P.O. Dublin.

NORTH AND SOUTH AMERICAN STATIONS

North Americans should provide interesting listening for DXers in this country also, during the coming weeks, around midnight. As these stations announce call signs frequently, it is generally not so difficult to identify them. KSL, Salt Lake City, 1160 kc., KNX, Los Angeles, 1070 kc. (after 6WB closes, 12.30 a.m.), KFI, Los Angeles, 640 kc. should be among the stronger signals.

The latest verification to reach our listening post is the blue and white card (with its dancing lady, station details, etc.) from the 10 kw. Hawaiian, KULA, operated by the American Broadcasting Co., on 690 kc. Transmissions are from 1 a.m. through to 8 p.m. next day (5 a.m.-midnight in Hawaii) except Monday mornings, when we hear them from 2 a.m. Listen for other strong signals from Hawaii around 2 a.m.

Reception of signals from stations operating from South and Central America and West Indies is very seldom experienced by medium wave DXers in this country, although from time to time we hear of someone picking up one or two stations from that part of the zone. LS4, Buenos Aires, Argentina, 670 kc. and one or two other South Americans were heard and verified in South Australia a few years back, the stations being heard (I think) around 11 p.m. or midnight.

We would be interested to hear from anyone hearing signals from these areas, (as well as from any other part of the world, of course) but we hasten to again point out that reception from the above areas is indeed an event in this country, although our friends in New Zealand are able to receive quite a few at sunset and later at night.

SHORT WAVE LISTENER

BY TED WHITING

RECEPTION CHANGES WITH LOCALITY

Although reference has been made previously to the variation in reception of short wave stations in different localities, this fact was brought to mind very forcibly a few days ago on receipt of a letter from a short wave listener of some years standing.

This enthusiast recently moved from a good Sydney suburban location to Kempsey, N.S.W., and he writes in an interesting letter on the variation in reception of both the short wave and broadcast bands. Using a communications type receiver of recent design, he finds that stations previously received at full strength are practically inaudible, and their place is now being taken by stations previously heard only in the background.

Such a change in reception is by no means uncommon and this letter serves to illustrate the value of receiving logs from various parts of the country, in order to present an overall picture of current reception conditions. Consequently, we do ask all short wave listeners, irrespective of whether you are using a single valve receiver or a large receiver as our friend, to send in listening logs each month, as this will then enable us to give a more comprehensive coverage of the stations which are likely to be heard at any given time.

So then, readers, let us have those reports, together with any other pertinent short wave data, and to avoid delays, suggest you address them direct to our listening post, 16 Louden Street, Five Dock, N.S.W.

READERS' REPORTS

Details are to hand this month from Miss D. Sanderson, Malvern, Vic.; Mr. A. T. Cushen, Invercargill, N.Z.; Mr. A. D. Addis, Ascot, Q'ld.; Mr. N. A. Hanson, Kempsey, N.S.W., provide interesting reading and we give details as follows.

Miss Sanderson writes of her reception, interrupted by a holiday spent in Adelaide, XEBT being her best station, with XEWW also doing very well in the afternoons. Italy on 15120 kc. in the mornings has been outstanding with its parallel transmitter on 11810 kc. heard at 7.45 a.m. with announcements in English.

H12T, 9727 kc. is heard at 7.45 a.m. with a good signal. Spanish news and a good programme of music are also heard.

HH3W, 10130 kc. is another one heard; this one at 10 p.m., news in French and music are heard, followed by the usual CBS relay.

China stations reported this month are represented by firstly, XGOA, 15100 kc., which is heard at good level at 7 p.m.; news and music are heard. The outlet of XGOA on 5985 kc. is heard with a service in Chinese at 9.45 p.m.

XNNR, 7097 kc. at 11 p.m. is another good one; English news is heard, but as Miss Sanderson reports, there is much QRM. XNNR and XGAS, 7105 kc. are two of the strong stations which are operating in the 7 mc. amateur band; both are unstable as regards to their frequency and cause a lot of bother on the band. XGAS carries an AFRS relay on that frequency, as do the other outlet on 11680 kc., also at 7.15 p.m.

XGOY, 15170 kc. is another one heard at 7.15 p.m.; good signal and news in English.

XLRA, 11500 kc. at the same time is strong, with a programme of Western type music, and news in Chinese.

XMTA, 12217 kc., with a programme of similar type; good signal at 7.30 p.m.

XKPB, 12120 kc., at 7.45 p.m. is a fair signal with very bad interference at 7.45 p.m.

XGOA, Nanking is heard on 17765 kc. on this new frequency at 6-7.40 p.m., with news in English at 7 p.m.; also heard on 9720 kc.

XGOA, 15105 kc., has a special service directed to Australia and New Zealand at 7-7.50 p.m. News is read at 7 p.m. Musical programme follows, "Concert Hour." Reports are requested by the station.

SEAC is heard on both 15120 kc. and 9520 kc. with good signals. Listen for these at 10 p.m.

Kuala Lumpur, 6030 kc. at midnight, with news in English and sporting results; fair signal here.

JFK2, Tokio, 4910 kc. has verified to Mr. Cushen; new address noticed is R. H. Nimmo, Liason Section, Broadcasting Corporation of Japan, No. 2, 2-Chome Uchisaiwaicho Chiyoda-ku Tokio, Japan.

YV3RN, "Radio Barquisimeto", 4940 kc. has also verified, address is "Radio Barquisimeto", Avienda Bellavista 461, Barquisimeto, Venezuela.

KZMB, Manila, 6000 kc is a new one, operating at 9 p.m. with a good signal. Station closes at 2 a.m.

Radio Pakistan has been reported as on 6063 kc. Located at Dacca, Pakistan, the station is heard using English at 1.30 a.m. News is read for local listeners at 10.30 p.m.

Radio Hanoi, Indo-China has moved in frequency to 6190 kc. from the former assignment of 6050 kc. The signal here is much stronger than formerly; best reception is at midnight.

The Forces Broadcasting Service, Cyprus, is heard on 7220 kc. at 1-6 a.m. This transmitter is the same as was in operation from Jerusalem under the calls JCJC and JCKW. A change in frequency is likely, as in some parts interference is experienced from KZCA, Salzburg, Austria. No address is available for reports.

Hamburg, 7295 kc. Nordwestdeutcher Rundfunk, Rothenbauchausse 132-134, Hamburg, Germany is the address for this one which has recently moved in frequency from 6115 kc. to 7295 kc. where is it heard at quite good level at opening at 2 p.m. News in German is read at 2.45 p.m.

Another station recently verifying to Mr. Cushen is CQM4 operating on 7925 kc. on their schedule of 7.30-9 a.m.. The address is Emissora de Guine Estacio CMQ4, Bissau, Portuguese Guinea.

VLT7, Port Moresby verifies by card and letter from C. G. Elworthy, Superintending Engineer, G.P.O. Brisbane, Q'ld. The schedule is: Sunday, VLT5, 7280 kc., 7.45-11 a.m., 6.15-10 p.m.; VLT7, 9520 kc., noon-2 p.m., 4-6 p.m. Monday to Friday, VLT5, 6.45-8.45 a.m., 6.15-10.45 p.m.; VLT7, 1-2.45 p.m., 4-6 p.m. Saturday, VLT5, 6.45-8.30 a.m., 6.15-11 p.m.; VLT7, noon-6 p.m.

PRLS, 11720 kc. at 7.15 p.m. with news in Spanish and PRL7, 9720 kc. at 7.45 p.m. are also heard, the latter using the slogan, "Radio Nacional".

LRM, 6180 kc. provides a nice signal at 8.30 p.m.; usual programme of music and announcements in Spanish are heard.

The Nicaraguan transmitter is still 11, heard at 10 p.m. on 6300 kc., opening at 9.58 p.m. with a fair signal; noise is bad on this frequency, but the signal is intelligible.

TGLA, 6295 kc. at 10.12 p.m. opens with a bugle call and announcements in Spanish. News, etc.; good signal.

XEHH, Mexico, 11880 kc. is fair at 3 p.m. and XEQQ, 9680 kc. is also fair at 3.30 p.m. Both stations are frequently heard in the afternoons till as late as 5 p.m.

COBC, 9370 kc., news in Spanish at 9.30 p.m., fair signal from this one in Havana.

LRY1, 9545 kc., with local and world news in Spanish at 8.30 p.m. is fair at most locations; good music following.

HIG, Dominican Republic, 6115 kc features a lottery drawing on Sunday nights at 8.45 p.m.; fair signal marred by interference from CW stations.

HP5A, Panama, 11700 kc., another good one from Panama at 9 p.m.

COHI, 6445 kc. and COCQ, 8830 kc., both from Havana are heard nightly from about 9.30 p.m. Frequently reach good level.

CP15, La Paz, Bolivia, "Radio El Condor", on 5840 kc. Verification received by Mr. Cushen, address "Radio El Condor," Ave. C. Camache, 72, La Paz, Bolivia.

PRL5, 11950 kc., "Radio Ministerio de Educacion", heard to sign off at 10.30 p.m.

HJKF, 9520 kc. Emisora Nueve Munde, Bogota, Colombia. Heard in New Zealand till noon on sign-off.

YV3RN, now on new frequency of 4940 kc. was previously heard on 4990 kc. Address is "Radio Barqueisimeto," Avenida Belleviata 491, Barquisemeto, Venezuela.

HC4LVC, Bahai, Ecuador, new station on the air on 4202 kc. and heard in N.Z. at noon.

OAX8A, 5840 kc., Piura, Peru, has moved to this frequency from 6195 kc., signs off at 12.30 p.m.

HORT, 6060 kc., "Radio Balboa," Panama, signs off at 12.15 p.m., new station.

HHCM, 6400 kc., Port au Prince, Haitii, has moved to this new channel; may be heard well about midnight.

"Radio Mundial", Panama, is another new transmitter on the air, on 6460 kc. and should be heard at around midnight.

PRL4, Rio de Janeiro, is on the air on 9770 kc. at the same time as the previously mentioned PRL5; closes at 10.30 a.m.

WRUX, 25600 kc., reported by Mr. Cushen, from "Universalite." Schedule is 2-5 a.m.

Radio New Zealand is heard well here on 11780 kc. and 15280 kc.; is putting in a tremendous signal in transmission at 5-7 p.m. daily.

HC4MN, 9870 kc., "La Voz de la Democracia", Manta, Ecuador. New station heard till 2.30 p.m. most days.

VP4RD, Trinidad, 9648 kc. is heard at good level with the session, "Church in the Wildwood,"; news and music are also heard at 8 p.m.

NEWS FROM AMERICAN CORRESPONDENT

In his usual monthly bulletin, Ken Boord, of "Radio News", U.S.A., reports that a new transmitter is soon to be set up on Mauritius.

The power of the new transmitter will be 1.5 kw. and should be heard in this country without much difficulty provided, of course, that a suitable choice of frequency is made.

PCJ, Hilversum, Holland, the following outlets are heard at good level. 21480 kc. at 8 p.m., 15220 kc. at 7 p.m., 11730 kc. at 6.45 a.m. and 9590 kc. at 7.30 a.m. Fine programmes are heard from all.

Paris, 17850 kc. at 12.15 a.m. is another fine signal, when news is read in French.

Geneva, 6345 kc., at 6.30 a.m. is a good signal; heard recently with talk covering the activities of the International Red Cross in Palestine.

Rome, 11810 kc. at 5.45 p.m., and also at 7.15 a.m. Heard in English in the morning.

SBP, Sweden, 11705 kc. at 5.45 p.m.; recently heard DX session conducted by Arne Skoog. Will be heard again at 5.15 p.m. on 9/10/48.

Radio Tirana, Albania, 7852 kc., news and music; French is the language used at 6.30 a.m.

Monte Carlo, 6038 kc. at 5.45 a.m.; good signal in news, followed by music.

CS2MK, 11027 kc., Lisbon, Portugal. Heard well with usual programme at 6 a.m.

Radio Dacia Romana, Societatea Romana de Radiodifuziune, Str General Berthelat 41, Bucharest, transmitting on 9250 kc. and is heard at 6.15 a.m.

Radio Denmark on 9520 kc. is heard in broadcast to South America at 2 p.m.; Spanish used.

HJCK 8300 kc., HJKB 6000 kc. and HJKF 9520 kc. are operating in relay from 5-7 p.m. and the stations are anxious to receive reports which should be addressed to Emisoras Nuevo Mundo, Bogota, Columbia.

U.N.O. Transmissions

Reports on U.N.O. transmissions heard from Paris should be addressed to Mr. Boothe, United Nations Services, Palais de Challiot, Paris 15. These transmissions will be relayed in English, Spanish, Portuguese, French and possibly other languages. Frequencies to be used are 17765 kc., 11845 kc. and 15100 kc.

A new outlet from Angola is Radio Clube de Bie, Silva Porto, Angola. Heard on 7550 kc. at 8-9 a.m.

Munich is now taking a relay of the Voice of America transmissions on 6080 kc., 7250 kc. 9540 kc. and 11870 kc., 7 a.m.-1 p.m.

The Hamburg outlet formerly on 6115 kc. has now moved to 7290 kc. is operating from 7 p.m.-1.30 p.m. Power is reported to be 50 kw.

Philippine Stations

Stations in the Philippine Islands are well received at most locations, among the best being:

KZMB 6005 kc. at 11.45 p.m., with news in English.

KZRC 6140 kc. at 12.50 a.m., musical sessions, chimes at the hour, etc.

KZPI 9500 kc., 12.30 a.m. with English news and usual programme.

KZOK 9692 kc. at 6.45 p.m. with programme for local listeners.

KZFM 96200 kc. at 7.45 p.m., with news in English.

KZOK 10000 kc. at 6.30 p.m.; bad choice of frequency as this signal interferes with the Frequency Standard station WWV. Can look for change of frequency here.

KZRH 9640 kc. at 7.30 a.m. in "Early Bird Session." News read later.

Radio France, Hanoi, Indo-China, has moved to 6190 kc. from the previous frequency of 6050 kc.; better signals are the result.

B.B.C. Controls Singapore

The BBC have now taken over the Singapore transmitters as forecast recently, and new transmitters are to be erected in the near future. These transmitters will, of course, take relays from London, but a certain amount of local programme will be radiated. At present, Singapore, the British Far Eastern Service is heard well on 6770 kc., 7.15 p.m.-2.30 a.m., 9690 kc., 9 p.m.-2.30 a.m., 11730 k.c., 7.15 p.m.-2.30 a.m., 15300 kc., 7.15 p.m.-2.30 a.m. All transmitters are using 7500 watts.

Hong Kong Schedule

ZBW, Hong Kong, 9520 kc. is heard regularly. Latest schedule is 2.30-4 p.m., 8.30 p.m.-1 a.m., with the English periods 3-3.10 p.m., 8.30-9.30 p.m., 11 p.m.-1 a.m. This station verifies by letter; address is ZBW, Hong Kong Broadcasting Studio, Gloucester Building, 2nd Floor, Hong Kong.

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.

lator system is derived from the modulating source) is made to frequency-modulate a 10 kc. signal, known as the *sub-carrier.*

This sub-carrier is then used to amplitude-modulate the r-f signal in the centre or the fixed aerial, as the case may be. Use of this 10 kc. sub-carrier method allows the reference-phase signal to be easily separated at the receiver from the variable-phase signal by the use of an audio filter.

Since the variable-phase signal represents a modulation at a relatively low audio-frequency (30 or 60 cycles/sec.) and since the reference-phase signal is transmitted as an f-m 10 kc. signal, there is available a frequency range from, say 300 to 3000 cycles, which can be used for speech modulation of the signal from the centre or the fixed aerial, as the case may be. However, the total effective modulation from all sources must not exceed 100 per cent. Hence the station can be used for V.H.F. communication in addition to its primary function as an omni-directional range.

Range Transmitter Details

Fig. 7 shows the general arrangement of an omni-directional range transmitter using fixed aerials and a balanced-modulator system, while Fig. 8 shows the corresponding arrangement when the balanced-modulators are replaced by a capacity goniometer. Note that the r-f input signal for the latter is derived from the output of the modulated power amplifier via a clipper or limiting circuit which removes the 10 kc. modulation.

The transmitter arrangement, when a rotating *figure-eight* aerial is used, is somewhat similar to that of Fig. 8, the difference being that the output of the clipper would be fed direct to the rotating aerial, while an A.C. generator driven from the shaft of the latter would be used to supply the modulating e.m.f. used in producing the reference-phase modulation.

Of the three methods described for producing a rotating cardioid diagram, that of the mechanically rotated *figure-eight* aerial appears the most straightforward and, requiring the least amount of associated equipment has, therefore, the least number of possible sources of error. It seems likely that when the inherent problems, mechanical and otherwise, in this form of aerial have been overcome, it will present the best solution for the omni-directional range.

Form of the Receiver in the Aircraft

The aircraft equipment for use with the omni-directional range is relatively simple. The basic requirement is that it shall measure the phase-difference between the received reference-phase and variable-phase modulations; this phase-difference angle in electrical degrees is then the bearing of the aircraft from the range station.

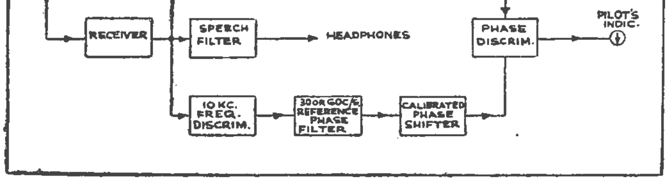
The receiver itself follows the conventional form for VHF communication equipment; it should have high sensitivity, a good A.V.C. characteristic, and linear audio amplification so as to avoid cross-modulation. The audio output of the receiver is applied to filters, which divide it into three parts, namely: (a) Reference-phase modulation (frequency-modulated 10 kc.); (b) Variable-phase modulation (30 or 60 cycles/sec.); (c) Speech modulation.

The f-m 10 kc. signal is fed to a discriminator, the output of which provides the reference-phase signal at 30 or 60 cycles. This signal is then passed through a variable phase-shifter, the purpose of which will be described shortly. The reference-phase from the phase-shifter and the variable-phase modulation are together fed to a phase-discriminator the output of which goes to the pilots' centre-zero type indicator.

A simple phase-discriminator circuit is shown in Fig. 9. This circuit gives a null indication on the pilots' meter when the two applied phases have a definite fixed relationship (90 deg. phase difference). The method of operation of the equipment is to rotate the reference phase-shifter previously mentioned, which is calibrated in degrees, until the pilots' indicator reads zero. The bearing of the aircraft from the range station can then be read directly off the phase-shifter dial, and if it is desired to fly on this bearing towards or away from the station, it is merely necessary to head the aircraft so that the pilots' indicator needle remains at its central position.

A block schematic diagram of the aircraft equipment is given in Fig. 10.

As an alternative to the above method of presentation, it is possible to devise a more complex arrangement using two discriminators, which presents the bearing of the station directly to the pilot on a meter, i.e., there is then no need for him to rotate manually a calibrated dial to find his bearing.



★ **Fig. 10. — Simplified block schematic circuit of airborne equipment.** ★

Experimental Flight Results

Flight tests made in the United States on the system in its present stage of development indicate that for a very large percentage of the tracks flown, the overall error is less than plus or minus 2 deg. Considerably greater errors than this have however been observed for short periods.

Errors in the system can arise in the transmitter, in the receiver, and as a result of anomalous propagation (reflections from hills, etc.). The latter type of error being least susceptible to control is likely to prove the most troublesome. Errors in the ground and airborne equipment can probably be reduced to negligible amounts.

In order to reduce propagation errors it has been found essential to use horizontal polarisation of the signals.

A considerable further amount of experimental and operational flying on omni-directional ranges of this kind is required before their full value can be assessed. Possible disadvantages are that each installation will require very exhaustive site-testing before being passed as safe for airline use, and also that relatively large errors which appear at short ranges from the station may render it unsatisfactory for localiser applications (i.e., track guidance in the final stage of the descent to the runway. On the other hand, advantages of the system are the truly omni-directional track system it provides, and the fact that only a single installation is required at each site.

STRATOVISION — AERIAL T-V SYSTEM

(Continued from page 26.)

commercial venture, since it can be adapted to the upper band T-V. The shifting to frequencies in the band 475 to 890 mc. would naturally call for many changes, particularly in aerial design, compensation for climb and bank effects, as well as signal polarisation, and for these reasons the system must be considered only as a future possibility.

That Stratovision is technically feasible can no longer be seriously questioned, but that does not bring Stratovision into being, as attention must be given to other problems associated with it. These include such factors as reliability of aircraft and telecast equipment over long periods of time, during high winds and under all types of storm conditions. Another factor to be considered and probably the most important will be the question of economics, as the system will have to prove that it is comparable in operating costs to present day systems. When these problems have been surmounted, it is possible that Stratovision will be the link for long-distance high-frequency transmissions, but on present indications this will be well into the future.

BASIC MAGNETISM AND ELECTRICITY

(Continued from page 25.)

transformed to light and heat energy, and the *power* rating of the lamp is the *rate* at which electrical energy is being transformed.

Obviously, the lamp cannot *consume* a rate; hence, it cannot consume power. If it consumes anything, it consumes energy, but technically, it *transforms* energy. This argument applies with equal force to all electrical apparatus. If, when you speak of *power consumption*, your listener infers that you mean *energy transformation*, no harm is done. If your listener infers that you mean *power consumption*, a great deal of harm is done.

This example emphasises the necessity of giving electrical terms their proper meaning. Before protesting that such pedantic exactitude is not necessary, it would be well to remember that some electrical phenomena is of a particularly abstract nature—for instance, radio transmission—and it is imperative that electrical terms be thoroughly understood before a study of abstract phenomena is attempted.

(To be continued)

NEW ZEALAND READERS

Ensure you receive every copy of RADIO SCIENCE as soon as it is published by taking out a subscription. This can be made through our local agents, H. Barnes & Co., 4 Boulcott Terrace, Wellington, any branch of Gordon and Gotch Ltd., S.O.S. Radio Ltd., 283 Queen Street, Auckland, C.1., or if you prefer, by writing direct to our office, Box 5047, G.P.O. Sydney.

In each case the rates are the same: 12/- per annum, or 21/- for two years, post free to any address in the Dominion.

X-RAY THICKNESS GAUGE

(Continued from page 6.)

of an inch. The instrument scale readily shows one ten-thousandth inch deviation from standard. Laboratory tests show that sensitivities of one-half of one per cent. and accuracies of one per cent. are easily obtained.

The operator can check the accuracy of the gauge from his remote position any time he questions it. By a solenoid arrangement, a test piece can be inserted in place of the product.

There are hundreds of applications for an x-ray thickness gauge, such as the measurement of the thickness of linoleum, plastic, sheet glass, many types of sheet metal and paper and cardboard. The gauging of glass container wall thickness is readily accomplished by scanning the container's wall to locate thin portions.

The Mail Bag

N.K.K. (East Maitland, N.S.W.) recently completed the Dual Wave Five and says:—"I am writing in appreciation of the fine performance experienced with the Dual Wave Five as described in the September issue of RADIO SCIENCE . . . Let me say that this set is unsurpassed in quality on both the gramo and radio sections and I would thoroughly recommend this circuit to anyone who wished to build a really good performer."

A.—Many thanks for the letter, N.K.K. We are pleased to hear of your success with this receiver and might add many other readers have written in a similar vein, of the outstanding performance of this circuit. Your remarks concerning the magazine are appreciated.

W.D. (Footscray West, Vic.) forwards the circuit of a direct coupled amplifier using a single 807 in the output stage.

A.—The circuit submitted was quite interesting, and should give good results. It may be possible to publish a copy of this circuit in a future issue when space permits, for the benefit of our many amplifier enthusiasts. If you can provide a photograph or two of the unit, together with a correctly drawn response curve and other pertinent data, we would accept this as a contributed article. In the meantime, we will retain the circuit until we hear from you again.

I.F.J. (Walgett, N.S.W.) asks for the socket connections for the 6U5/6G5 type of tuning indicator.

A.—This valve requires a six-pin base, and the socket connections are as follows:—Pin 1, Filament; Pin 2, Plate; Pin 3, Grid; Pin 4, Target; Pin 5, Cathode; Pin 6, Filament. This valve can be operated with 250 volts on the target, and the plate fed through a 1 meg. coupling condenser. The usual set connection is made to "F" of the second intermediate. The grid is connected through a series resistor, and a suitable value condenser is connected from grid to earth to form a filter circuit to prevent modulation flicker.

L.S.D. (Claremont, W.A.) refers to the quiz in the September issue of RADIO SCIENCE and queries our answer to question 8.

A.—Yes, L.S.D., you are quite correct. Apparently one of those "slips of the pen" has occurred and the answer in this case should be (b) and not (d) as shown. Transport difficulties are usually the cause of the late deliveries in your State, but we anticipate a big improvement in the near future. It is hoped to have the issue on sale in most States by the 1st of the month, commencing with the next issue. We are pleased to hear you are a regular reader and that you find each issue to your liking.

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.C. (Annerley, South Brisbane) asks several questions concerning the two-valve tuner in the March issue of RADIO SCIENCE.

A.—The circuit diagram is correct with the five .0001 mfd condensers. Apparently one of these was left out in the parts list. The condenser in the EBF35 cathode circuit marked 25 and .1, simply means that across this resistor there should be connected a 25 mfd electrolytic condenser as well as a .1 mfd r-f bypass. This method of marking obviates the need of showing two separate condensers. We appreciate your remarks about the magazine, and regret it is impossible at the moment to answer technical queries by mail. We wish you success with your radio studies and would be pleased to hear from you any time you may have a technical problem.

N.M.P. (Bulahdelah, N.S.W.) recently built up the All Wave Two as a broadcast receiver only, and writes in to tell of his success with this small receiver.

A.—Your interesting letter was much appreciated. We are pleased to hear that the remarks in the August issue in reply to your earlier letter were of assistance to you. The receiver looked quite smart in the cabinet, but unfortunately the photographs were not clear enough for us to make a suitable block for reproduction. The use of a two gang condenser would not affect the selectivity unless an r-f stage was added. Small receivers of this type having a single tuned circuit are not very selective and difficulty is often experienced in separating strong nearby stations. You could try shortening the aerial, or alternatively connecting a .0001 mfd condenser in series with the aerial lead in. Either of these changes may improve reception in your area. The photographs will be returned to you very shortly and thanks again for sending these along.

H.F.D. (Norwood, S.A.) is an ardent short wave listener and writes in to ask why the tuning on the short wave section of a receiver is always more critical than on the broadcast band. To all intents and purposes, the same tuning arrangement and tuning condenser is used in each case.

A.—This state of affairs is by no means uncommon and is one which frequently puzzles the non-technical reader. However, it can be simply explained by considering the frequencies covered on each of the wavebands in question. Since you have not mentioned any specific frequencies, the following hypothetical case will serve equally as well, since the principles involved are the same. On the broadcast band, the usual coverage is from 550 kc. to 1500 kc.—that is, a change in frequency of 950 kc. This will allow 95 station channels to be accommodated, each 10 kc. apart. In the case of a short wave band, tuning from say 19 to 48 metres, the position is different. Here the frequency range is approx. 15,800 to 6250 kc.—that is, a change of 9550 kc. Allowing 10 kc. separation for the stations it can be seen that the maximum number of stations is 955. Thus, in the same movement of the tuning dial there is the possibility of receiving 10 stations on the short wave band compared to 1 on the broadcast band. In practice, on many parts of the short wave bands the stations are separated by less than 10 kc. and as a result, the finer tuning is necessary to separate these stations.

P.S. (South Brisbane, Q'ld.) in writing for an early issue of RADIO SCIENCE mentions he is interested in F-M and was pleased with the description of the F-M tuner in the August issue.

A.—Your remarks about the magazine are appreciated, and the issue requested has been forwarded along to you. The present government plans to open a full-time F-M service in all capital cities as soon as practicable, so it may not be long before you have such a transmission in Brisbane. The present capitals with F-M are Sydney, Melbourne and Adelaide, and the transmissions are daily from 10.30 a.m. to 10.30 p.m.

J.E.J. (Eastwood, N.S.W.) forwards a very interesting letter and mentions his main interest is in the development of the electronic organ.

A.—Your letter was appreciated, and we thank you for the appreciative remarks concerning the magazine. You are certainly a veteran in the wireless game, and the remarks about your early experiences were read with interest. Several other readers have written in regarding articles on electronic organs and such equipment, and it may be possible to publish something on these subjects in a future issue.

W.A.F. (Port Pirie, S.A.) writes an appreciative letter regarding RADIO SCIENCE, and enjoys reading each issue. He asks if we can recommend suitable radio texts which will improve his knowledge of the subject.

A.—Without knowing something of your background and your ultimate aims, it is rather difficult to suggest any specific texts which will assist you. If you intend making a career of radio, you have many sections to choose from, depending on your own inclinations and ability in that field. Probably the easiest method of gaining the necessary knowledge is to undertake one of the courses available through the various technical schools. Any of these will be pleased to forward information regarding their specific courses, and you have the advantage of supervision, which is lacking when texts are read indiscriminately. However, if you would care to let us have more information as to what you really have in mind, we will be only too pleased to assist in any way we can. Thanks for the appreciative remarks about RADIO SCIENCE.

W.H.H. (Bankstown) has just become interested in radio and asks the difference between "self bias" and "back bias" systems.

A.—Thanks for the letter, W.H.H., and we are pleased to hear you enjoy RADIO SCIENCE. A self bias system is one in which the bias resistor is connecetd between the cathode (or filament centre tap, if directly heated) of the valve and earth. This carries the total valve current, which causes a voltage drop to be developed across the resistor, making the cathode end positive, with respect to chassis. Since the grid resistor is also connected to earth, it means that the cathode is positive with respect to grid, or in other words, the grid is negative with respect to the cathode. In this manner, we obtain the grid bias for the stage. With the back bias system, the cathode of the valve is earthed and the grid return connects to the negative end of the bias resistor connected between the power tranformer centre tap and earth. The total set current flows through this resistor thus providing the necessary bias voltage. We trust this explanation clears up the difficulty for you.

J.I.R. (Mentone, Vic.) is interested in the D/W Five circuit recently published, but wonders if a push pull audio stage could be used in place of the single 6V6-GT.

A.—Whilst it would be possible to make this change, it would be necessary to redesign to audio end. There are several ways in which this could be done, much depending on the output required. Firstly, you could retain the present audio amplifier, using a separate phase inverter stage or you could use a paraphase system, obtaining the excitation voltage for the second 6V6-GT from the first 6V6 screen. This latter method would have the advantage of not requiring the separate phase inverter stage. Alternatively, you could replace the entire audio end with an amplifier based on the Low Cost Amplifier circuit published in the February issue of RADIO SCIENCE. This used a 6SN7 as combined audio-amplifier and phase inverter with two 6V6-GT's in the output stage. Irrespective of the method used, it will be necessary to increase the power transformer rating up to 100 ma.

G.D.P. (Glenelg, S.A.) has built up a small amplifier and now asks the meaning of the terms Class A, B and, C, often applied to such equipment.

A.—in the limited space available, it is not possible to fully define these terms, but we think the following remarks should assist you. The terms you mention refer to specific operating conditions of the valves concerned, these being based on the plate voltage and applied negative bias. A class A amplifier is one in which the negative grid bias and input signal voltage are such that plate current flows at all times. This state of affairs is obtained by selecting a bias value which will enable the valve to be operated at the mid-point of the characteristic curve for that particular plate voltage. This operation results in minimum distortion in the input stage and an output signal which is an exact reproduction, except for amplitude, of the input signal. The efficiency of such a stage is relatively low. Class B operation is one in which the grid bias voltage is chosen which just reduces the plate current to zero with no signal input. Under these conditions, it can be realised that plate current will only flow during one-half of the input signal voltage—that is, for 180 degrees. This class of amplification, when used in audio circuits, requires two valves, so connected that their grids are operated 180 degrees out of phase. Characteristics of a Class B stage are medium output and efficiency (approx. 78%). A Class C amplifier, on the other hand, is one in which the grid bias is so arranged that it is approx. twice the value to give plate current cut off. Consequently, under these conditions, plate current will flow appreciably less than 180 degrees of the input signal voltage. This form of amplifier is restricted to transmitter circuits and is not used in receivers. More specific information on these points can be obtained by referring to a text book dealing with this type of equipment. We appreciate the remarks about the magazine.

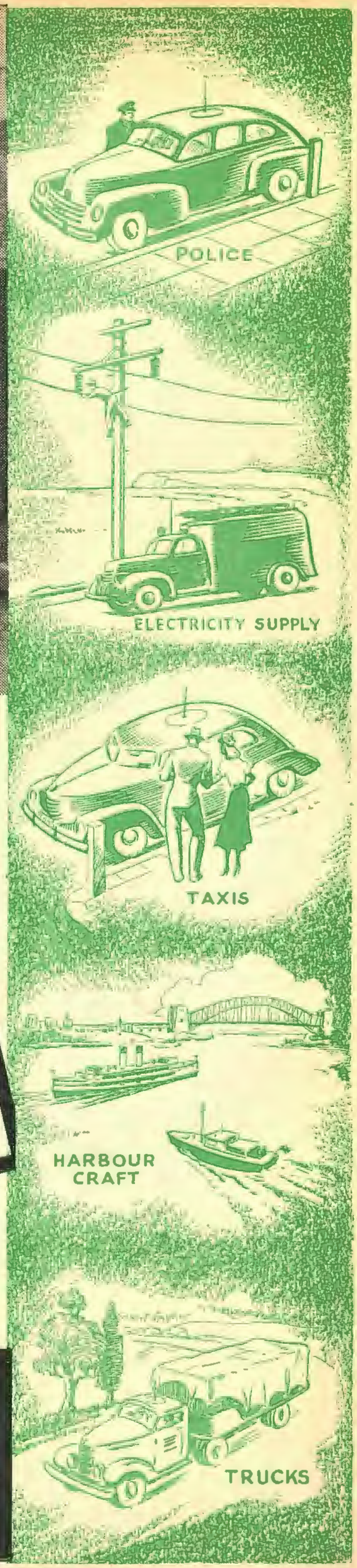
J.R.F. (Hawthorne, Vic.) has a commercial receiver and recently noticed a blue glow showing intermittently in the output valve.

A.—The blue glow you mention may be due to either stray electrons striking the glass bulb, or the fact that the valve has become slightly gassy. However, for safety, we suggest you have this valve checked, especially if the receiver output appears distorted, and replaced if faulty. If it tests O.K., then you need not worry any further about the matter.

J.H.E. (North Melbourne, Vic.) sends a circuit along for comment and mentions that when the set is in operation, the two support rods in the 6A7 become red-hot.

A.—Thanks for the letter, J.H.E. In general, the circuit appears to be satisfactory except for the following point. The support rods you mention are actually the oscillator plate in this valve, and we can understand them becoming red-hot. These should be connected to the B plus line through a .02 meg resistor and .25 mfd bypass condenser and not direct to B plus 250 as shown on your circuit. If you make this change, everything should be O.K.

CAR 1 to CONTROL ...



. . . returning now—any instructions?

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