RADIO SCIENCE

Vol. 2—No. 2 Registered at the G.P.O., Sydney, for transmission by post as a periodical. FEBRUARY, 1949

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TELEVISION IN BRITAIN TODAY

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The science and practice of electronics doubtless commenced with the first application of the thermionic electron tube—familiarly known as the "valve". The name of Mullard was closely associated with the early developments of the valve and Mullard was one of the first in the world to manufacture valves commercially. During the first World War Mullard Valves were used extensively by the Services, particularly the Mullard Silica Transmitting valves supplied to the Admiralty. Then, as now, Mullard Silica Valves were famous for their long life and high efficiency.

Early radio experimenters remember affectionately their first valve—carefully nursed and wrapped in cotton-wool—which in a majority of cases was the famous Mullard "ORA". Those letters represented "Oscillates, Rectifies, Amplifies"—one valve type for all purposes. Today, the Mullard range of valves includes a highly-developed specialised type for every conceivable application in science, industry, defence and entertainment.

In the television field, too, Mullard was (and remains) right out in front. The late John L. Baird is recognised as the "father" of practical television and most of the special tubes and valves he required were developed and made by Mullard. From that beginning Mullard has become England's leading source of electronic tubes for television and special defence applications.

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Our First Anniversary

With this issue RADIO SCIENCE enters into its second year of publication, and we take the opportunity of thanking our many readers, advertisers and friends, made during the past year, for their loyal support and constructive assistance which has so materially contributed to the present high standard of this journal.

As mentioned in our first Editorial, the main objective of this Magazine is to present a complete coverage of the radio, electronic and allied fields. Our growing circulation clearly indicates that this policy has been welcomed and endorsed by both technician and layman alike, and consequently readers can be assured of the continuance of those articles which, generally, have met with such wide approbation.

Viewed in retrospect, the past year has seen many major developments take place in the radio field, both here and abroad, and it appears more than likely that even greater changes will come to pass in the ensuing year. For example, the introduction of regular FM transmissions in all States seems to be a foregone conclusion; in addition, experimental work will be continued in connection with the proposed television stations and thus bring this country's broadcasting services on a par with overseas operations.

Although these developments are still in their embryo stage, it seems an opportune time to once again stress the fact that highly skilled personnel will be required to instal and service these new types of receivers. There appears to be little future for the untrained man in the rapidly expanding field of radio and electronics.

The successful serviceman will be the man who is wise enough to keep abreast of all current developments in the overall technical field as well as in his own immediate sphere of activity. Only the individual possessing this knowledge will be able to readily assimilate continued progress and thus be in a position to render valuable service to the listening public.

Our many technical colleges and correspondence schools bring the boon of education within the reach of all who are willing and anxious to become more skilled and competent. The old cry that education is the prerogative of the rich does not apply today, and it merely rests with the individual whether or not he is sufficiently interested and industrious enough to take advantage of the opportunities which are at present offering.

For those who may not be in a position to avail themselves of these prescribed courses, no small amount of technical knowledge can be obtained by the home study of suitable radio texts and publications. Quite a number of such books are readily procurable, and whilst perhaps not providing the individual touch of a coaching institution, can still yield considerable information to the intelligent and studious reader.

To assist in this respect, RADIO SCIENCE will continue to feature articles dealing with the latest overseas and local research as well as other pertinent data of interest to the Australian technician.

RADIO SCIENCE

For the Advancement of Radio and Electronic Knowledge

Vol. 2. No. 2. FEBRUARY, 1949

EDITORIAL CONTENTS

OUR COVER: Adjusting the main transmitter of Radio New Zealand, the Short Wave outlet now being operated by the Shortwave Division of the New Zealand Broadcasting Service.
(Photograph made available through courtesy of New Zealand Broadcasting Service, SW Division).

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TELEVISION IN BRITAIN TODAY

After a brief resume of the early history of Television, the author discusses current practice as well as possible future developments in the B.B.C. Television Services.

The history of television in Great Britain is a long one, for as far back as 1926 the late J. L. Baird succeeded in transmitting recognisable images of persons and things by radio; and shortly afterwards the first regular television transmissions by the British Broadcasting Corporation began. These early transmissions were of a low order of definition. The scanning disc was used in both transmitter and receiver. Images, each built up of 30 scanned lines, were sent and received at the rate of 12½ per second.

The source of light at the receiver was a neon lamp and the small, flickering reddish-brown images were observed through a viewing lens. The system was thus extremely crude. Still, it undoubtedly worked; it was, in fact, the first practical method of television ever devised.

Later, Baird improved enormously on his original system. By using a very large scanning disc, revolving at high speed, in the transmitter, and a cathode ray tube in the receiver, he was able to produce 180-line images, thus throwing the first bridge across the gap between the old low-definition and modern high-definition methods.

The E.M.I. System

So much for its early history. British television really got into its stride in 1936, when the London high-definition transmitting station, installed at Alexandra Palace, began its regular broadcasts. During an initial test period, transmissions were made on alternate days by the latest Baird system and the E.M.I. system. The latter was eventually adjudged the better, since it was found to give clearer pictures, with an almost complete absence of flicker. With certain modifications and improvements, this E.M.I. system is that in use in Britain to-day.

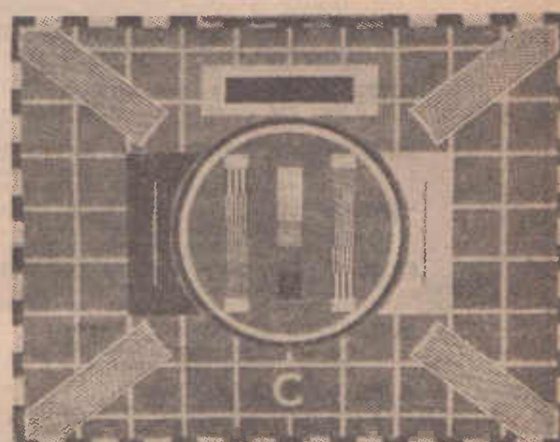

Fig. 1—BBC Television Service, Alexandra Palace. One of the test cards shown on the screen to enable viewers to adjust their receivers.

The basic principle of the system is the process known as *"interlacing."* The image is built up of two frames, each complementary to the other. The first frame at both transmitter and receiver consists, so to speak, of the odd-numbered scanning lines Nos. 1, 3, 5 and so on. The second frame of each complete image fills in the gaps left by the first by supplying the even-numbered scanning lines, Nos. 2, 4, 6 and so on.

The whole image is built up by 405 lines, and actually each frame contains 202½ lines. There are 50 frames and, therefore, 25 complete images a second. Experience has shown that this system is almost as effective in reducing flicker as would be the transmission of 50 complete images each second.

by
RALPH H. HALLOWS, M.A., M.I.E.E.

Though some systems in other countries use a larger number of lines, it is a mistake to suppose that the number of scanning lines per image is the decisive measure of the quality of a television transmission. For certain technical reasons, the resolving power of television apparatus, that is, its ability to bring out small details clearly, depends chiefly on the width of the modulating band of vision frequencies that can be sent out by the transmitter and properly handled by the receiver.

B.B.C. Transmitter

The British Broadcasting Corporation's transmitter at Alexandra Palace, near London, sends out vision-frequencies up to 2.7 Mc. per sec.; the carrier wave and sidebands thus occupy a channel 5.4 Mc. per sec. in width. To produce, at a popular price, vision receivers containing wide-band amplifiers capable of dealing faithfully with such a range of modulation frequencies is no mean task for designers; but the stimulus of healthy competition and

Fig. 2—Television radio link developed by the G.E.C.

the help given by the British Broadcasting Corporation to both designers and owners of televisors in checking the performance of their sets have set and maintained a remarkably high standard.

Method of Ensuring High-Quality Transmission

Fig. 1 shows the test pattern which is now radiated each morning between 10 o'clock and 11 o'clock from Alexandra Palace. It will be seen at once that only a high-grade transmitter can send out such a pattern and only a high-grade receiver reproduce it properly.

The pattern provides a ready means of checking almost every important point in the performance of a televisor. For the squares to be truly square, and the circle truly circular, both horizontal and vertical times bases must be linear; any of the various forms of distortion are at once shown up if they exist; defocusing in any part of the raster is immediately apparent; the sets of vertical straight lines inside the circle present a ready means of measuring the vision-frequency response of the receiver, corresponding as they do to 1, 1.5, 2, 2.5 and 3 Mc. per sec. It will be realised, then, that the British Broadcasting Corporation maintains a high standard of quality in its transmissions and that the test patterns ensure a correspondingly high standard of performance in the receivers made by British manufacturers.

Present-day Television Service

At present there is only one television transmitter broadcasting in Britain. This serves the densely-populated area within a radius of 30-35 miles (48-56 km) of London, in which about one-third of the people of England live; and already between 40,000 and 50,000 televisors are in use there. A second transmitter will shortly be erected at Sutton Coldfield, near Birmingham. Others will come into action as funds, labor and materials permit; and it is expected that within about five years the greater part of the population of Britain will be within range of television broadcasts.

At first, at any rate, local transmitters will mainly re-transmit the London programmes; but it will be possible for any station to televise local events of particular interest. Eventually, the inter-station links by radio and co-axial cable will allow of two-way working between all stations. The television net work will then be such that events taking place in any part of the country can be televised in all other parts of it.

G.E.C. Radio Link

One of the experimental radio-links developed by the General Electric Company for use in the London-Birmingham chain is seen in Fig 2. The paraboloid, 14 ft. (4.25 m.) in diameter, seen on the lattice mast is so arranged that it can be raised or lowered at will for field strength tests. The smaller paraboloids on the pole mast are used in connection with the V.H.F. (very high frequency) telephony link between the mobile laboratory seen in the photograph and others in the chain.

A possible further development is the erection at the site of each radio link of an automatic transmitter with a "broadcasting" aerial system. This would ensure the covering of a strip of country from 40 to 80 miles (about 65 to 130 km) in width (according to the power output of the transmitters and the surface contours) between each pair of main television centres. Much higher frequencies would of course, be used for the beamed link transmissions than for those broadcast by the automatic transmitters.

Use of Telephone Cables for Outside Broadcasts

A recent outstanding development by the British Broadcasting Corporation makes it possible to use ordinary telephone lines, such as those linking a subscriber to his local exchange, or one exchange to another, for the purpose of television "outside broadcasts." Until quite recently the only means of sending over a wire the wide range of frequencies required by television was to make use of a co-axial cable. Before the war such a cable was laid specially for television "O.B." (outside broadcast) purposes between Alexandra Palace and the central area of London.

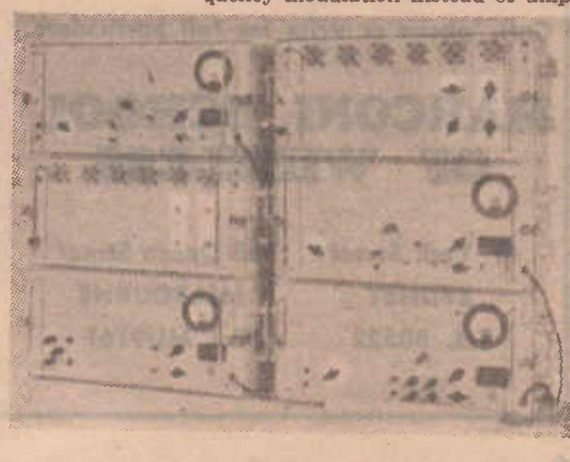

Fig. 3—Portable Television repeater equipment for telephone cables.

It was soon found, however, that broadcasts were required from places which it did not reach; nor could the radio link be relied upon for these owing to the prevalence of interference. To extend the cable would have involved enormous expense. Instead, the British Broadcasting Corporation's engineering department began to investigate the possibilities of ordinary telephone lines. It was found that the problem of using them was simpler than had been expected.

The two main effects produced by such lines are **(1) attenuation of the higher frequencies and (2) the introduction of some phase distortion.** Both of these have been overcome by the use of specially designed portable repeater-equalisers (Fig. 3) inserted every 1½ miles (about 2.5 k.m.) in the telephone lines. With the aid of these, up to 8 miles (about 13 km) of ordinary telephone lines are now regularly used for outside broadcasts from theatres, sports grounds and so on —a very notable advance in the technique of television transmissions.

Elimination of Interference

It has been mentioned that interference of one kind or another may sometimes rule out the use, for outside broadcasts, of the British Broadcasting Corporation's mobile radio link.

In normal conditions, however, wide use is made of the apparatus. Each of these link units consists of a generating plant, a transmitter and a monitoring cabin. There is provision for two-way V.H.F. telephonic communication with headquarters and two emitron television cameras are carried.

One recognised method of minimising interference effects is to use a carrier of extremely high frequency; another is to employ frequency modulation instead of amp-

Fig. 4.—Marconi experimental VHF link aerials at Danbury, near Chelmsford, Essex. General view of tower supporting "wedge" reflectors, horn reflector, and Yagi aerials used in connection with the receiving and re-transmitting of VHF (very high frequency) and UHF (ultra high frequency) signals over a "multiplex" radio link. These aerials are designed to operate on frequencies between 100 and 200 Mc. per sec. and 600-900 Mc. per sec. This station has also been used to pick up the television transmissions at 45 Mc. per sec. from Alexandra Palace, London, and re-transmit them on 600 Mc. per sec. to another experimental station at Great Bromley, near Colchester (a distance of 25 miles). This process can be repeated many times by means of a chain of these stations without any apparent loss of quality.

litude modulation. A combination of both methods is the basis of the highly original Marconi radio link, the receiving and retransmitting aerials of which are seen in Fig. 4.

Horn Type Aerial

A horn-type aerial is used in the transmitter and wedge-shaped reflectors in the receiver. The carrier frequency of the vision channel is 510 Mc. per sec., and since the radiation is focused into a narrow beam, a carrier power of about 5 watts has been shown in recent successful trials to be amply sufficient to cover distances up to 25 miles. This is believed to be the first practical employment of frequency modulation for vision transmission. Its use enables a remarkable constance to be obtained in the receiver output by means of limiters.

Considerations of space forbids more than a mention of two notable developments made by designers of British television receivers. The first is the use of single-side-band reception which greatly facilitates the realisation of level-response, wideband amplifiers. The second is the production, on the Cockcroft and Walton "ladder" principle, of a device incorporating a chain of metallic rectifiers which enables the extra high-tension voltage (5,000-6 000 volts) required for the final anode of the cathode-ray tube to be obtained by multiplication of the normal high-tension voltage. This device, quite small in size, makes it unnecessary to use a large, heavy and expensive transformer, with insulation capable of standing up to voltages at least twice as high as those applied to the final anode of the tube.

Reprinted courtesy "British Science News."

VARIABLE RESISTANCE SPRING TRANSDUCER

A highly sensitive mechano-electrical transducer, which transforms slight displacements into large changes of resistance, current or voltage is being developed by the National Bureau of Standards, U.S.A. The active element of the device is a helical or conical spring wound in such a way that the initial tension varies slightly along its length. Thus, when the ends of the spring are pulled apart, the turns separate one by one rather than simultaneously.

When the spring is entirely closed, it has an electrical resistance approximately that of cylindrical tube. Completely open, its resistance is that of the total length of the coiled wire. As the percentage change in resistance may be hundreds of times greater than the percentage change in length, displacements as small as 1/100,000th of an inch may be measured without the use of electrical amplifying devices. When connected to another transducer which gives a displacement output, the combination gives an easily measurable electrical output.

EXPERIMENTS IN R. F. HEATING

This article details some of the experiments performed at the National Physical Laboratory during the war years to determine whether certain industrial processes could be accelerated by the use of high frequency heating.

by
L. HARTSHORN
D.Sc., A.M.I.E.E.
National Physical Laboratory

The experiments here referred to were carried out during the war of 1939-45 at the National Physical Laboratory in order to find out whether certain industrial processes, that were very troublesome because of their slowness, could be improved by the application of radio-frequency heating, a process which had recently risen to great prominence. It should be stated at once that the results were not altogether conclusive; they cannot be quoted as new achievements for the process; they rather illustrate the difficulties that must be contended with in applications of a certain type, and the ways in which they can sometimes be overcome.

Dielectric Heating

There are two kinds of radio-frequency heating; **induction heating**, which is only effective with good conductors, chiefly the metals; and **dielectric heating**, which is only applicable to poor conductors—i.e., to non-metals. The processes under consideration were concerned with the dehydration of vegetables, the sterilisation of foodstuffs, and the gluing of wood; that is to say they were all concerned with non-metals. It will be well, therefore, to describe first the process of dielectric heating.

Consider what happens when a pair of metal plates separated by an insulating material is connected to a radio-frequency generator, so as to maintain a fairly high voltage between the plates. A considerable current flows through the material (the dielectric), but it does not necessarily cause any heating. For a given voltage, the current has the lowest value when the dielectric is air or a vacuum; for most liquids and solids it is from 2 to 20 times larger, the actual factor being known as the dielectric constant of the material.

Some liquids and solids, like paraffin oils and waxes, suffer no appreciable heating, but others are strongly heated. One would expect materials known to be of low resistivity, like water, to be heated strongly, merely from a consideration of the elementary law, heat generated = (voltage 2 subscript -:- resistance. This law is found to hold reasonably well for such materials; but other materials of much higher resistivities are also strongly heated in a way that cannot be accounted for by normal resistivity.

Effect of Power Factor

The tendency to generate heat is therefore represented by another property called the **"power factor"** of the material; the heat generated is proportional to the product of the voltage, the current and the power factor. Thus the power factor is zero for air and for the other materials which generate no heat, but is large for those that are strongly heated.

The power factor of a material is found to be largely dependent on its molecular structure; indeed, the high-frequency current is pictured as a vibration of the electrical structure of the material rather than a migration of ions or electrons through it, as in normal conduction. The dielectric constant is a measure of the amplitude of the vibrations, or of the energy elastically stored in the material in each pulse of the vibration; the power factor is a measure of the fraction of that energy converted into heat by processes analogous to elastic fatigue or friction in the structure.

The process of dielectric heating, then, is operated by simply inserting the material to be heated between two metal plates (the electrodes) to which a high voltage at radio-frequency is applied, but we

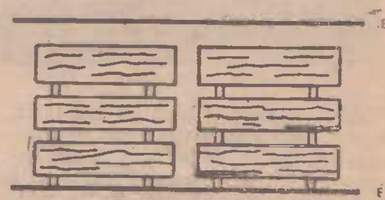

Fig. 1—Arrangement of vegetable blocks between electrodes E. The shreds composing the blocks tend to lie parallel to the electrodes and therefore across the path of the current; an arrangement tending to equalise the current distribution in different shreds.

can only predict how the material will respond to the treatment if we know something about its dielectric constant and power factor. Materials differing in these two dielectric properties, if placed between the same electrodes—i.e., in the same electric field, are heated to different extents. It follows that the chief advantage of the process, which is the uniformity of the heating throughout the body of the material, is only obtained if the material to be treated is uniform in dielectric properties, and that (as we shall see) is not always the case.

The Drying of Rayon Yarn

Before dwelling on the limitations of the process it will be well to cite one example of an application in which its full possibilities were realised without difficulty. It is the drying of artificial silk yarn described by A. J. Maddock. In the industry the yarn is handled in the form of massive cylindrical "cakes" into which it is wound as it is made.

When these cakes were dried solely by warm air, it was found to be necessary to perform the operation very slowly, keeping the air temperature quite low, so that the speed of removal of water from the surface layers was not greater than the rate at which the water in the inner layers could work its way to the surface; otherwise the drying, shrinkage and subsequent dyeing were all uneven. The process occupied some 10 to 14 days.

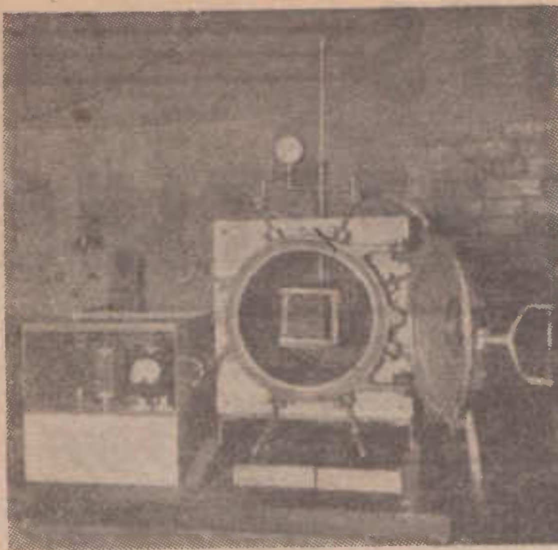

Fig. 2—Experimental arrangement for drying of vegetable blocks at reduced pressure. Three blocks are seen mounted in the vacuum enclosure between a pair of electrodes of thin metal sheet supported and held flat by wood. The power is supplied to the electrodes by the radio-frequency generator on the left of the enclosure. In the background is the apparatus for measuring dielectric constant and power factor.

When dielectric heating was tried, it was found that the rate of evaporation could be very greatly increased. The material composing the cake being substantially uniform, heat is generated uniformly throughout its volume. Since the cellulose itself will withstand heating to 95 deg. C. or 100 deg. C. without chemical deterioration, and the physical structure of the cake itself is not adversely affected by the rapid ejection of water, the whole mass is rapidly brought up to a temperature at which the water almost boils off, the duration of the process being reduced to about half an hour.

In this example the improvement is just what was hoped for. We now proceed to our experiments in which greater difficulties were encountered.

The Dehydration of Vegetables

During the war of 1939-45 dehydrated vegetables were, for economy of transport, handled in the form of compressed blocks about 2 cm. thick. For safe storage the water content of the material had to be less than say 5 per cent., but the dried shred of material would not cohere into blocks unless the water content was, say, 9 per cent.

Thus the final stage in the process consisted in the removal of a small percentage of water from a nearly dry block, an operation which took some 6 to 8 hours when performed by ordinary convection heating on a current of air at 60 deg. C. Higher temperatures cause a deterioration of the material, visible as a change from a green color to brown called "scorching."

It became important to find out whether the process could be accelerated by the use of radio-frequency heating, and these experiments were directed to this end. The blocks were placed between flat metal (Fig. 1) sheets serving as electrodes, and voltage at a radio-frequency was applied. It was almost immediately obvious that, in principle, a great increase of speed is obtainable.

The blocks begin to "steam" within a minute or so of switching on the power; but it takes only another minute to show that the material will not tolerate a very high speed, for the blocks begin to swell and disintegrate, and even when the power is reduced until no deformation is visible, some local scorching is liable to occur.

Cause of Scorching

This tendency to local scorching was found to set the limit to the permissible speed, and it became necessary to find out its cause and the means whereby it could be minimised. Essentially, it consists of an excessive generation of heat at certain spots which became damaged in spite of the fact that the total power supplied is, if uniformly distributed, quite insufficient to raise the temperature of the material up to the scorching point.

The explanation is to be found in the variations of dielectric constant and power factor in the material. The heat generated in any given region is proportional to the product of the current, voltage, and power factor for that region. Now for a given voltage, the current is proportional to the dielectric constant, so that for a given voltage the heat generated is proportional to the product of dielectric constant and power factor. These quantities were measured, and each was found to increase with water content, which tends to be greater for the stalky portions of a cabbage than for the leafy portions.

Thus heat tends to concentrate in the dampest, stalky portion, and since the power factor also increases rapidly with rise of temperature, the local rise of temperature increases still further the concentration of heat at that spot: locally, the process runs out of control, although the total power supplied, and therefore the average temperature of the material, is quite moderate.

Effect of "Hot Spots"

This development of hot spots at points of high dielectric constant and high power factor was encountered in many experimental trials of dielectric heating, and it is particularly noticeable if the material to be heated touches the electrodes at one or two isolated spots. The dielectric constant and power factor of such spots are necessarily much greater than those of the surrounding air-space, and the effect is even more marked than it is in the interior of the material, for the difference between any part of the material and air is almost much greater than that between any two parts of the material. It was noticed that if a flake of cabbage happened to protrude into the gap between the block and the electrode, it would generate so much heat as to catch fire. For exactly the same reason scorching was found to occur at any point of contact between two blocks.

We see, then, that in regions where the voltage is the same, high spots develop at points of high dielectric constant and high power factor, because the high dielectric constant leads to a concentration of current. However, we can sometimes arrange the material so that the different regions are traversed by the same current instead of being subjected to the same voltage—i.e., they are in series in the high-frequency circuit instead of in parallel, and then we must remember that the higher the dielectric constant the lower the voltage for a given current and therefore the lower the heat generated for a given current and power factor.

(Continued on page 46)

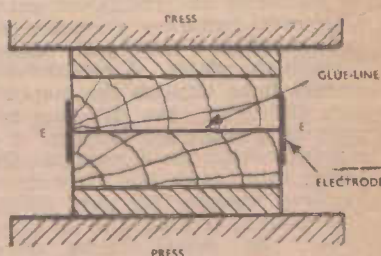

Fig 3—Arrangement of electrodes for glue-line heating. The coating of glue and the wood itself both span the electrodes and are therefore subjected to the same voltage. The heat generated is then mainly concentrated in the glue film for the product of its dielectric constant and power factor is much greater than that for the wood.

CONSOL

RADIO NAVIGATION AID

Developed from German medium wave systems, "Consol" was a long range navigation aid used by the Allies during World War II. In view of the simplicity of the airborne equipment, this system is now finding favor with civil airline operators, and is likely to be used extensively in the North Atlantic region.

In this article it is proposed to discuss a long-range navigational aid which has an interesting history in that it was evolved by the Germans during the recent war.

It is now widely known that the brilliant and rapid development of radar by the Allies during the war was a vital factor in maintaining our supremacy at sea and in the air. The radar art advanced so rapidly that German techniques were outstripped. It is interesting to note that while the technical effort of the Allies was very largely concentrated on pulse systems for both detection and navigation, German navigation aid was almost entirely based on the use of continuous waves, and it is a C.W. system with which we are concerned in the present article.

"Electra" System

Early in the war it was found that German aircraft were using a navigational aid working in the medium frequency band between 250 and 500 Kc. The system was observed to have the well-known characteristics of two—and four course radio-ranges, in that courses were defined by regions in which a steady signal ("*equi-signal*") was heard, any departure from the course being indicated by the reception of either dot or dash characters.

However, the German system was found to have a new feature in that instead of two or four courses as many as twelve radiated from the station. This system was known to the Germans as "*Elektra.*" An aircraft at a distant point, on picking up the signal from an

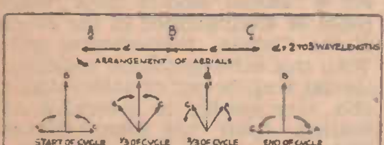

Fig. 1—These vector diagrams show the current relationship in the various aerials.

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Fig. 3—Block schematic diagram of a Consol Station.

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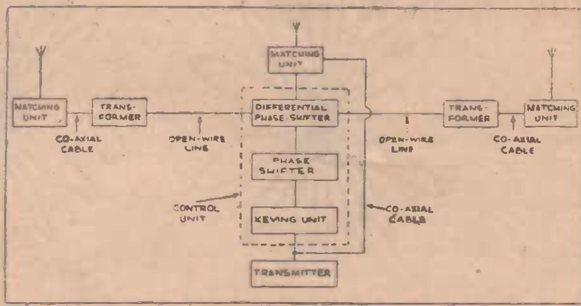


"*Elektra*" station, would in general hear either dots or dashes. Such a signal would in itself not give the aircraft information regarding its bearing.

If, however, the aircraft then flew so as to bring itself on to one of the equi-signal courses, its bearing would be known, assuming the position of the aircraft was roughly known by other means (such as dead reckoning, radio compass, &c.)

by
JOHN G. DOWNES,
B.Sc., A.M.I.E.E:

so that the particular "*Elektra*" course on which it was flying could be identified. In other words, the "*Elektra*" system lays down some twelve courses of known bearing, but does not give any useful bearing information to aircraft which are not on any of the equi-signal courses; in this respect the "*Elektra*" system is precisely similar to the more common two—and four—course radio ranges.

Three Aerials Necessary

Investigations showed that an "*Elektra*" station consisted of 3 vertical mast radiators in a straight line (the spacing between adjacent masts being some 2 to 3 wavelengths) together with a C.W transmitter, to feed the masts in a suitable phase relationship. This phasing was such that with reference to the current in the centre aerial the currents in the two outer aerials were respectively ahead and behind by 90 degrees in phase. These changes in phase were produced by suitable phase-shifting networks connected in the feeders to the outer aerials.

The current in the centre aerial was arranged to be approximately double that in each of the outer aerials. With the aerials fed in this manner, a horizontal polar diagram of the form shown by the full line in Figure 2 (b) is obtained. This is a multi-lobe pattern which, it will be noticed, is symmetrical about the line joining the three aerials, A, B. C.

If the phases of the currents in the two outer aerials are now *reversed*, the polar diagram swings over, and is represented by the dotted curve in Fig. 2a. It will be seen that the new diagram is multi lobed and symmetrical as before, and is in fact that "*mirror image*" of the full line pattern.

Now suppose that the change over of phases in the outer aerials is made at frequent and regular intervals by means of a switch, so that the radiation corresponds alternately to the full line and dotted diagrams of Fig. 2a, and consider what will be the effect in a distant aircraft which is receiving the signals.

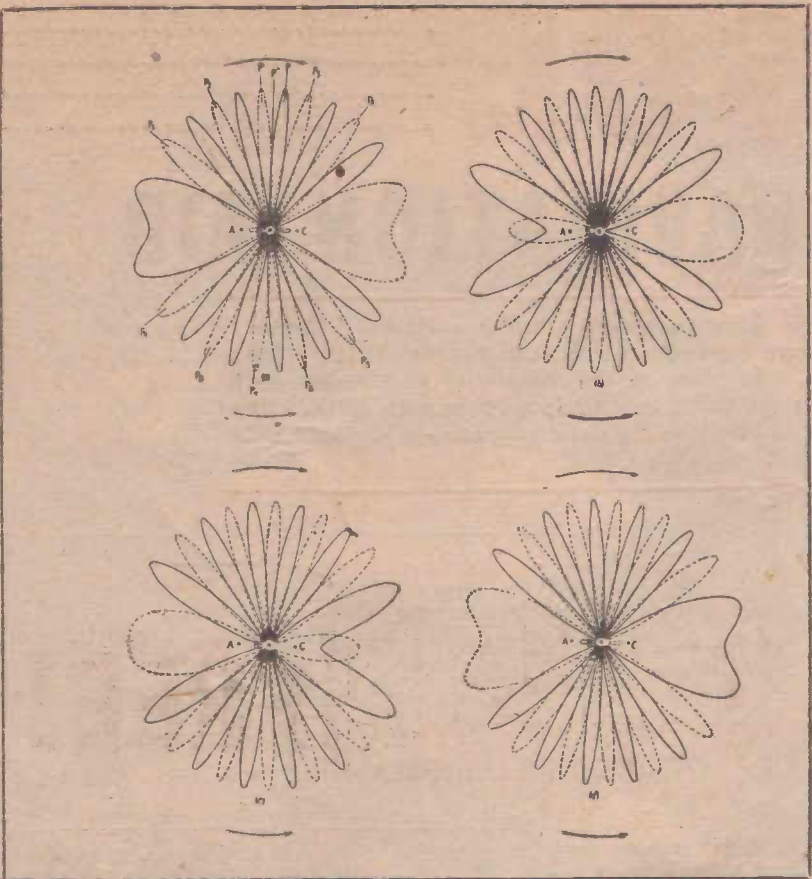


Fig. 2.
Radiation pattern from a Consol station. See text for explanation of patterns.

Explanation of Patterns

If the aircraft is on a bearing such as that denoted by P in Fig. 2a, it will receive strong signals for that period when the dotted-line pattern is being radiated, while for the other part of the cycle a very weak signal or none at all will be received. If the full-line diagram represents the radiation pattern during 1-8 second and the dotted-line diagram that during the following 3-8 second (the keying cycle thus occupying ½ second), it will be clear that an aircraft on a bearing such as that denoted by P will hear a signal consisting predominantly of *"dash"* characters, with possibly a weak background signal in the intervals between dashes.

Correspondingly, an aircraft on a bearing such as that indicated by P1 in Fig. 2a will receive a signal consisting predominantly of *"dot"* characters with, in general, a background signal which is relatively weak.

An aircraft on any bearing such as represented by P11 that is to say a bearing delineated by the intersection of the full—and dotted—line patterns, will hear a continuous signal which in fact is made up of *"dot"* and *"dash"* characters of equal strength, such a bearing therefore being known as an equi-signal course.

Examination of the radiation patterns of Figure 2a shows that because of the multiple-lobe structure (actually six lobes on each side of the line of aerials in the case illustrated) there will be a large number of equi-signal courses laid down by an *"Elektra"* station. In the case shown there are in fact eleven equi-signal courses for which as one approaches the station a *"dot"* sector lies to the left and a *"dash"* sector to the right and correspondingly there are eleven courses for which the reverse situation exists, i.e., *"dashes"* to the left and *"dots"* to the right. The existence of these courses may be checked by reference to Fig. 2a.

Practical Value of System

As mentioned previously, the *"Elektra"* system does not give any very useful navigational information to aircraft which are in *"dot"* or *"dash"* sectors. Its value lies in guiding aircraft along the fixed equi-signal courses. It is worth repeating that an aircraft, in order to make full use of the *"Elektra"* system, requires a rough knowledge of its position by some other means, so that it can identify any particular equi-signal course on which it is flying. There is nothing in the signal radiated from the *"Elektra"* station which allows any differentiation to be made between different equi-signal courses; all give the same aural indication.

Early in 1943 it was observed that German aircraft were using a new navigational aid which appeared to be a development from the earlier *"Elektra"* system. This new aid possessed the important feature that it provided information regarding bearing to aircraft *anywhere* within a wide sector. The new system was known to the Germans as *"Sonne"* and was renamed *"Consol"* by the Allies during the war; it is now usually known by the latter name.

"Consol" Characteristics

We shall first describe the nature of the signal received from a *"Consol"* station by a distant aircraft, and shall then show how such signals are produced.

An observer in an aircraft wishing to obtain his bearing from a *"Consol"* station tunes in the station (in the medium-frequency band, a typical frequency being 300 Kc) and hears a steady signal interrupted at intervals by a Morse call-sign for identification purposes. There is then a short pause in the transmission, followed by a series of *"dash"* characters. At first the characters will have very little back-ground signal.

As successive characters occur, however, the strength of the *"dashes"* decrease while that of the background increases, so that a stage is reached at which it is impossible to distinguish any *"dash"* characters; instead, a constant signal is heard. This condition exists for a short period, after which the observer can detect *"dot"* characters against a background of signal. As the *"dots"* continue to be received they are observed to increase in strength, while that of the background diminishes, so that the *"dots"* become more prominent.

After a certain number of dots have been received there is a pause, followed by a resumption of the transmission of the steady signal together with a call-sign. The observer will have counted the number of *"dashes"* and of *"dots"* which could be distinguished in the course of the whole transmission cycle. With this information he consults a special map or set of tables and is able very quickly to determine his bearing from the Consol Station with an accuracy as good as a ¼ of a degree under favorable conditions.

As in the *"Elektra"* system it is necessary for the observer to know, by other methods, his approximate bearing (to within about 10 degrees) so that bearing identification can be made. The process of taking a bearing occupies about one minute.

Fig. 5, *read from right to left*, illustrates diagrammatically the signal heard by the observer as the equi-signal condition approaches and recedes.

Radiation Pattern

It will be suspected, from a knowledge of the form of the received signal, as just outlined, that the *"Consol"* system depends for its operation on a rotating horizontal polar diagram, and this is in fact the case. The procedure in the *"Consol"* system is first to radiate a pattern similar to that which is used in *"Elektra"* (Fig. 2a), and then to cause this pattern to rotate slowly through an angle of about 10 degrees.

The appearance of the radiation patterns at various stages during the rotation is illustrated in Fig. 2. On one side of the line of aerials the pattern rotates clockwise, and on the other side counter-clockwise. This is indicated by the arrows in the figure. Consequently the lobes on both sides of the line of aerials tend to move in the same direction (from left to right).

The full—and dotted—line diagrams have the same significance as before, representing the patterns for the transmission of *"dot"* and *"dash"* characters respectively. Fig. 2a represents the conditions at the start of the transmission of the character sequence, and Figs. 2b, c and d indicate respectively the conditions at one-third, two-thirds and the finish of the sequence.

Production of Signals

To see how the rotation of the radiation diagram produces at a distant point a sequence of characters of the kind we have described, consider an aircraft on a bearing such as that indicated by P in Fig. 2a. From this diagram it will be seen that, at the start of the character sequence, strong *"dashes"* will be received, since bearing P corresponds to a maximum of the dotted-line pattern. As the radiation diagram rotates, the maximum of the dotted line lobe moves away from bearing P to the right, which means that the strength of the *"dash"* signals on bearing P decreases.

However, there is an adjacent full-line lobe simultaneously moving towards bearing P, which means that *"dot"* characters of increasing strength will be heard in the intervals between the *"dashes."* As yet, however, the *"dash"* characters are the stronger, so that the aural indication is one of dashes against a weaker background. This state of affairs is represented by Fig. 2b.

As the diagram continues to rotate the *"dash"* characters will diminish in strength and those of the *"dots"* increase so that a stage will be reached when the characters are equal in strength, producing a steady tone. This condition, however, is of short duration, and soon gives way to one such as is represented by Fig. 2c, where bearing P corresponds to a point well up on a full-line lobe and to a point approaching a minimum of the dotted-line pattern, so that the signal will be predominantly one of *"dots."* Ultimately, one half-minute after the sequence has commenced, the condition will be that of Fig. 2d where bearing P corresponds to a maximum of the full-line (*"dot"*) diagram and a zero or minimum of the dotted-line (*"dash"*) diagram.

In the case of an aircraft on a bearing such as P a typical *"count"* of characters might be, commencing from the start of the sequence: 29 *"dashes"* (each character together with its adjacent interval occupies one half-second); a steady signal of 1 second duration; and 29 *"dots."* (Of the 60 characters transmitted in the half-minute sequence 2 have been *"lost"* in the equi-signal region). Such a count would indicate that the aircraft lies on a bearing midway between the initial and final values of the equi-signal bearing.

Count Of Character

Now information can be given to navigators using the system regard-

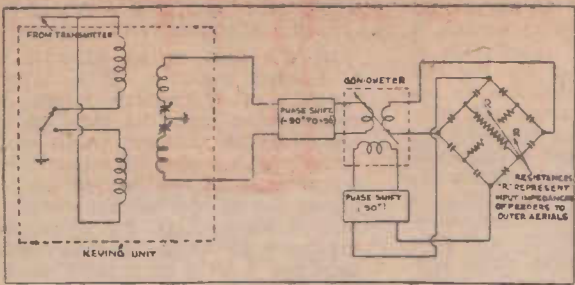


Fig. 4 — Simplified circuit of the control unit.

ing the initial values of the equi-signal bearings and also the amount by which they shift during the character sequence. Suppose, to illustrate the case we have just taken, that the initial value of the equi-signal bearing is 345 degrees and that the total shift is 10 degrees in the positive direction. It will be clear to the navigator from his "*count*" of characters that he is at a bearing which is half-way through the shift, i.e., 5 degrees in the positive direction from the initial bearing of the equi-signal. His bearing from the station is, therefore (345 + 5) = 350 degrees.

Clearly the "*count*" of characters may take a large number of forms but the total number of characters will always be slightly under 60. As a further illustration, a "*count*" might consist of 11 "*dashes*" an equi-signal period of 1 second, and 47 dots. This would indicate to the navigator that he was distant from the initial bearing of the equi-signal by an amount approximately one-fifth of the total shift of bearing, that is to say, taking the same figures as before, by an amount 1/5 x 10 degrees, or 2 degrees, so that his actual bearing would then be (345 + 2) = 347 degrees.

Clearly, it is necessary for the navigator to be able to distinguish which particular equi-signal bearing he is using when he makes his "*count.*" In other words, he must know his bearing by other methods to an accuracy of about 10 degrees; a rough indication of this kind is not difficult to obtain by dead reckoning or other means.

Rotatian Of Aerial Pattern

The method by which the horizontal radiation pattern of the *Consol* system is made to rotate is as follows: At the start of the rotation the currents in the 3 aerials are, as already described for the *Elektra* system; that is, the phases of the currents in the outer aerials are respectively ahead and behind by 90 deg. with respect to that of the centre aerial, while the magnitude of the latter is twice that of the currents in the outer aerials. This state of affairs is illustrated in Fig. 1a, which is a vector diagram of the currents in the aerials, A, B and C.

The phases of the currents in the outer aerials are now made to change simultaneously and smoothly by equal amounts. The phase angle of current in aerial C is reduced, while that of aerial A is increased (see Fig. 1b.). This simultaneous change of phase in the two outer aerials results in a change in the total signal strength at any point (which is the sum of the signals from the three aerials having regard both to magnitude and phase), the effect is a rotation of the symmetrical lobe-patterns on each side of the line of aerials in the way illustrated in Fig. 2.

At the same time the dot-dash keying action is being carried on, this being done by simultaneously reversing the phases of the currents in the two outer aerials at a frequency in conformity with the desired keying, i.e., two dots and two dashes per second. (Note that the phases in the outer aerials are *reversed*, not interchanged. As an example, at a given instant during a "*dash*" character the currents might have phases of + 60 and — 60 degrees with respect to that of the centre aerial. The keying changeover to a "*dot*" character would make the phases (+60 + 180) and (—60 + 180) degrees, i.e., + 240 and + 120 degrees).

Phase In Aerial Systems

Figure 1c represents the phases in the aerials at a later stage of the shift. It will be seen that current C now lags, while current A leads by an equal amount. The end of the shift is represented by Fig 1d, each of the outer aerial currents then having been shifted 180 degrees in phase. When this stage has been reached radiation from the outer aerials ceases. The centre aerial alone radiates omnidirectionally, giving the call sign of the station.

The complete transmission cycle from a Consol Station is typically as follows:

	Seconds
Omnidirectional signal with call sign	28
Interval	1.5
Rotation of aerial pattern and simultaneous transmission of 60 characters	30
Interval	0.5
	60

THE CONSOL STATION

The transmitter used may be of conventional pattern; for example a standard service communication transmitter of 2 kilowatts power has been used successfully. The aerials are vertical radiators arranged as nearly as possible in a straight line, and spaced usually between 2.5 and 3 wavelengths apart (the spacing partly determines the nature of the radiation diagram). The height of the masts used is approximately 300 feet.

To improve the efficiency of the radiators, buried earth systems consisting of large numbers of radial wires are used in conjunction with the radiators. The aerials are fed by buried co-axial cables which at a suitable distance from the aerials are replaced by open-wire lines on poles, the latter are not used in proximity to the aerials since they might lead to distortion of the radiation pattern of the station. The connection of the feeder cables to the aerials is made through suitable matching units.

Block Station Diagram

A block schematic diagram of a Consol station is shown in Fig. 3. It will be seen that special keying and phase-shifting equipment is interposed between the transmitter and the feeders to the outer aerials. This equipment, known collectively as the *control unit*, sets up the character sequence and causes the phase changes in the currents of the outer aerials which we have already described in connection with the rotation of the radiation pattern.

The control unit comprises a keying unit, a coarse phaseshifter, and a continuous differential phase shifter. The purpose of the keying unit is to control the "*dot-dash*" character cycle which, it will be remembered, results from regular reversal of the phases in the outer aerials with respect to that of the centre aerial. The required phase reversal is brought about by a vacuum switch in conjunction with a three-winding transformer (Fig. 4) which in effect changes over the polarity of the currents in the outer aerials. The switch is controlled by a motor-driven cam and associated contact.

The coarse phase-shifter is used to adjust the phase of the current in the centre aerial to approximately its correct value, i.e., 90 deg. out of phase with the currents in the outer aerials at the start of the

(Continued on Page 44)

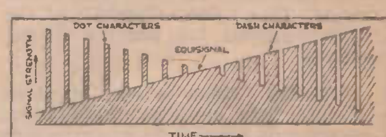


Fig. 5—The nature of the signal heard as an equi-signal zone passes the observer.

A Technical Survey of Latest Overseas Developments

NEW F-M TUNER

One of the problems of the 88-108 Mc FM band has been to produce a simple means of tuning the r-f and oscillator sections of the receiver. A recent approach to this difficulty has been the development of the "eggbeater" type of tuner.

The "eggbeater" is a modernised version of a high frequency variometer in which the physical shapes of the stator and rotor resemble the kitchen utensil of the same name. This tuner unit is a simple device, and because of its low inertia is not microphonic and is not easily detuned by shock or vibration.

Ganging of the three inductors was effected by means of a common non-metallic shaft to reduce electrical coupling between circuits. Both the fixed and moving inductors were made from phospor bronze wire which was heavily plated. The ends of the rotor wires have spherical tips which fit into contact sockets. The contacts are fashioned from beryllium copper stock, silver plated and backed up by flat steel springs. (Fig. 1).

The steel springs are necessary to maintain constant contact with the ends of the rotors which, as they turn, change somewhat in physical length and tend to pull from their contacts at the extreme position. This could cause noisy tuning under some conditions.

When unloaded the rotors have a slight tendency due to their springlike characteristics to seek the neutral or centre dial position. However the normal dial drive friction is sufficient to prevent creeping. The eggbeater tuner is comparatively stable thermally, and, after the normal receiver warm up period, will stay tuned over long periods.

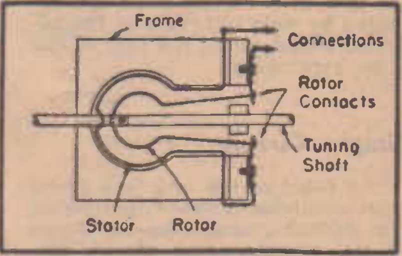


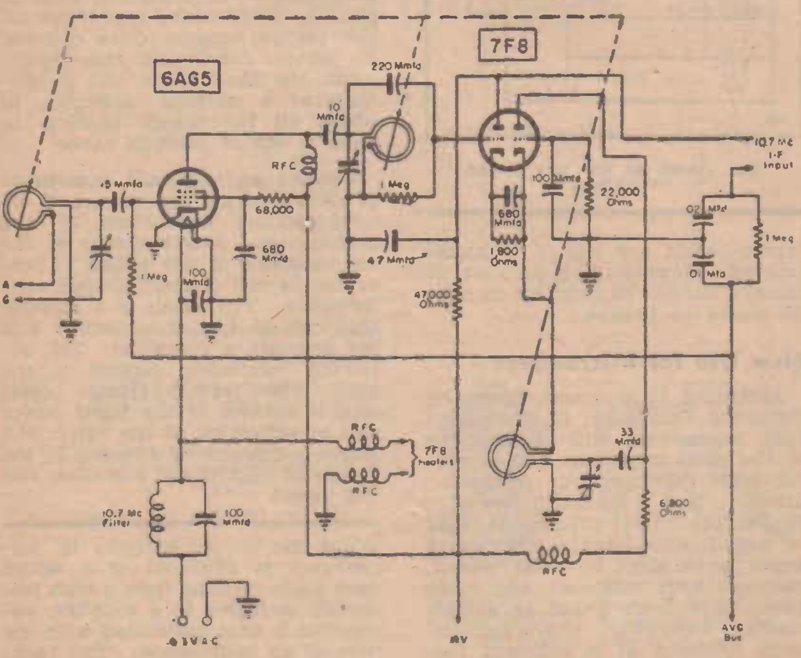
Fig. 1. Construction of the contacts on the eggbeater tuner.

Typical Receiver Circuit

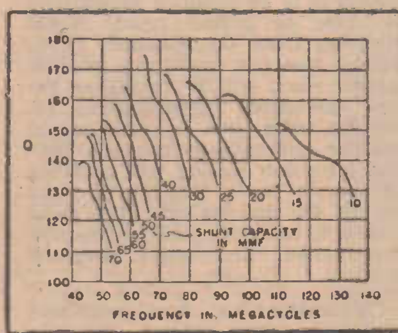
The front end of the receiver employed a type 6AG5 r-f stage and a type 7F8 dual triode oscillator-mixer in a conventional circuit. Whilst this arrangement does not provide great improvement in electrical performance over a standard LC type of tuner it does ensure that sensitivity is relatively uniform through the whole band.

Individual sections of these "eggbeaters," either series or parallel connected can be employed in transmitters, test oscillators or for any other use where standard LC circuits are normally used.

Simplicity and low construction cost make them practical for many such applications.



A typical two-valve F-M input unit using an eggbeater type tuning unit.



Curves of the Q versus frequency with various values of shunt capacity. —Courtesy "Service."

SOUND FLASHLIGHT FOR THE BLIND

A recent development in obstacle-detecting devices to aid the blind in foot travel is a relatively simple "flashlight." This has been successful in aiding sightless persons to detect and avoid objects in walking which might otherwise be discovered by collision.

Similar in size and shape to a large flashlight, the unit is carried by the blind person with a scanning motion. Sound waves projected from the unit in a narrow beam are reflected by solid objects, and the reflected sound warns the user of the object's presence.

Simple Circuit

The heart of the unit is a single valve oscillator powered by hearing aid batteries, connected as shown in the accompanying circuit diagram. A headphone unit was chosen for the transducer and its inductance in conjunction with the 0.002 mfd condenser form a resonant circuit for the desired frequency range between 8kc and 15kc.

The choice of this range of frequencies was guided by the consideration of reflection and interference from ambient noises which might be encountered out of doors. It was found advisable to make the frequency adjustable to allow for different conditions and for relief of ear fatigue.

Beam widths between 12 and 30 degrees (depending on the frequency) are possible with the reflector which is four inches in axial length and four inches in diameter at the mouth. The reflector is made of spun aluminium covered with papier-mache.

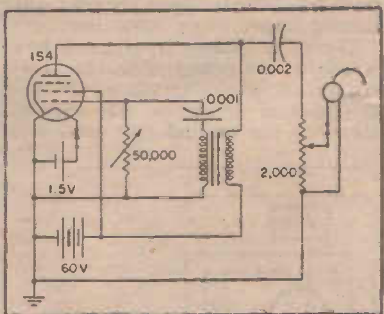
The headphone transducer is mounted at the focal point of the reflector. It is insulated from the metallic reflector by a layer of sponge rubber and held in place by rubber cement and papier-mache. A male plug is embedded in the rear of the horn for connection of the extension cord from the oscillator which is carried in a pocket.

To reduce the intensity of the sound reaching the user caused by leakage around the rim, baffles of cotton and sponge rubber are used with only a slight reduction in the intensity of the main lobe.

Although the sound flashlight was designed primarily as an obstacle detector, skilled operators have been able to detect slight depressions by directing the beam so that it makes an angle of about 60 degrees with the ground. The device is most successful, however, in detecting such obstructions as trees, lamp posts, parked vehicles, hedges, flights of stairs leading up, and open doorways.

Preliminary experiments showed that detection was possible at distances up to and greater than 30 feet, depending on the number of obstacles present, the prevailing acoustical conditions and the user's experience and proficiency.

COURTESY ELECTRONICS



The circuit of the new Sound "Flashlight."

RECENT CATHODE DEVELOPMENTS

One of the major problems confronting the radio valve designer is the effect of the cathode expanding when it becomes hot during operation. Because the distance between cathode and grid plays a vital role in the performance of the thermionic valve, a change in this dimension when the valve is in use is highly undesirable.

V.H.F. Problems

This problem becomes even more critical in the very-high-power (1000 watts or more) valves in the FM-television frequency (50 to 200 Mc) range. Here the distance between the cathode and the grid may be only about 0.002 inch and even the minutest variation in this dimension causes serious fluctuations in power amplification and power input requirements. Further the range of cathode temperatures (up to 3300 degrees F) makes the expansion effects a major concern.

The answer to this problem now appears to be provided by a recent development of the Westinghouse Research Laboratories. This is a cathode design in which all the expansion effects cancel out so that the net movement of the cathode with respect to the grid is virtually zero.

Mode of Construction

In appearance the cathode is a rigid sheet of tantalum, folded down the sides to form a channel shaped piece with the flat top facing the grid. Struts of tantalum, held in place by water-cooled copper blocks, give vertical support to the cathode. By careful calculation and experiment, the ideal shape and dimensions of a cathode assembly in which all the forces tending to move it out of position cancel.

Upward and outward expansions of vertical struts are "absorbed" by corresponding expansions of the cathode top. Any tendency of the top to buckle in the middle is prevented by the channel-shaped construction. The result is a cathode that can be heated uniformly and yet presents a completely flat, relatively motionless surface to the grid. This permits greater precision in control of the input power and amplification of the valve, and marks a noteworthy advance in the design of high-power television and FM valves.

Television Developments

In Britain, the present television system is to be retained indefinitely in order to protect nearly 60,000 receivers from obsolescence. Prolonged research, requiring possibly several years will be necessary before substantial improvements including color, can be realised in practice and consequently the London television station will continue to operate for a number of years on the 405 line system. The same system is being adopted for the new Birmingham and other proposed stations.

Czechoslovakia's first television station has been opened, and now operates for three hours each day. As there are only five television receivers in the country, present transmissions are but of technical interest. However, it is proposed to instal a further 20 receivers in public places in Prague.

New Use for Microwaves

According to a report from the Columbia University, it now seems that microwaves will become one of the most important and powerful tools developed for molecular, atomic and nuclear research. Earlier theoretical predictions, that at certain wave-lengths microwaves would be absorbed by water vapour, has now been validated, and other gases have been found to exhibit similar absorption characteristics, each resonant at a different frequency. Thus microwaves can be used for identifying various chemicals.

The gas to be analysed by microwaves is admitted to a sealed wave guide running from a high frequency oscillator to a detector, absorption is then calculated with the help of an oscilloscope. This technique resembles a reversal of the conventional spectroscopic process but is far more exact.

MARCONI—A Tribute To A Pioneer

By ROTH JONES, VK3BG.

This article recalls some of the early experiments carried out by Marconi and his associates, and which laid the foundations of our present day international radio communications.

Recently a memorial plaque in honor of Guglielmo Marconi and George Kemp was unveiled and dedicated at St. Lawrence Church, Lavernock, near Penarth, England, to commemorate the first successful radio transmission over water between Lavernock and Flat Holm on May 11, 1897. The simple ceremony performed by the Rotary Club of Cardiff recalled the great work done by these two great men. It was the second memorial erected in England to these radio pioneers.

The other is an obelisk erected within sight of Land's End, Cornwall, by the National Trust of England. The inscription of this memorial is the only witness today of the early pioneering work in international communication which is being quickly forgotten in this modern world.

Station at Poldhu

The small radio station erected by the Italian radio pioneer at Poldhu, Cornwall, in 1901 was not very impressive when we compare it with today's broadcast stations, yet it was the parent of them all; the cradle of the greatest scientific revolution mankind has known.

On arriving in England in 1896 —more than half a century ago—young Marconi conducted successful experiments over 15 miles. A year later he succeeded in exchanging messages across the sea from Lavernock.

This gave him an incentive to cover great distances, with the possibility of bridging the Atlantic by radio. With these thoughts in mind, the Poldhu station was built. Then on one stormy day in 1901, when the Atlantic was a fury, a handful of men stood at Poldhu with their strange apparatus.

Signals Across the Ocean

Across the ocean Marconi had set up receiving apparatus in some old barracks on Signal Hill, at St. John's Newfoundland. On this cold September day he sat there with telephone receivers waiting to hear the letter "S" tapped out from Poldhu.

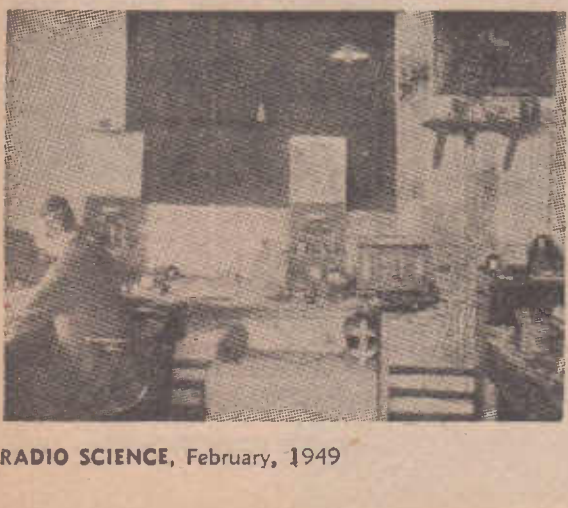
His own account of the successful experiment does full justice to his great achievement:—

"It was about half-past twelve when I heard these little clicks in the earphones. Several times they sounded, but I hardly dared to believe. 'Can you hear anything, Mr. Kemp?' I asked, handing the receiver to my assistant. 'Of course,' he told me, 'the letter S in morse!' And then I knew I was right. Electric waves were sent out from Poldhu and were speeding over the Atlantic, serenely ignoring the curvature of the earth, which so many doubters told me would be a fatal obstacle. And in that moment I knew the day was not too far off when I would be able to send full messages without wires across continents and oceans."

By sending his first trans-Atlantic wireless signal, Poldhu had achieved the first chapter of an amazing history that it was to crown in so short an existence. Marconi returned to Poldhu in triumph, feted by the scientific world.

A year later (1902) a second Marconi station was erected at Glace Bay, Canada, to begin the world's first trans-oceanic radio telegraphy service.

The same year Marconi was 2000 miles in the steamship Philadelphia, and at night Poldhu succeeded in getting a message to him —Poldhu had now shattered the silence of the ocean. Gradually the world's steamship companies realised the great safety factor offered by radio. Within a few years all the large modern ships were carrying wireless and the Royal Navy was beginning its own experiments.



A view of the operating position at Poldhu about 1923.

An early photograph of Guglielmo Marconi.

First Sea S.O.S.

Work at Poldhu continued and in 1912 the station lent its wonder ear to one of the most dramatic cries of despair the world has known —the S.O.S. broadcast from the sinking Titanic, 1000 miles from Land's End.

The first great call from the isolated waters had ushered in the end of dumb impotency in the endless fight against the ocean. During the 1914-18 World War, Marconi's staff, sworn to secrecy, worked in their now famous little hut, tapping out messages and navigational aids to the ships carrying men, food, and munitions to beleagured England.

Men on darkened anxious ships listened intently to Poldhu. Aboard the Lusitania creeping around the north of Ireland they heard the confident voice of Poldhu calling "Caution, Beware."

Following the end of the first World War, Marconi turned his experiments to the transmission of the human voice and the erection of short wave beam systems.

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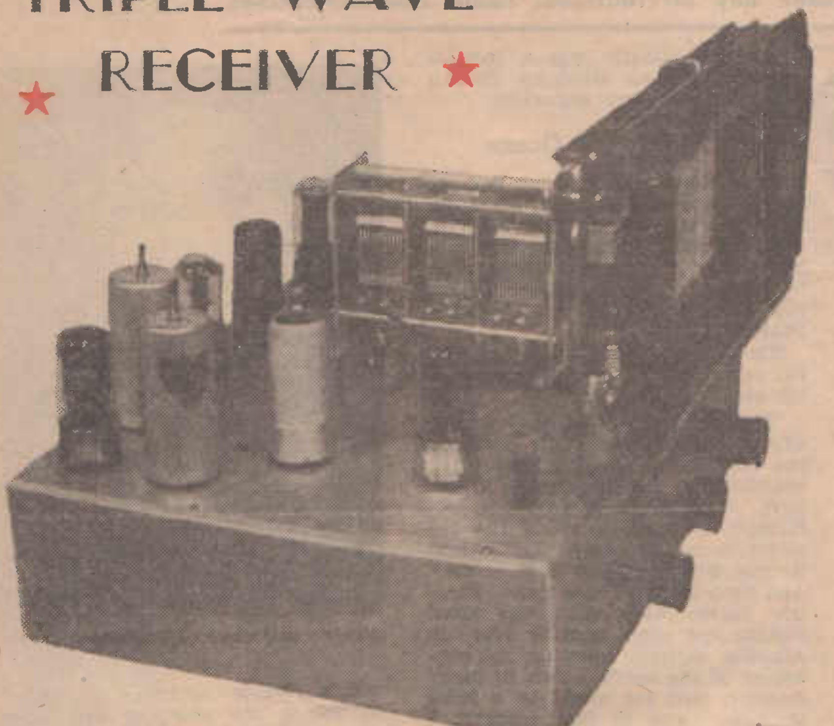
"WORLD-WIDE SIX"

TRIPLE WAVE RECEIVER



The tuning end of the receiver.

SPECIAL FEATURES

- Uses latest high gain converter and single ended valves.
- Efficient coil unit ensures complete coverage on broadcast and two short wave bands.
- Will tune to 20, 40 and 80 metre amateur bands.
- Negative feedback tone control and provision for gramophone pickup.

Designed around an efficient triple wave coil unit, and featuring modern type valves, this circuit will provide excellent reception on both short wave and broadcast bands.

Although dual wave receivers have appeared in previous issues—in one instance a five valve and in the other a seven valve design, the introduction of this new six valve circuit has been brought about by the recent release by the A.W.V. Coy. of a new converter valve. This is the X61M, an English high conversion type, and consequently this circuit is intended to provide the home constructor with a sound basic circuit indicating the application of this new valve.

Originally it was intended to present a design somewhat more elaborate than those described to date, but this was finally ruled out in favor of a circuit likely to have more appeal, and yet provide outstanding performance on the broadcast and short wave bands. Bearing in mind the cost factor, the final design resolved itself down to the six valve circuit shown, and it will be found that the overall performance of this receiver leaves little to be desired.

Triple Wave Coil Unit

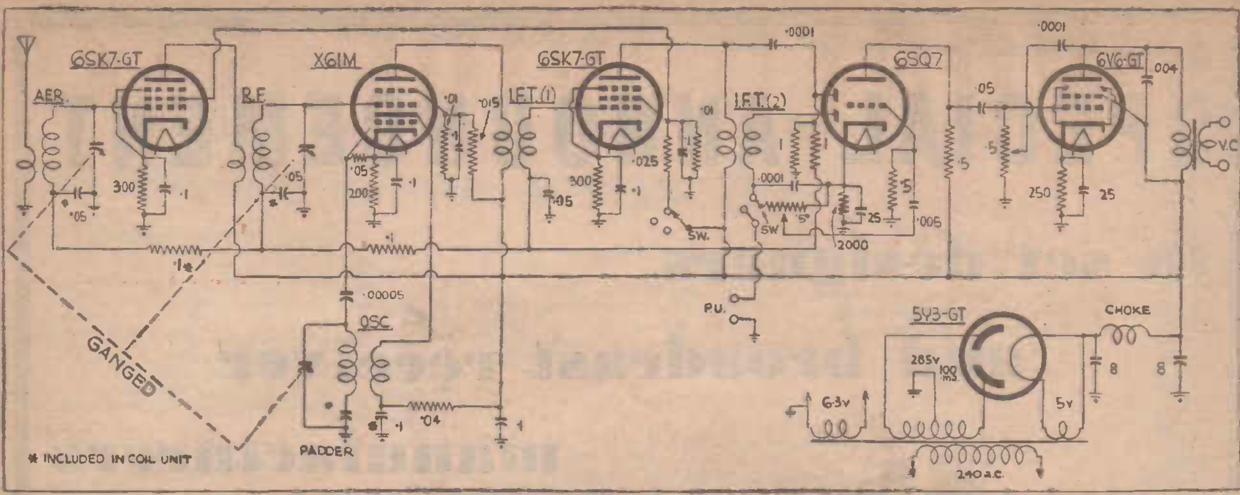
The circuit has been based around an efficient commercial triple wave coil unit, which, for the slight extra expense involved appeared a worthwhile addition. This particular unit covers the standard broadcast as well as two short waves bands—namely, 13-49 metres, and 42-100 metres. These latter ranges cover all the major international S.W. bands, in addition to the 20, 40 and 80 metre amateur bands.

In this design there have been no radical circuit changes, as whilst there may be several ways of achieving identical results, there seemed little point in differing from what may be considered standard practice just for the sake of being different. As a consequence the receiver has resolved itself to: an RF stage, converter, i-f amplifier, combined diode detector, AVC and first audio, power output and a rectifier stage.

For the r-f and i-f amplifiers, there are several suitable valve types to choose from, but in this case the modern single-ended 6SK7-GT has been used. Operating under conditions of 250 volts on the plate and 100 volts on the screen, this valve will provide ample circuit gain, without any tendency towards instability. In addition, due to the internal shield, there is no necessity to use an external valve shield.

R-F Screen Supply

As will be noticed the two screens are fed from a common voltage di-



This high performance circuit uses the latest single ended type valves in conjunction with the recently released X61M converter. In addition to providing broadcast and short wave reception, there is also provision for a gramophone pickup.

vider network, comprising a .025 and .01 meg resistor in series and this arrangement provides a screen voltage that is practically unaffected by input signal variations. Each valve is provided with its own cathode resistor and bypass condenser to reduce any likelihood of circuit interaction and possible instability. It should be remembered that Pin No. 1 on these valves connects to the internal shield and this must be connected to earth.

Converter Details

The converter is the recently released X61M, a new type to the Australian market. This is of English manufacture, and has a high conversion conductance, permitting efficient operation up to 60 mc. In the tentative data released to date, there are two sets of operating conditions for this valve. The maximum conversion figure of 750 micromhos is obtained with a plate voltage of 250, screen voltage of 85 and a control grid voltage of -2 volts. Increasing the screen voltage to 100 volts and the control grid to -3 volts, results in a slight loss of gain, the conversion conductance then being 620 micromhos.

To provide effective AVC control and prevent any overloading of the i-f amplifier, it is necessary to feed the screen from a voltage divider resistor network in place of the usual series screen resistor. In this case it will be seen that the screen is taken from the junction of the .015 and .01 meg resistors connected from B plus to earth. The operating bias for the valve is provided by means of the 200 ohm cathode bias resistor.

Conventional Oscillator Circuit

The oscillator section is conventional, with the triode plate being connected to B plus through the .04 meg dropping resistor. Although the makers recommend a tuned plate circuit, mainly in the interests of stability, the more usual tuned grid circuit has been used and this will be found quite satisfactory in operation, on both broadcast and short wave bands.

For the second detector, AVC control and first audio, a 6SQ7-GT has been chosen. The two diode plates are used separately, one for detection and the other for delayed AVC control. In this latter case the necessary voltage is derived from the primary side of the second intermediate transformer via the .0001 mfd mica condenser.

The triode section of the 6SQ7-GT is used as the first audio amplifier. The centre moving arm of the volume control is connected to the grid through a .005 mfd condenser, with the necessary bias voltage being provided by the 2000 ohm resistor in the cathode circuit. Cathode bias has been used in place of the so-called *contact potential* method, since the requisite 10 meg resistor necessary for this is now difficult to obtain.

To enable the receiver to be switched from Radio to Gramo, a switch has been mounted at the rear of the chassis, adjacent to the two pickup terminals. In addition to allowing this changeover the switch also breaks the screen lead to the r-f and i-f amplifiers when switched to PICKUP. This then prevents any chance of the radio being heard when playing records.

Feedback Tone Control

The output stage uses the well-known 6V6-GT, and here the connections call for little comment. The tone control circuit is similar to that used in the Dual Wave Five. This consists of a .5 meg potentiometer which takes the place of the usual .5 meg grid resistor and a .0001 mfd condenser connected from the 6V6 plate to the centre moving arm of the potentiometer. In operation the control varies the amount of feedback from the plate circuit, and provides a smooth effective tone control.

PARTS LIST:

1 Chassis 14 x 11 x 3½.
1 3 gang tuning condenser (A.W.A.).
1 Tuning dial 4SL/46.
1 Triple wave coil unit (Aegis).
2 455 kc. I.F.T.'s.
1 Power transformer 285v HT 100 ma, 5v at 2 amps. 6.3v at 3 amps.
1. Filter choke 100 ma.

CONDENSERS:

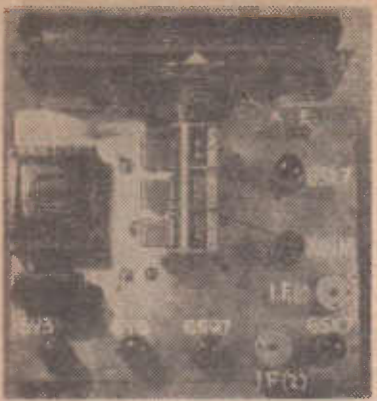
2 25mfd Electrolytic.
2 8mfd electrolytic 600v.
7 .1 mfd tubular.
4 .05 mfd tubular.
1 .005 mfd tubular.
1 .004 mfd mica.
3 .0001 mfd mica.
1 .00005 mfd mica.

RESISTORS:

2 1 meg
2 .5 meg
2 .1 meg
1 .05 meg ½ watt
1 .04 meg
1 .025 meg
1 .015 meg
2 .01 meg
1 2000 ohm
2 300 ohm WW
1 200 ohm WW
2 .5 meg potentiometers. (one with switch).

VALVES: 2-6SK7-GT, 1-X61M, 1-6SQ7-GT, 1-6V6-GT, 1-5Y3-GT.

SUNDRIES: 6 octal sockets, 1-4 pin socket. 1 3 x 3 rotary switch, 4 terminals, nuts and bolts, solder lugs, hookup wire, shielded wire, etc.



This top view shows the location of most components.

When the moving arm is at the grid end, the high frequency response is attenuated, thus providing a full bass effect. Then as the control is moved to the other extreme, the feedback is gradually reduced, allowing the high notes to accentuated, and so giving a treble response. So much then for the circuit considerations.

Layout Problems

One of the major problems of the design was to ensure the shortest possible leads between the various stages. Using a large coil unit of this type having the switch placed centrally, leaves little choice of position on the chassis for it other than in the centre. Since it is necessary to use a larger tuning dial for a set of this type, this then means that to provide a balanced appearance, the gang and dial must also be centred on the coil unit. This brings up another problem—namely to provide adequate clearance between the coil unit and the flywheel fitted to these type dials.

The net result of all this was to set the coil unit sufficiently far enough back to clear this flywheel, and also raise the gang off the chassis to prevent this flywheel from fouling the coil unit spindle. The only other alternative to this scheme would have been to offset the coil unit sufficiently to enable all controls to be placed in line, but this would then have raised other problems of long leads etc.

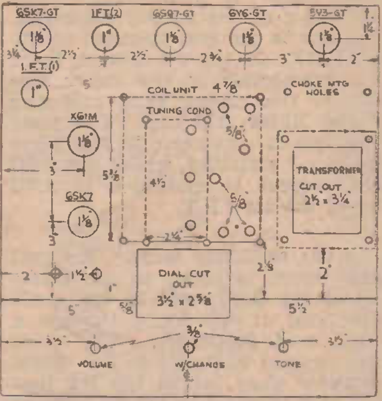
The chassis measures 14 x 11 x 3½ inches and this has been provided with a central dial cut out to accommodate the dial flywheel and spindle. The tuning dial is bolted direct to the front chassis, with the gang being raised sufficiently high to provide adequate clearance. Since the coil unit is now placed back from the front edge of the chassis, it will be found necessary to attach an extension spindle to the wave change switch. This should be fitted before bolting the unit in position.

The r-f and converter valves are mounted alongside the tuning gang, and this arrangement permits short leads. Since the 6SK7-GT is a single ended type, all connections to this valve are made under the chassis, the only top chassis connection being to the X61M grid cap.

The second 6SK7-GT—the i-f amplifier is at the back edge of the chassis. Next to this is the second I.F.T., the 6SQ7-GT, the 6V6-GT and the 5Y3-GT rectifier.

Wiring Up

Since the coil unit used in this receiver is the Aegis K3 type, the following remarks concerning coil connections refer specifically to this unit. In cases where the construc-



Used in conjunction with the top chassis photograph this diagram will give all essential chassis measurements.

tor may be using another type, then the connections supplied for that unit should be followed.

In this particular coil box, it will be found that r-f and converter AVC resistors and bypass condensers are already fitted, and consequently all return circuits for the coils are already taken care of. This leaves only a minimum of connections to be made.

Starting from the aerial section, there are two connections. The aerial lead (green) is taken to the aerial terminal mounted near the front of the chassis. The grid lead (blue) is connected to the stator lug of the tuning condenser, and also to the grid terminal of the 6SK7-GT. In the r-f section, there is a connection to the stator section of the tuning gang and also to the X61M grid cap. The plate lead (green) connects to the plate of the r-f amplifier, whilst the AVC lead (black) is connected to AVC lug of the 1st I.F.T.

In the oscillator section, the grid lead (blue) is taken to the stator lug of the gang, and to the oscillator grid of the X61M through a .00005 mfd condenser. The plate lead (green) connects to the X61M oscillator plate, whilst the HT tension lead is taken to B plus through a .04 meg resistor. The r-f section B plus lead is connected direct to 250 volts. In addition the several short metal braids should be earthed at some convenient point.

All the leads mentioned are clearly color coded, and can be identified from the leaflet accompanying the coil kit.

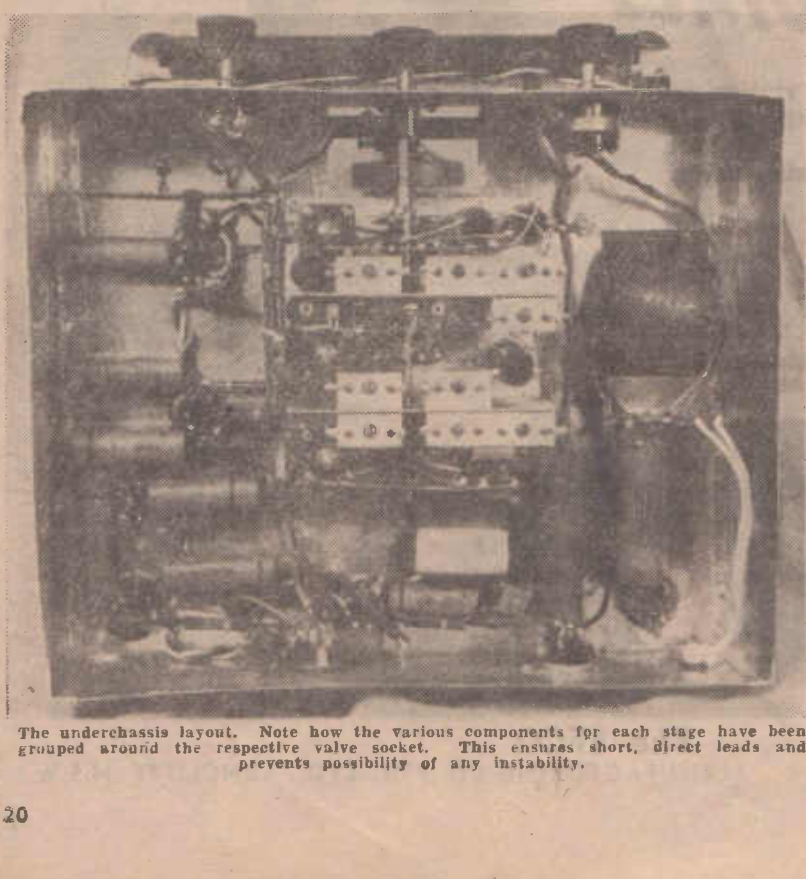
Radio-Gramo Switch

The only other section of the wiring likely to cause any trouble is the Radio-Gramo switch. This is a 3 x 3 rotary type, although only two sections have been used in this case. The moving arm of one section is wired direct to B plus, whilst one contact of this section is connected to the .025 meg screen resistor. In the second section, the moving arm is connected to the "hot" side of the volume control, with the first contact of this section being taken to "F" of the second I.F.T. The second contact is taken direct to the unearthed pickup terminal.

Thus when the switch is in the RADIO position, it can be seen that the radio circuit is completed as the volume control is connected to "F" of the IFT, and at the same time the screen circuit of the r-f and i-f amplifiers is connected up. On switching to PICKUP, the volume control is switched to the pickup terminal, and at the same time the screen circuit is opened, thus preventing any chance of the radio being heard. All leads around this section should be made with shielded wire to prevent any hum pickup, making sure the outer metal braiding is well earthed.

The balance of the wiring should not cause any difficulties. First of all wire up all heater circuits, high tension wiring, AVC leads as well as the leads from the coil unit.

(Continued on Page 48).



The underchassis layout. Note how the various components for each stage have been grouped around the respective valve socket. This ensures short, direct leads and prevents possibility of any instability.

Basic Electricity and Magnetism

A thorough knowledge of electric fields is necessary for the complete understanding of certain radio phenomena, such as transmission, reception and valve operation. In this article, the author explains in detail some fundamental ideas of this most important subject.

This digression is for those readers who are probably starting to wonder when they are going to read something that they can put to practical use.

These articles will develop the basic concepts about electricity and magnetism, but their more important aim will be to explain *why* these fundamental ideas are used. This will give you the necessary background to enable you to read and understand advanced electrical literature.

A thorough understanding of electric fields is necessary because they play such an important part in radio transmission and reception. Thermionic valves are, fundamentally, devices which permit the control of an electrostatic field. Basic concepts about valve operation are concerned more with electric fields than with electron streams. Condensers, or, more correctly, capacitors function by virtue of an electric field wherein energy is stored or released as is required. These two examples are enough to indicate why we must know just what an electric field is.

Graphical Representation of an Electric Field

The form and extent of an electric field may be conveniently represented by means of *lines of electric force* and/or *lines of electric induction or electric flux.* Lines of electric force and lines of electric induction *differ intrinsically in significance and meaning.* They are only common in that they are abstract ideas founded on mathematical concepts, and are endowed with properties on logical deductions which follow from the definitions given them.

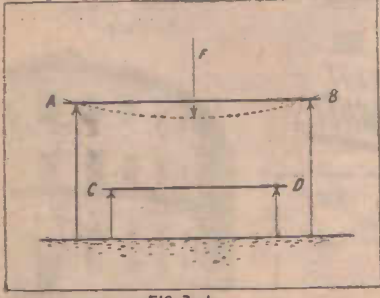


FIG. 3-1

Fig. 1. A force applied to surface AB at point F has effect on the second surface CD.

Most electrical texts include maps of electric and magnetic fields; you are doubtless familiar with the *"lines of force"* which show their extent. You may not be so familiar with lines of induction; some books never mention them. Other books develop the idea that lines of force and lines of induction are the same. Only advanced texts take the trouble to distinguish between them. Clearly, if we intend to read advanced electrical literature intelligently we must be able to grasp the difference and purpose of both kinds of "lines."

Mechanical Analogy

If you rest each end of a light rule on a match box and press it in the centre with your finger, you will feel the rule pressing back on your finger, and you will see that the rule bends in the centre. The pressure you apply at the centre of the rule is resisted by it, and the resisting force which opposes the pressure is called *stress* or, *stress intensity*. This stress, acting within the rule, causes the rule to bend, that is, the stress produces *deformation.* This deformation or distortion is called *strain.*

by
A. L. THORRINGTON
A.S.T.C.

Any body which resists an applied pressure must be deformed or strained because of its resistance; we can conveniently think of stresses, set up in the body, by the applied pressure, as producing a state of strain in the body.

Similarly, we can think of an electrified body establishing a field of electric force throughout the medium which surrounds it, and this medium resisting the force with electric stresses which are developed throughout it, and so becoming electrically strained.

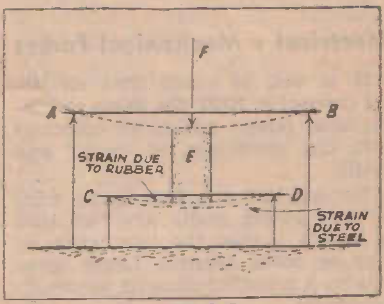


FIG. 3-2

Fig. 2. With the addition of the column E, a force applied to AB will now deform CD as shown by the dotted lines.

Dielectric Constant

Any non-conductor of electricity has the property of resisting electric forces to which it may be subjected. This property, *which must not be confused with resistance to an electric current,* is called the *dielectric property* of the non-conductor. Substances which resist electric-static forces are called *dielectrics.* Substances differ in their ability to resist electric-static forces. The degree to which any substance can resist electric-static forces is expressed as a number which is called the *dielectric constant* of the material.

Since a vacuum is a non-conductor it is also a dielectric; in opposing the forces established throughout it by an electric field, we think of a vacuum, which is defined as *empty space,* as being electrically stressed and strained. In other words, space is warped and deformed by the electric field established in it by an electrified body.

The idea of space being "pushed out of shape" by intangible electric forces was just a little too much for early experimenters. The notion was a challenge to their commonsense. The pathetic invention of *ether* is indicative of the effect that the idea had on their minds.

You will doubtless find the notion a little incredible at first. It will comfort you to know that everyone, when they first hear it, are confused, bewildered, cynical or disdainful according to their temperament. Actually, the difficulty which attends acceptance of the idea is due to the inherent tendency of our minds to endow all concepts with physical meaning and significance. The concept that space is warped by electric fields is an abstraction because the deformation has mathematical implication only. It cannot be explained or expressed in terms of reality. The abstraction is justified because it is ammenable to mathematical manipulation, and because it can adequately account for electrical effects we see and hear and consequently accept as being very real indeed.

Electrical v Mechanical Forces

It is well to recall that electrical forces are NOT the same as mechanical forces, which we associate with the sensations of "push" and "pull."

No one has any idea as to what electric forces really are; all that is known is that the interaction of two or more electric forces gives rise to a manifestation of mechanical forces.

Neither may be regarded *Electric stress* and *Electric strain* in the same way as we regard mechanical stress and mechanical strain, although, for the development of basic theories we can accept them as analogous.

Summarising then, we can regard an electric field of force as being similar to the pressure of your finger on the rule, and we can think of this electric field as inducing an electric stress, or an opposing force throughout the dielectric surrounding it, similar to the stress induced in the rule to oppose the pressure of your finger. Finally, the *electric stress* causes the dielectric to be electrically strained, in the same way as the stress induced in the rule caused the rule to be deformed.

Electric stress is sometimes called, *electric field intensity;* electric strain is also called *electric induction* or *electric flux density.*

Lines of electric force indicate the direction of the electric stress promoted by an electric field. They are closely linked, and used in conjunction, with mathematical expressions involving *field intensity.* Lines of electric induction indicate the direction of *and the amount of* electric strain promoted by an electric field. They are linked, and used in conjunction, with mathematical expressions involving *flux density.*

Lines of force show direction only; they have no quantitative meaning. Lines of induction show direction *and* have quantitative meaning.

Dielectric Action in an Electric Field

The completed concept of an electric field is a mosaic analogue and analysis, which, in the early stages, seem entirely unrelated. Initial development will of consequence seem discontinuous and even disjointed. The fact that we are reverting to matters discussed in the last article does not mean that we have finished with lines of force and induction; we will consider them again shortly.

It was emphasised in the last article that the relationship,

$$F = \frac{q1\ q2}{d2} \qquad ....3.1$$

was true only when the charges, q1, q2 were immersed in a vacuum. When the charges are surrounded by some other dielectric such as air, hydrogen, oil, etc., the force between them is *reduced* and its reduction is proportional to the dielectrical constant of the dielectric involved.

Vacuum D.C. is Unity

Our definition of unit charge, which specifies that the charges are immersed in a vacuum, automatically fixes the dielectric constant of it as unity. It is important to realise the significance of this because it stresses just how much we depend on definitions for many of the properties we give electrical materials.

When electric charges are surrounded by some other dielectric the reduction in the force between them is readily expressed mathematically by writing,

The dielectric constant for air is slightly greater than one, but little

$$F = \frac{q1\ q2}{K.\ d2} \qquad ....3.2$$

where K is the dielectric constant of the substance involved.

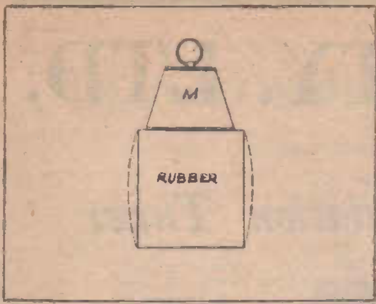


FIG. 3-3

Fig. 3. The reason why a non conductor having a high dielectric constant stores more energy than one with a low dielectric factor is illustrated with this mechanical analogy.

error results if we assume the K for air as being, unity. Tables of dielectric constants for many common non-conductors can be found in any electrical handbook.

The fact that dielectrics can so modify an electric field so as to reduce the forces between electrified bodies is readily understood when we realise the significance of the electric strain which exists between them.

Why Non-conductors Modify Electric Fields

The dielectric around a charge is in a state of strain owing to the opposition it offers to the electric forces which exist throughout it. We can think of the dielectric being stressed and strained in the same way as a spring under tension, or a piece of stretched rubber.

Now, the degree to which a substance is deformed depends entirely on the nature of the substance. A pound weight resting on a piece of soft rubber will deform it a lot more than it will a piece of felt of the same dimensions. In the extreme case, the same weight, resting on a piece of hard steel, of the same size and shape, as the rubber, will produce such little deformity as to be indiscernable to the eye. Clearly, the same force does not produce the same degree of strain with different materials.

We can think of non-conductors as having varying degrees of resistance in the same way as we know that rubber, felt, and steel have to mechanical forces.

The dielectric constant of a non-conductor can be regarded then as a measure of its ability to withstand deformation when subjected to electric forces. A high dielectric constant means that the material is readily strained electrically. Water has a dielectric constant of 81; it is strained 81 times as much as a vacuum when subjected to the same electrical forces.

The reason why substances with a high dielectric constant reduce the mechanical forces between charged bodies is readily explained by reverting to our analogy of the rule.

Figure 3-1 shows a light rule AB, supported at each end. Beneath AB, and supported independently of it, is another rule CD. A force F, applied at the centre of AB, causes AB to bend as indicated by the broken line. The rule CD is unaffected by the force F. In Figure 3-2, a column of soft rubber, E, has been fitted between AB and CD, and the same force F, applied to AB. The effect of the force F in this latter case is to deform the rubber, E, and, a component of the force, transmitted through the rubber, will slightly deform CD, as shown by the broken line below CD.

If we now substitute a steel column for the rubber one, then the same force F, applied at the centre of AB will produce considerable curvature of CD—shown by the dot-dash line in Figure 3-2.

Clearly, by changing the material between the rules, AB, CD we were able to alter the amount of force applied to the lower rule, despite the fact that the original force, F was the same in each case. The mechanical force acting between AB and CD depends entirely on the substance between them. The more readily the substance is mechanically strained so less is the force between the rules.

Energy Storage

In exactly the same way, the more readily a dielectric is electrically strained—the higher its dielectric constant—so less is the force between the charged bodies straining the dielectric. The reason for this of course is that any substance which is readily strained, either mechanically or electrically, absorbs and *stores more energy* than a material which is not so easily deformed. Since we intend to develop the idea that electricity is a form of energy, it may be just as well to see why easily deformed bodies do store more energy.

Suppose that the block AB, in Figure 3-3, is a piece of soft rubber, and let it support a weight of one pound as shown. As the weight M is rested on the block, the block will shorten and bulge as shown by the dotted line. Suppose M, in distorting the block, moves through a distance of one inch.

Now, work is defined as the product of force and distance, that is, $W=F.s$ . . . 3.3, where W is the work done, which is equal to the energy stored in the rubber, F is the force and s is the distance.

In our case, F is 1lb. wt., and s is 1 inch. Hence, $W=1 \times 1=1$ inch pound. The energy stored in the rubber is thus, 1 inch pound.

If a steel block is substituted for the rubber one, the effect of the weight M will be indiscernable, but let us assume that the steel is compressed 1/100 of an inch. Hence, with the steel block, the work done, $W=1 \times 1/100=1/100$ inch pound. The energy stored in the steel block is thus 1/100 inch pound or 100 times less than that stored in the rubber one.

We can think of a non-conductor having a high dielectric constant as being capable of storing more electrical energy than one with a low dielectric factor. If two identical capacitors, except for their dielectric, are charged from the same source, then the capacitor with the dielectric having the high dielectric constant will store the greater amount of energy. We will consider this later.

The Effect of Electric Fields on Conductors

One of the most valuable properties of an electrical conductor is that it *cannot be electrically strained.* The instant a conductor is introduced into an electric field the electric strain existing in the space it occupies immediately disappears. This disappearance of electric strain necessitates a movement of electric charges along the conductor. The movement of charges along the conductor continues until either the strain disappears entirely or is reduced to the lowest possible value.

An important fact, seldom mentioned, is that it is the existence of an electric field about an energised conductor which maintains the flow of charge along the conductor. A battery or generator in maintaining a potential difference between the ends of a conductor also sustains an electric field around and along the conductor, and the dielectric surrounding the conductor, in attempting to alleviate the resultant strain it experiences, maintains a flow of charge through the conductor. A non-conductor is just as necessary for the transmission of electric energy as the conductor itself. As a matter of fact, radio transmission is proof that the conductor can, under certain conditions, be eliminated.

Electro-static Induction

When an insulated, uncharged conductor BC (Figure 3-4) is brought near a positively charged body A, tests show that positive

(*Continued on Page* 44)

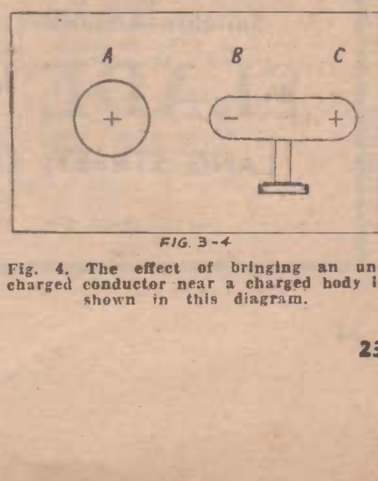
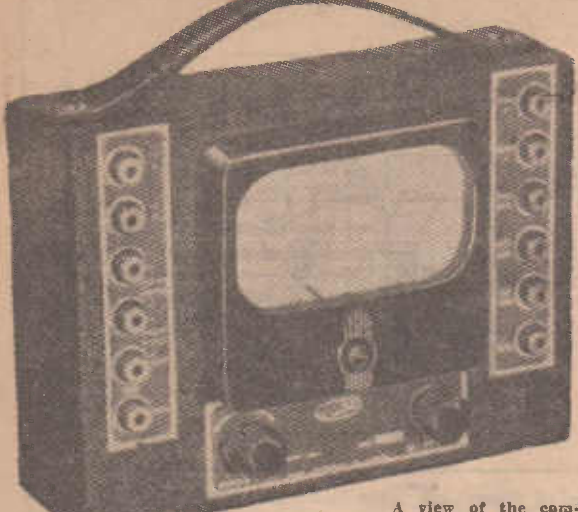


FIG. 3-4

Fig. 4. The effect of bringing an uncharged conductor near a charged body is shown in this diagram.



A view of the completed unit.

BUILD THIS A.C.—D.C. MULTIMETER

Designed by Radio Equipment Pty. Ltd., this multimeter has provision for A.C. and D.C. volts, current and resistance measurements and is admirably suitable for the radio serviceman or experimenter.

A multimeter is probably one of the most useful pieces of test equipment for the radio serviceman or experimenter as its prime purpose is to enable any voltage, current or resistance measurements to be made in a radio receiver. From the serviceman's point of view it is the instrument which finally localises the trouble after the defective stage has been determined.

For the unit to have the widest practical value, it is essential that it be capable of reading various ranges of current, voltage and resistance measurements. The addition of AC on the voltage range also increases the usefulness of the equipment, by enabling the unit to be used as an output meter and thus ensure accurate receiver alignment is carried out.

These main requirements have been incorporated in this particular multimeter—the various ranges being: Volts, AC-DC, 0-10/15-250-1000 Current, 0-1-10-50-250 ma. Resistance: 0-10,000–1 meg. These are sufficient to enable most receiver measurements to be carried out, and if carefully constructed, the accuracy of this unit will compare quite favourably with more expensive instruments.

The following description has been based on the full kitset being used, but in cases where the constructor may intend building up similar equipment from components on hand, this description will still serve as a useful guide.

Assembly

The first step in constructing the unit is to assemble the various parts in their correct position. In the kitset this procedure has been simplified by supplying some of the sections partly assembled. These include the front panel section, some of the tip jack sockets and the 'Low Ohms" tip jack socket.

Commence by taking the balance of the tip jack sockets and assemble them on to the panel in the holes that are in the labels. In doing this make sure the sockets are tightened up from behind the panel, thus avoiding any danger from scratching the labels. The main control label, with the word "unikit" on it should be held on with the potentiometer and the three insulating washers. The smaller washer fits between the two larger. The small black knob should then be screwed on the potentiometer shaft.

Take the meter out of its carton, and it will be seen that four screws are loosely fitted in the mounting holes. This meter is already adjusted so it is only necessary to remove the four screws and mount the meter on the front of the panel. First of all put in the two screws on the left hand side or the negative terminal of the meter. Then take the panel which has the battery clip on it, put that on the right hand side of the meter and the two mounting screws will go through the holes in this panel into the meter. Screw up the four mounting screws and the meter and battery holder are then in their correct position.

Resistor Panel

Next comes the resistor panel, which is almost the final assembly. Place the panel over the meter terminals — first of all removing the loose nuts, lockwashers and solder lugs—so that the single rectifier hole is down at the bottom of the kit —very near the AC-DC switch. Re-

PARTS LIST — AC-DC MULTIMETER

- 1 Metal Case with Lid.
- 1 0-1 ma meter.
- 1 Battery panel with clip (Bakelite).
- 1 Bakelite resistor panel.
- 2 Bakelite tip jack socket insulating Strips.
- 1 MBS1 1 marectifier with screw.
- 1 Rotary switch.
- 12 tip jack sockets (complete).
- 1 .25 mfd condenser.
- 1 1150 ohm resistor. WW.
- 4 .25 meg resistors (multipliers).
- 1 .05 meg resistor (multiplier)
- 1 .01 meg resistor (multiplier).
- 1 14.8 ohm resistor WW.
- 1 type 950 cell.
- 1 shunt.
- 1 Potentiometer.

SUNDRIES: 2 socket labels, 1 knob, 1 round knob with indicating line, 4 self tapping screws, 1½ mm spaghetti, 1 control label, 1 leather handle complete with screws, etc., Resin cored solder, hook-up wire, etc.

erences to the back panel photograph will show how this is done. Next screw down the panel making sure the lugs are pointing to each other for easy wiring.

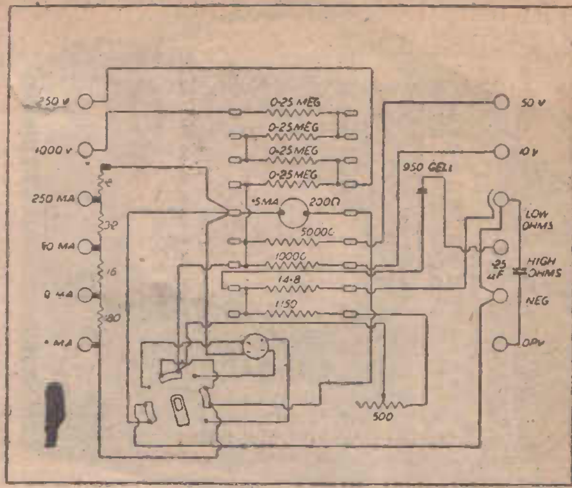
The major assembly is now complete, and ready for the wiring up. Before doing this re-check the assembly and ensure the lugs are equally spaced and pointing as shown in the photograph.

Wiring Up

The next step in the construction is the wiring of the instrument. This can best be done in stages, the first of which is to wire all the resistors on to the main resistor panel.

Referring to the photograph and the drawing showing the wiring you will see that there are six resistors in moulded bakelite and these are the voltage multipliers. At the top of the panel farthest away from the potentiometer, solder on four .25 meg resistors. Make sure all lugs and the end of the wires on the resistors are tinned so that soldering can be carried out quickly, as any excessive heat may effect the accuracy of the resistor.

Immediately below the two meter terminals are two more resistors. In their order they are the .05 meg resistor and then underneath it is the 10,000 ohm resistor. Immediately below these again are two wire wound resistors. One of these is 14.8 ohms and the other is 1150 ohms.



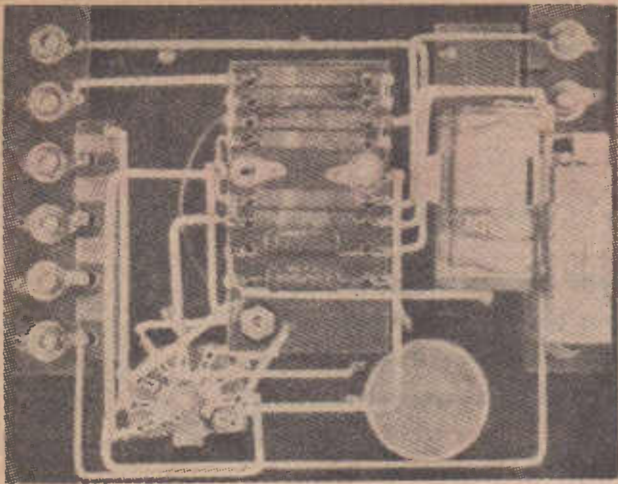
Circuit diagram of the AC-DC multimeter. Note this is drawn similar to wiring diagram on the next page.

Resistor Connections

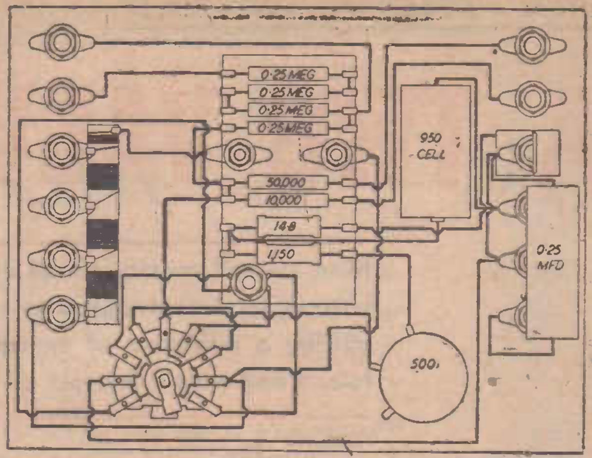
Next connect the resistors together where they have to connect. For example the .25 meg resistors are wired in series, the 14.8 ohm and 1150 ohm resistors are connected together at one end as are the 10,000 ohm, 50,000 ohm and one .25 meg resistor. Reference to the circuit and wiring diagrams will make this quite clear. Now connect the solder lugs of the resistor panel to the various tip jacks and other parts of the circuit, using 18 gauge tinned copper wire covered with either spaghetti or nylex tubing.

The milliameter shunt should now be wired in. One lug of this shunt has a red dot on it and this connects directly to the tip jack marked 250 milliamperes. The remaining lugs should be soldered direct to the other milliampere tip jack sockets, except the extreme top end, which connects to the nearest meter terminal.

This leaves only two wires to be connected. One is from the end of the



This photograph shows the back panel wiring and should be used in conjunction with the wiring diagram.



This wiring diagram shows the relative position of each component and should simplify the construction.

1150 ohm resistor and this goes to the positive side of the battery. The other comes from the ohms terminal to the negative side of the battery.

This completes the wiring of the DC section of the unit and leaves only the AC section to be added.

Adding the AC Section

To add the AC section, there are only four parts to consider. First of all screw the rectifier in the hole provided on the main resistor panel. Next, put in the changeover switch in the position shown in the photograph, and fit the knob having the white line marked on it.

Turn the switch to the extreme right or DC side. Adjust the knob so that the white mark points to the letters "DC" on the front panel. Then by turning the knob to the left-hand side the white line should point to the letters "A.C.V."

The first step in the wiring is to take the .25mfd condenser and solder it on the two appropriate tip-jacks. One end of the condenser is soldered to the solder lug on the double circuit tip jack, whilst the other end is taken to the tip jack marked "OPV." A wire also comes from the lug on the double circuit tip jack to the appropriate switch contact.

Rectifier Connections

The rectifier has four wires coming from it, and two of these have little white blobs, and the other two have a black and red blob. The black lead is negative, the red is positive and the whites are AC, and these should be connected into the circuit as indicated in the wiring diagram. Care should be taken in soldering these leads as excessive heat can damage the rectifier.

This completes the wiring of the A.C. section and the wiring should be re-checked for any errors. If you have carried out the wiring correctly, the multimeter is now ready to use.

Care should be taken when making the first measurements. Start off by measuring a known source of low voltage using the thousand volt range. This should cause a slight deflection, then switch to the 250 volt range, and this should give a bigger deflection. Continue down the ranges making sure that the voltage being checked does not exceed the scale range, otherwise damage to the meter may result.

To test the Ohms section put the test prods provided in the appropriate tip jack sockets and touch the prods together. The needle should then swing over towards the ZERO end of the Ohms scale. Adjust the potentiometer to bring the needle directly on to the figure "0" on the scale, and then the unit can be used for measuring resistance. Make sure that the potentiometer adjustment is made at all times before measuring resistance values.

Output Meter

The AC section of the multimeter, in addition to allowing AC voltage measurements up to 1000 volts to be made, also enables the meter to to be used as an output meter when aligning an ordinary radio receiver, or making any output measurements.

The whole instrument is one which should find a ready place in any radio enthusiast's equipment. The modern and improved circuit should give the user many years of successful and satisfactory performance.

NEW PRACTICAL RADIO COURSE

From the Australian Radio College, well known for its radio training facilities, comes details of a new practical course which can be taken in conjunction with their regular radio servicing course.

This recent addition to the serviceman's course, is an optional extra, and now provides the country or overseas students who may not have the facilities for readily obtaining radio components, etc., with an easy means of gaining the requisite practical knowledge.

The practical section of the course comprises some nine different kits of parts, together with special home experiment lessons explaining in detail the actual procedure to be followed.

With these kits of parts the student is then able to construct many types of test equipment and radio receiver circuits thus obtaining experience in the actual operation of radio circuits. Typical of the equipment that can be built up are: Continuity tester, one, two and three valve receivers, r-f and a-f oscillators, A.C.-D.C. voltmeter, multivibrator oscillator, condenser tester and a signal tracer. In addition full instruction is given in such topics as soldering, wire splicing, aerial construction, coil winding, valve testing receiver alignment, use of amplifier circuits and many other important subjects of vital interest to the technician.

When all the practical experiments have been completed, the equipment supplied during the course will provide the student with a complete array of test equipment which can be put to practical use during everyday servicing problems.

An illustrated brochure fully describing this course is now available and can be obtained free of charge by writing direct to the Australian Radio College, Broadway, Sydney.

A TWO-VALVE RECEIVER

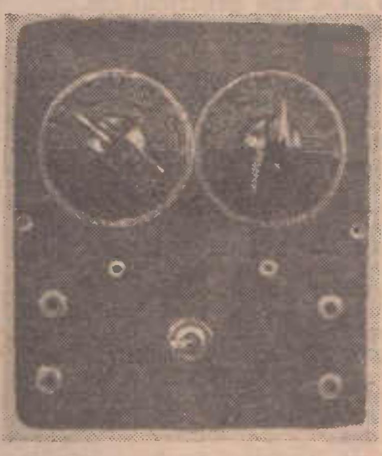
Here are full constructional details of an efficient two-valve battery receiver designed to cover the broadcast band. Requiring a minimum of components, it is entirely self-contained and should interest all in need of a compact receiver.

As it is now some months since a small type of receiver suitable for our younger readers has been presented, we feel sure this description of a small two valve battery receiver obtainable from the FN Radio Co. should be of interest to many.

The completed receiver using a 1T4 and 1S4 in an efficient circuit is housed in an attractive cabinet measuring only 4½ x 5 x 3 inches. Being entirely self contained, this is the type of receiver that should appeal to all those readers requiring a small compact unit that will provide good listening.

Headphones or Speaker

Although only two valves are used it will be found that under general conditions, and using an efficient aerial and earth system, there will be no difficulty in tuning in all the local stations, at good strength on the headphones. In some cases where the listener is situated near these stations, it should be possible to operate one of the small permagnetic type speakers, thus adding to the utility of the receiver.



A view of the front panel, showing tuning and regeneration controls. The aerial and earth terminals are at the left, and those for the headphone connections at the right hand side of the panel.

Simple Circuit

Reference to the schematic diagram will show that the circuit is not complicated and follows what may be considered standard practice for a small receiver of this type. Consisting of a regenerative detector and an output stage, this two-valve receiver is capable of excellent results, and as the latest 1.4 volt miniature battery valves are used, it will be found that the current drain is kept at a minimum, thus ensuring maximum battery life.

A 1T4 r-f pentode is used as a regenerative detector and it will be noticed that screen regeneration is employed in place of the more usual condenser control. As a result the reaction winding of Reinartz type coil is returned to earth through a .001 mfd fixed mica condenser whilst the screen grid of the valve is connected to the centre moving arm of the 20,000 ohm potentiometer. This potentiometer is the reaction control, and since it allows the screen grid voltage to be varied over wide limits provides an efficient means of adjusting and controlling the regeneration.

Standard Coil

The tuning coil used is a standard type having the usual aerial, grid and reaction windings, and the connections to this should not prove difficult. The grid leak detection is provided by means of the .0001 mfd condenser and 2.0 meg resistor connected as shown in the grid circuit.

The output from this stage is then resistance coupled to the 1S4 output stage via the .1 meg resistor and .01 mfd coupling condenser. The .02 meg resistor and .00025 mfd bypass condenser take the place of the usual r-f choke and form an effective r-f filter, thus preventing any r-f signals from reaching the audio stage. If desired the resistor can be replaced by an ordinary r-f choke, without any effect on circuit operation or performance.

The connections for the 1S4 stage are conventional and require little comment. The bias for this valve is obtained from the back bias system, consisting of the 1500 ohm resistor connected from B minus to earth. The 2.0 meg grid resistor is connected to the B minus lead, and consequently it can be seen that any voltage developed across this back bias resistor due to the HT current flowing through it, will be applied to the valve as the required grid bias voltage.

Assembling the Components

As can be seen from the photograph all components are mounted on the front panel plate. The metal bracket which supports the two valves and the tuning coil measures 3⅜in. x 1 1-8in. wide and this is riveted in place on the front panel. Immediately above this bracket are mounted the .02 meg potentiometer and tuning condenser, making sure to fit the indicator plates before screwing these controls into position.

The DPST switch is mounted centrally below the chassis bracket, with the Aerial and Earth and phone terminals being positioned on either side of the switch, as shown in the photograph.

Wiring Up

With all the parts mounted in their correct positions, the next step is to wire up the receiver. This can be most conveniently carried out by taking each valve socket in turn. Commencing with the 1T4 socket making the following connections: **Pin 1**—Earth, **Pin 2**—To "P" of the coil (Blue lug). Connect a .02 meg

See notation page About March issue re special coils and .1 meg resistor in series from this lug to B plus. A .00025 mfd condenser is also connected from the junction of these two resistors to earth. **Pin 3**—To the centre moving arm of the .02 meg potentiometer. **Pins 4 and 5**—Unconnected. **Pin 6**—Wire a .0001 mfd condenser to the green lug of the coil, also take a lead from this point to the stator lug of the tuning condenser. Connect the 2.0 meg resistor from pin 6 to earth. **Pin 7**—to pin 7 of the 1S4.

The remaining connections in this section of the set are to wire a .001 mfd condenser from the Red terminal of the coil to earth, earth the black lug and connect the White lug to the aerial terminal.

Output Valve Connections

The connections to the 1S4 socket are as follows: **Pin 1**—Earth, **Pin 2**—One of the phone terminals, **Pin 3**—to the junction of the .02 and .1 meg resistors via a .01 mfd condenser. Also connect a 2.0 meg resistor to B minus on the switch. **Pin 4**—to second phone terminal and B plus lead of the battery. **Pin 7**—to A plus of the battery.

The remaining connections are to wire one side of the .02 meg potentiometer to B plus, earthing the other contact. Make sure the earth terminal has been earthed to the chassis.

Putting in Operation

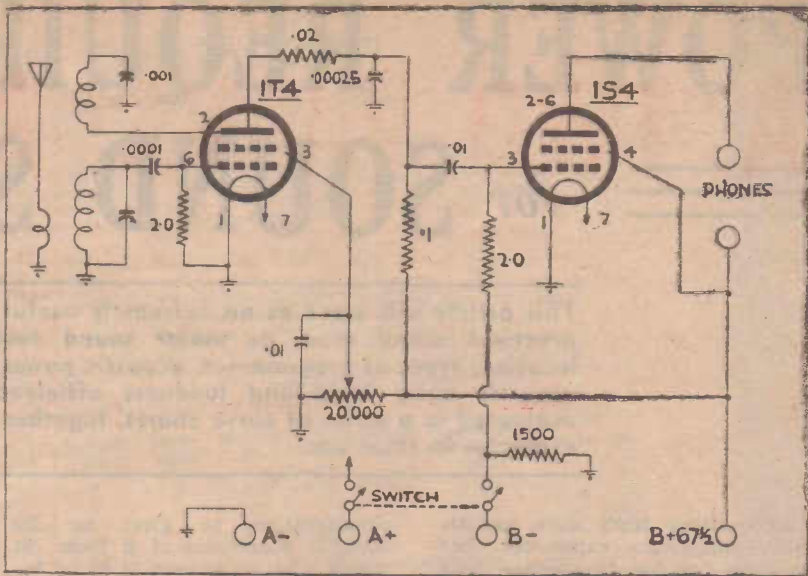
After rechecking the wiring, plug in the valves in their correct sockets, connect up the phones, aerial and earth, and switch on the batteries. As the potentiometer is rotated in a clockwise direction, the usual characteristic rushing sound should be heard, together with a "squeal." This condition will indicate the valve is oscillating correctly. For best results the control should be adjusted so that the set is almost on the verge of oscillating.

Next tune across the band, using the potentiometer control to keep the set oscillating, and if everything is in order, there should be little difficulty in hearing the local stations at good strength. The receiver is so simple to construct that providing normal care is taken with the wiring up, there should be little difficulty in duplicating the results obtained with the original model.

In conclusion, it should be mentioned that the optimum performance of a small set of this type depends largely on the aerial system. Although in some localities satisfactory reception may be obtained with only a short piece of wire as the aerial, it is suggested that where possible, something more effective than this be used.

For preference the aerial should be about 40-50 feet long, and erected as high as possible, clear of any roofs, buildings, etc., to ensure maximum signal pickup.

For the earth, which is a necessity with all battery type receivers, the lead can be taken to a water pipe, or a metal rod sunk into the ground, preferably in a damp spot. A little care to these points will make all the difference in your reception, especially if you are trying for country or interstate stations.



The circuit is quite straightforward and should present little difficulty to the constructor.

TWO-VALVE RECEIVER PARTS LIST

1 Cabinet, complete with front plate.
1 Chassis, as detailed.
1 Tuning condenser (single gang).
1 Reinartz Coil.
1 DPST Toggle Switch.

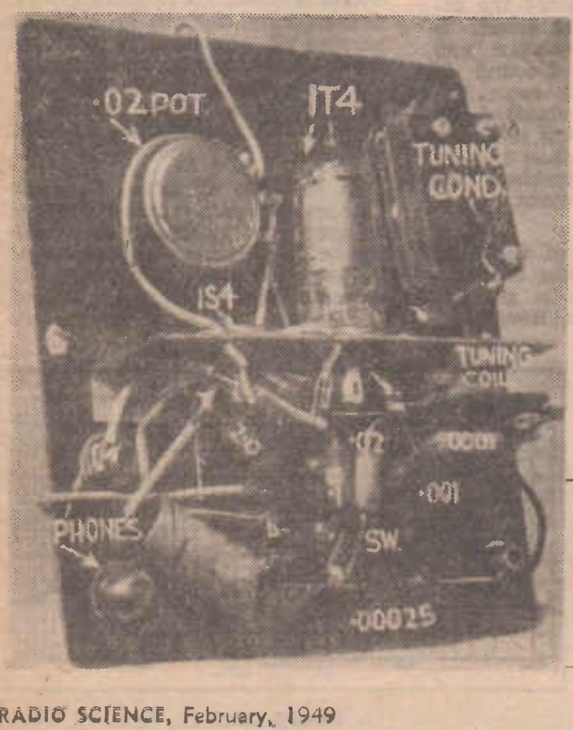
CONDENSERS

2 .01 mfd Tubular.
1 .001 mfd Mica.
1 .00025 mfd Mica.
1 .0001 mfd Mica.

RESISTORS

2 2.0 meg. ½ watt.
1 .1 meg ½ watt.
1 1500 ohm ½ watt.
1 20,000 ohm potentiometer.
VALVES: 1T4, 1S4.

SUNDRIES: 2 miniature sockets, 4 terminals, 2 indicator plates, 2 pointer knobs, 1 67.5 volt, 1 1.4 volt battery, nuts and bolts, hookup wire, etc.



This photograph of the back panel shows the location of most components and should be used as a guide when wiring up the receiver. Note the 1S4 has been removed to show the regeneration control.

POWER REQUIRED for SOUND SYSTEMS

This article will serve as an extremely useful guide for the practical sound man, as major sound factors such as: location, types of programmes, acoustic power requirements, acoustic noise level and loudness efficiency have been evaluated in a series of curve charts, together with practical examples in their use.

Information from wide, practical, application experience has made it possible to prepare data which relates the acoustic levels required and the electric power capabilities for sound systems for indoor volumes and outdoor areas.

For the determination of required electrical power requirement, the following factors must be taken into account:—

(1) **Location to be covered (indoors or outdoors).**

(2) **Type of programme material to be reproduced.**

(3) **Acoustic power capacity required.**

(4) **Acoustic noise level in the location to be covered.**

(5) **Loudness efficiency of the loud speakers being used.**

Location

If the location is an outdoor one, the distance to be covered must be known (Fig. 2). The necessary angle of coverage with respect to the point of location of the loud speaker or loudspeakers must also be known. If the location is an indoor one, the volume to be covered must be known. (Fig. 1.)

The information which follows will be adequate for the volume to be covered if the reverberation time at 512 cycles per second is within the limits of one half to twice the average time for reproduced sound.

Room Acoustics: The purpose of a sound system is to supply sound throughout a room at the proper volume and quality. It should never be considered as a remedy for the acoustic defects of a room. Although there are cases where a sound system helped improve listening conditions in a room which was poor acoustically, there are other cases where the increased loudness of sound made it more difficult to understand. It is therefore important that careful consideration be given to the acoustic conditions of a room in which a sound system is to be installed.

Echoes: When a surface of a room is so situated that a reflection from it is outstanding and is heard by the listener an appreciable length of time later than the direct sound, it will appear as a distinct echo and will be disturbing. If the surface is concave, it may have a focusing effect and concentrate reflected sound energy at one locality. Such a reflection may be several db higher in level than the direct sound and its arrival at a later time will be particularly disturbing.

In such cases there are three possible remedies. The offending surface can be covered with absorbing material to reduce the intensity of the reflected sound; it can be changed in contour and thus send the reflected sound in another direction; or some improvement may be obtained by changing the loudspeaker to a new position. The best method of solving any particular problem will depend on local conditions.

Reverberation: One of the most common acoustic defects encountered in an auditorium is that of excessive reverberation. Reverberation is the **persistence of sound due to multiple reflection of sound waves between the several walls of the room.** Some of the sound energy is absorbed at each reflection; the rest remains in the room as audible delayed images of the original source. The longer the time interval between reflections (the larger the room), and the lower the absorbing efficiency of the reflecting surfaces, the longer will be the time that this residual sound will persist. The result is an overlapping of the original sound and its images.

Reverberation Problems

This reverberation causes a general confusion which is detrimental to speech intelligibility. At the same time, it increases the loudness of the sound in the room, which is beneficial to intelligibility. Consequently, there is an optimum amount of reverberation for any room, determined by a balance between the loss in intelligibility due to confusion and the increase in intelligibility due to the increased loudness.

In the case of music, a certain amount of reverberation is required to give pleasing quality and brilliance. Reverberation which would be ideal for music is somewhat in excess of that which would be best for speech, and since most audi-

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Fig. 1—Acoustic power requirements, indoors. The A plot shows the maximum requirements for concert music; B normal public address requirements for music; C normal requirements for speech.

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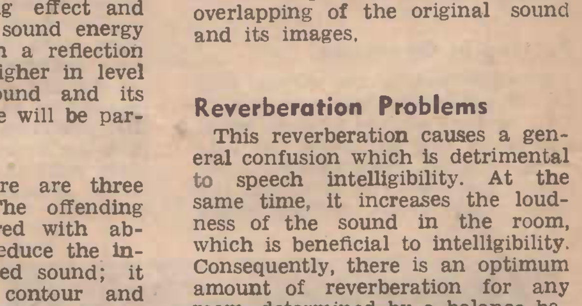

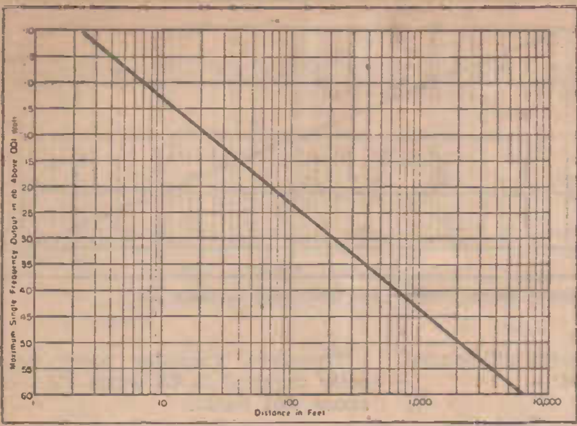

Fig. 2—Acoustic power requirements, outdoors.

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toriums are used for both speech and music, a compromise is usually made.

Reverberation in a room is expressed quantitatively by the **reverberation time, which is the number of seconds required for a sound to decrease 60 db from its initial value, after the source has been stopped.** In general, the time will be different for different frequencies, and the reverberation time for a room is usually given for a frequency of 512 cycles.

The reverberation time at other frequencies is just as important as at 512 cycles. In fact, it is fully as important to have the proper relation between reverberation time and frequency, as it is to have the optimum reverberation time at any one frequency. The desirable relation between reverberation time and frequency varies with room volumes.

Type of Programme

Indoors: The greatest sound pressure level is required for the reproduction of concert music. For this type of reproduction curve A of Fig. 1 should be used. For the average sound system used to reproduce speech, vocal music, dance music and the like, curve B should be used. For a system intended to reproduce speech only, curve C should be used.

Outdoor Programmes

More power is ordinarily required to produce the desired sound pressure levels outdoors because the sound is not reinforced by reflections from walls and ceilings. The levels required are based on the maximum distance from the loudspeaker at which the sound is to be heard. For outdoor applications, the curve in Fig. 2 should be used.

The coverage angle is 30 degrees for the information contained in this figure. Speech levels are used, as music is ordinarily incidental to speech programme material in outdoor applications.

Acoustic Power Requirement

The acoustic power requirement of a sound system is the maximum rms acoustic power which the system is required to reproduce on a steady tone without exceeding the distortion and power handling ratings of the components of the system.

The required acoustic power requirement for the conditions of use stated is obtained from Figs. 1 and

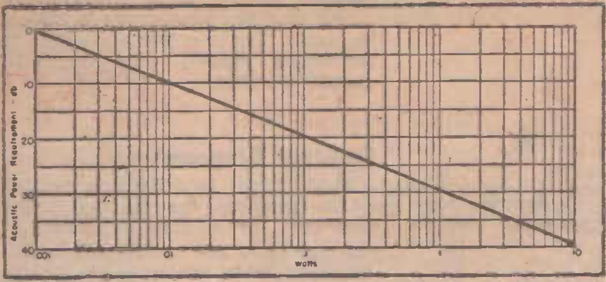
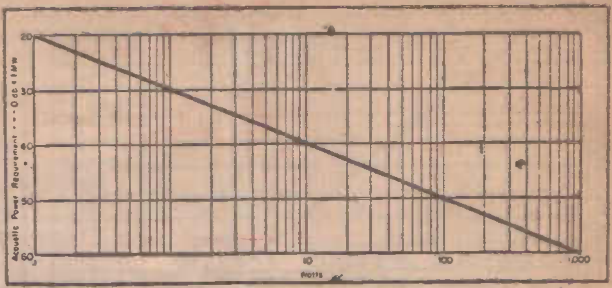

Fig. 3 (left) and Fig. 4 (right)—Amplifier power capability characteristics are illustrated in these plots.

2, In using these data, the following considerations also enter:—

(a) **A loudspeaker arrangement is assumed which will distribute sound properly throughout the space (room or area) to be covered.**

(b) **The use of the information given is not recommended for rooms of odd shapes such as very long, narrow rooms.**

Systems providing the acoustic power capacity indicated on Figs. 1 and 2 will produce average sound pressure levels approximately, as follows, on steady tones at rated power:—

Curve A (Fig. 1), Concert music indoors, 105 db.

Curve B (Fig. 1), Average music indoors, 95 db.

Curve C (Fig. 1), Speech only indoors, 80 db.

Curve (Fig. 2), Speech outdoors, 80 db.

Acoustic Noise Level

The information contained in Figs. 1 and 2 is based on the assumption that the locations being covered are quiet locations. Should the acoustic noise level be higher than 70 db, the required acoustic power capacity of the sound system must be increased by the number of db that the noise is higher than 70 db for the curve in Fig. 2 and curve C in Fig. 1.

When music is to be reproduced and the noise level is higher than 70 db, the same considerations apply. In addition, each case is a special problem involving subjective factors such as distraction of listeners due to the wider dynamic range existing in music than in speech. Therefore, no general rule can be applied safely.

Loudness Efficiency of Loudspeakers

The loudness efficiency of a loud speaker is the figure which, when applied to the electrical power capacity of a sound system, gives the acoustic power capacity. Thus it is the loss factor to be used in converting from electrical to acoustic power. The following efficiency values should be used:—

Type of Loudspeaker	Tentative Efficiency Values	
Small Direct Radiators (10in. and smaller)	**2%**	**17db**
Large Direct Radiators (12in. and over)	**5%**	**13db**
Horn Type Loudspeaker	**15%**	**8db**

In addition, it will be found necessary to add a correction for outdoor coverage, if the actual coverage angle of the loudspeaker used is other than 30 degrees. This correction in db is:

$$\text{Db} = 10 \log 10 \frac{\text{S deg.}}{\text{30 deg.}}$$

where S deg. equals the horizontal angle of the coverage of the speaker being used in degrees.

Typical Examples

To illustrate the application of the foregoing data in determining required electrical power requirement, two typical examples are offered:—

Indoor Example.

Known: Room dimensions, 80 feet long, 40 feet wide, 20 feet high. (Volume 64,000 cubic feet.)
Direct radiator loudspeaker to be used, 12in. diameter.
Reverberation time at 512 cps, 1.2 seconds.
Noise level, 65 db.
Speech and dance music to be reproduced.

Then: From Fig. 1, curve B: the acoustic power capacity for 64,000 cubic feet is 23.5 db above .001 watt.
Noise level is 65 db. Therefore no additional capacity is required on this account.

For the 12in. direct radiator add 13 db. Then the electrical power capacity required for the amplifier is 36.5 db above .001 watt.

Therefore, amplifier power capacity required is 4.5 watts (36.5 db above .001 watt).

Outdoor Example.

Known factors: Distance from loudspeaker to be covered, 200 feet.
System primarily for speech reinforcement.
Included angle to be covered, 70 degrees.
Horn type loudspeakers to be used.
Horizontal coverage angle of each, 40 degrees.
Noise level, 72 db.

Then: From the curve in Fig. 2, the acoustic power capacity for 200 feet distance is 29.2 db above .001 watt.
Noise level is 72 db. Therefore 2 db must be added (72-70) to 29.2 to obtain required acoustic power capacity or 29.2 + 2 is 31.2 db above .001 watt.
For a horn type loudspeaker 8 db must be added. Then the electrical power capacity required for a single horn type speaker is 39.2 db above .001 watt.
The horn being used covers 40 degrees, but the curve is based on 30 degrees coverage. Therefore, a 1.3 db correction is required (10 log10 40/30 = 1.25), or electrical power capacity of 40.5 db above .001 watt.
Finally, each speaker covers only 40 degrees, but an included angle of 70 degrees is to be covered. Therefore, two speakers are required, so twice the electrical power capacity, or 43.5 db above .001 watt, is required.
Therefore, amplifier power capability required is 22.5 watts (43.5 db above .001 watt).

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RADIO FREQUENCY MEASURING EQUIPMENT

By ALAN WALLACE

The control and checking of frequencies are of prime importance to the radio amateur. This article details a highly accurate, crystal controlled standard frequency meter which should be of considerable value to every amateur.

Although the Heterodyne Frequency Meter as described in the previous issue has an accuracy which is quite adequate for most amateur purposes, the occasion sometimes arises when a greater accuracy is desirable. When it is desired to measure frequencies with sub-standard accuracy the only reliable method is to make accurate comparisons with the output of a crystal controlled sub-standard oscillator which has been checked against a suitable standard such as the WWV transmissions.

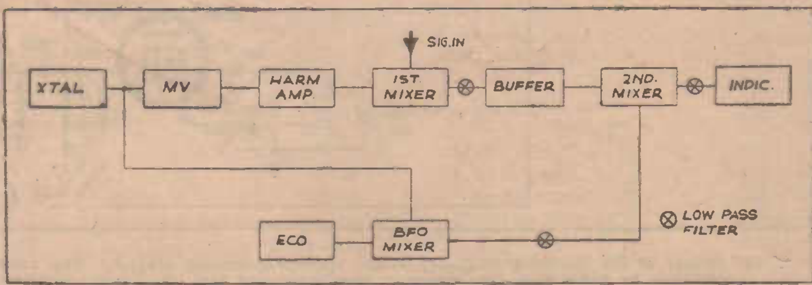


Fig. 3. This block diagram shows the arrangement of a standard frequency meter unit. Compare with the schematic shown in fig. 4.

Beat Frequencies

Since the frequency of such an oscillator is usually either 100 or 1000 Kcs. it is necessary, if the measurement of frequencies which are not multiples of 100 Kcs. is to be undertaken, to provide a frequency dividing circuit, e.g., a multivibrator, so as to give spot frequencies at 10 Kcs. intervals. It will be seen that any frequency which lies between two 10 Kcs. points will produce a beat frequency, and if this beat frequency be measured, it then becomes a relatively simple matter to determine the absolute frequency. The basic idea of this frequency comparison is shown in Fig. 1, and the necessary circuit arrangements are shown in block form in Fig. 2.

Block Diagram

In order to produce a reasonably compact unit, which will nevertheless have the required accuracy and discrimination, these circuits have been collected on to the one chassis, the form being that of the block diagram shown in Fig. 3. It will be appreciated from the complexity of the circuit that the construction of this instrument should only be attempted by an experienced constructor who is well provided with the necessary test equipment to adjust and check the various circuits, but doubtless a description of the design considerations involved will be of interest to all enthusiasts.

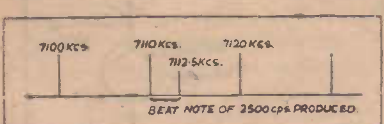


Fig. 1. This diagram indicates one method of producing a beat note of 2500 c.p.s.

Special attention must be paid to the crystal oscillator circuit as upon the stability and accuracy of this circuit depends the final accuracy and usefulness of the instrument. In order to allow adequate adjustment of the output frequency, as well as to minimise the effects of crystal heating, a *crystal locked* Meisner form of oscillator circuit is employed.

PART 3—
Secondary Standard Frequency Measurement

In this circuit, which will oscillate even without the crystal inserted, the function of the crystal is to stabilise the output frequency, and to lock the circuit at some frequency closely approximating the natural unloaded frequency of the crystal, whilst still permitting small variations by changing the capacity connected across the crystal circuit. The constants shown are such as to produce these conditions, along with maximum stability in the oscillator circuit, the output being taken from the plate of the tube as in previously described calibrating oscillators.

The crystal oscillator output at 100 Kcs. is used to lock a multivibrator, the natural frequency of which is approximately 10 Kcs. A special feature of the multivibrator is that its output, whilst very rich in harmonics, is normally very unstable.

However, it is very easy to lock its operation, by the injection of a small amount of a fixed frequency signal so that its output is some sub-multiple of the locking frequency, thus producing in effect a dividing circuit the ratio of which may be an integral up to 10 or so. Beyond 10 it is difficult to secure reliable operation, so that this corresponds to the maximum division which may be undertaken in one stage.

Multivibrator Frequency Set

In the circuit shown the fundamental frequency of the multivibrator is set by varying the time constant of the grid circuit by means of R5, and of course this should be set so as to produce 9 multivibrator pips between 100 Kcs.

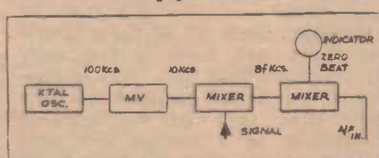


Fig. 2. The basic circuit arrangement necessary to produce the beat frequency is shown in this block diagram.

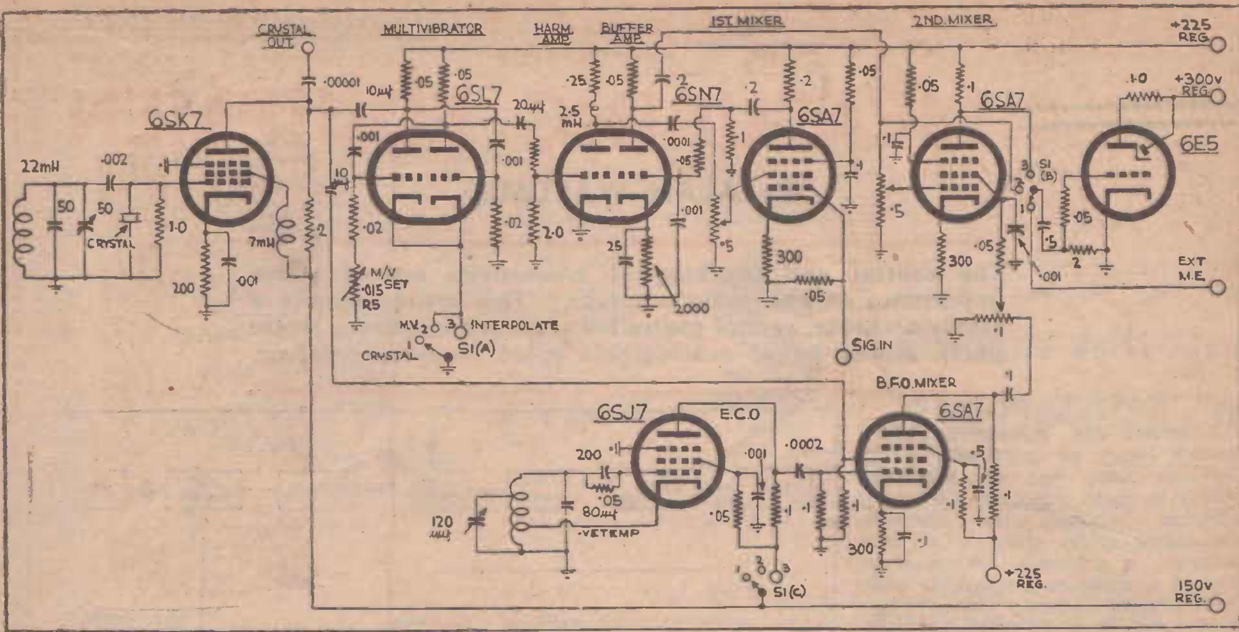


Fig. 4. The circuit of the standard frequency meter employing crystal control. The construction of this instrument should only be undertaken by those with the necessary experience and test equipment required to adjust the various circuits.

points on a receiver dial. This results in a 10 Kcs. output, the frequency of which is accurately stabilised by the crystal oscillator.

Since the multivibrator output, although rich in harmonics, is spread widely over the spectrum, and the region in which we require output is restricted (in this case between 1750 and 1900 Kcs.) it is necessary to employ a harmonic amplifier, with a selective output circuit to produce maximum harmonic output at these frequencies. By the use of a high value of grid resistor, in a stage which has no other form of bias, sufficient distortion is assured to provide a very high harmonic content in the output, the harmonics being of sufficient amplitude to provide a suitable output from the first mixer,

First Mixer Stage

In this first mixer the incoming signal is mixed with a harmonic of the multivibrator, so as to produce the first beat output, which will represent the difference in frequency between the incoming signal and the nearest 10 Kcs. harmonic. Reference again to Fig. 1 will make this clear. Also produced in the output of this mixer will be sundry other beat frequencies, resulting from the mixing of the input signal with other multivibrator harmonics.

However, since all of these spurious beats will have a frequency higher than 5000 cps., which represents the upper limit of the true beat, they may be substantially eliminated by a simple low pass filter network, designed to cut off at sharply above about 5000 cps. This filter network need not possess any exceptional properties, though, as the presence of small amounts of spurious beats will in no way affect the accuracy of the reading obtained, their presence causing only a general blurring of the zero as observed on the indicator screen.

The buffer amplifier following the first mixer is of conventional design and requires little comment. However, here, as in the rest of the system, emphasis must be placed on the ability of the system to handle the lower frequencies without attenuation, whilst any attenuation of frequencies above 5000 cps. is advantageous.

V.F.O. Requirements

The next requirement is for a variable frequency oscillator in the audio range. This should possess good inherent stability, be accurately calibrated, and which can beat against the first beat frequency to permit measurement of its exact frequency, so providing a means of accurate interpolation. Whilst any suitable external oscillator may be used it has been decided in this instrument to incorporate a BFO as an integral part of the unit, taking advantage of the existence of the highly stable crystal oscillator unit.

Obviously if we have a variable frequency oscillator having a tuning range of from 95 to 100 Kcs., then the resultant output, after mixing with the output of the 100 Kcs. crystal oscillator, will comprise a fairly pure and highly stable, audio signal, the frequency of which may be easily varied, and which may be accurately calibrated.

The output of the oscillator is fed once again through a simple low pass filter to attenuate any frequencies higher than about 5000 cps. which may be present, to the BFO mixer, in which stage it is mixed with the signal from the crystal oscillator to produce the desired audio frequency output. It remains now only to provide for the comparison of this BFO signal with the first beat frequency as produced from the first mixer, and this is accomplished in the second mixer stage.

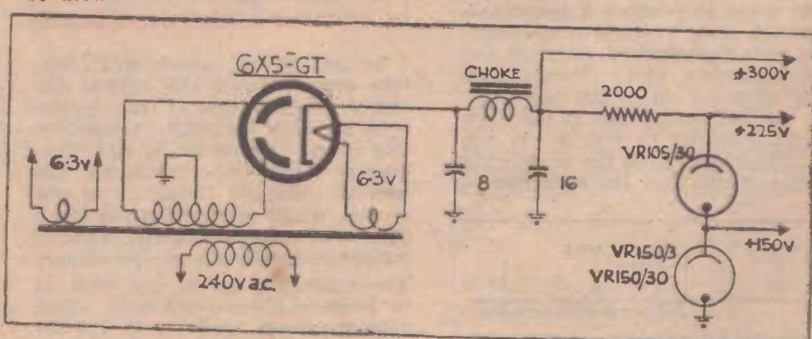


Fig. 5. The power supply follows standard practice and uses a 6X5-GT. The power transformer is a 325v HT 80 ma type. Note the use of the two regulator tubes to provide the required output voltages.

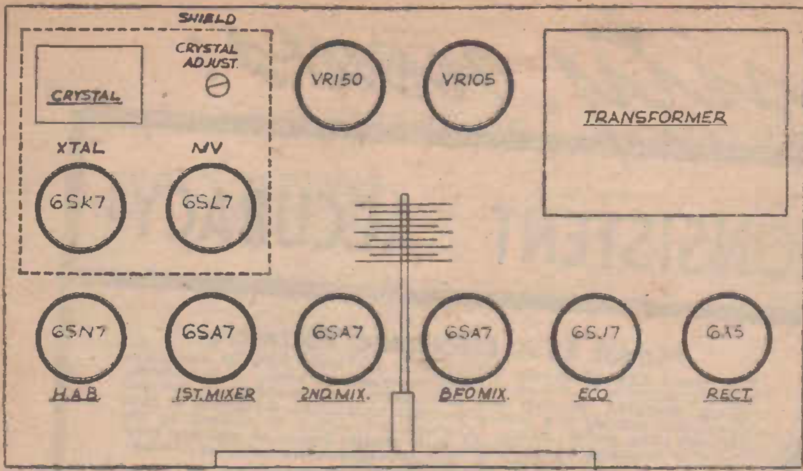


Fig. 6. This diagram shows the general layout of the unit. The chassis dimensions are 12 x 8 x 2½, but these can be varied to suit the individual constructor.

Particular attention must be paid to the output circuits of this stage since the frequencies normally handled, and those at which minimum attenuation is required are those below about 25 cps. Hence the coupling condenser to the indicator tube, which in this case is a standard magic eye indicator, must be large as must the input impedance of the indicator. However, since we are now only interested in very low frequencies, it will be advantageous, in order to clarify the pattern on the screen, to incorporate a further low pass filter circuit which will attenuate those frequencies above about 200 cps.

E.C. Oscillator

The oscillator employed for this purpose is a conventional electron coupled circuit, using a type 6SJ7 tube, and for convenience a standard RF choke with an inductance of about 5mH is used as the grid inductance. Feedback is obtained by tapping the cathode connection on to this choke, whilst the correct amount of frequency spread is obtained by tapping the tuning condenser down on to this choke, final small variations in the spread being obtained by the removal or addition of plates to the variable condenser.

It must be stressed, with this, as with all accurately calibrated variable frequency oscillators, that the condenser mechanism and the dial movement must be of the highest quality in order to obtain consistent results. Whilst thermal considerations are not of such importance as at higher frequencies, care must be taken not to employ any components which will show large alterations in characteristics with change in temperature.

The power supply circuit is quite conventional, using a standard 325v 80 ma power transformer in conjunction with the 6X5-GT rectifier. In an instrument such as this it is most essential to incorporate some form of voltage regulation for the supply of critical portions of the circuit, and to this end two voltage regulators have been included. The series connection of the VR150/30 and the VR105/30 provides a regulated supply of 255 volts for the multivibrator, and other critical plates, whilst 150 volts is *tapped* off to supply the crystal and electron coupled oscillators.

In the original unit, it was found possible to construct the complete equipment on a chassis of dimensions 12 x 8 x 2½ inches, but it is recommended that wherever possible a large, roomy chassis should be used to minimise any heating effects due to crowded construction.

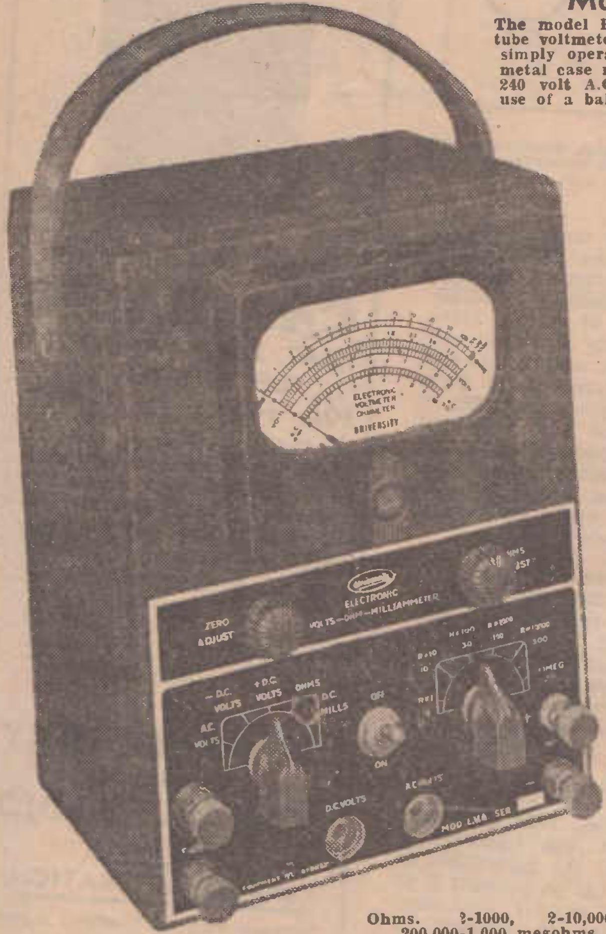
Function of Switch

It will be noted that a switch, S1, is provided, the function of which is to allow the instrument to be used either (a) in position 1 as a conventional crystal controlled sub-standard (b) in position 2, as a crystal controlled sub-standard with 10kc. reference points and provision for accurately setting the frequency of the incoming signal to some multiple of 10 Kcs., and (c) in position 3 and the complete unit with provision for interpolation. Whilst this is the simplest control system which will fulfil the requirements many variations are possible, but these are best left to the inclinations and desires of the individual constructor.

Radiations similar to cosmic rays will be generated by the 1,000,000,000 electron-volt accelerator being constructed at the Stanford University, California. The wave guide accelerator will be 160 feet long and is due to be completed by 1951.

University news:

For the Serviceman Who Expects **CONSISTENT ACCURACY!**



Model EVA Electronic Voltmeter

The model EVA Electronic Voltmeter is the ideal form of vacuum-tube voltmeter for radio service and experimental work. It is reliable, simply operated, accurate and is ruggedly constructed in a compact metal case making it a perfect portable instrument. Operation is from 240 volt A.C. power mains. Consistent accuracy is assured by the use of a balanced bridge circuit with a high degree of negative feed-back, making it almost independent of line voltage changes or ageing of tubes.

D.C. VOLTS. Its high input resistance of 11 megohms on all D.C. voltage ranges enables the accurate measurement of A.V.C., bias, screen and plate voltages, even in circuits containing high values of resistance. It can measure positive or negative voltage with respect to a receiver chassis without the necessity of reversing test leads or resetting to zero. Accuracy on D.C. voltage ranges plus or minus 2 per cent. on full scale value.

A.C. VOLTS. The input resistance on all A.C. voltage ranges is 1 megohm. Accuracy at 50 cycles is plus or minus 2 per cent. of full scale value. Frequency response varies from the 50 cycle value by no more than plus or minus 3 per cent. or .25 decibel between 30 and 20,000 cycles. This means that the instrument can take frequency response curves of gramophone pick-ups or audio amplifiers. The instrument is completely electronic on alternating voltages; no copper oxide rectifier being used.

Unlike simpler and less effective instruments it responds to the "mean" value of both half cycles of an alternating wave and consequently does not suffer from "turn-over" effect. It is calibrated in effective values of a sine wave and, due to the much more constant relationship between mean and effective values than between peak and effective values, any error introduced by distorted signals will be much less than with the simple half-wave peak reading type.

OHMS. Six ohms ranges are provided covering values from 0.2 ohm to 1000 megohms. The extensive coverage is not only ideal for all ordinary resistance tests, but also for condenser leakage and insulation testing. No external batteries are required, and a single adjustment to zero on any ohms range is equally effective on all other ohms ranges

D.C MILLIAMPS. Six ranges of D.C. milliamps cover values up to one ampere. The milliamp ranges do not require connection of the instrument to power mains.

R.F. VOLTS. An input socket is provided on the case to allow an external plug-in diode rectifier probe to be connected for the measurement of R.F. voltages up to 100 volts at frequencies as high as 100 megacycles. This probe is available as an extra.

RANGES.

D.C. Volts. 0/3, 10, 30, 100, 300, 1000. Resistance 11 megohms on all ranges. Accuracy plus or minus 2 per cent. of full scale value.

A.C. & Output Volts. 0/3, 10, 30, 100, 300, 1000. Resistance 1 megohm on all ranges. Accuracy at 50 cycles plus or minus 2 per cent. of full scale value. Frequency effect within 3 per cent. or 0.25 db of 50 cycle value from 30 to 20,000 cycles.

Ohms. 2-1000, 2-10,000, 20-100,000, 200-1 megohm, 2,000-10 megohms, 200,000-1,000 megohms.

D.C. Milliamps. 0-3, 10, 30, 300, 1000.

A complete set of shielded leads, special test probes, ordinary test probes, and full operating instructions are supplied.

R.F. Volts. 0-3, 10, 30, 100 at high input impedance, with special probe available as an extra.

RADIO & ELECTRONIC TEST EQUIPMENT

University

Manufactured by RADIO EQUIPMENT PTY. LTD., 5 NTH. YORK ST., SYDNEY. BU3169 (2 lines)

Amateur NEWS and VIEWS

Conducted by KEN FINNEY, VK2AIL.

SPOT NEWS

VK2AQQ: The Blind Radio Amateur this week bought an Eddystone 640 Receiver, and will shortly have its dial adapted to Braille.

VK2AV: Arthur Thurston is believed to be secretly building a receiver to end all receivers in his campaign of efficiency.

VK2SW: Sid Ward has recently installed a 144 M/C transmitter and receiver in his car. Sid has had excellent reports from all Sydney suburbs.

VK2ASK: Cedric Harte, testing his new modulator with excellent results; the modulator is tried as transformer coupled right from the mike to the final.

VK2ARR: Graham Connelly, the man with the automatically operated station, may soon be heard with a 813, maybe!!

VK2GS: Phil Edwards, recently returned from Japan, and soon to be off to Queensland, is heard when in Sydney pounding the key T94 with a very nice fist!!

VK2AH: Allan Lewellyn, the man with the Antenna farm at Epping, nicely situated in the Heights complete with steel tower. Heard on the VHF with an excellent signal.

W4MIA: Bob Duggan, of Georgia, sends Christmas greetings to Amateurs in Sydney, whom he met on a visit to Australia. Now operating W4AQL from Georgia Uni.

VK2ADC: Gordon McLeod, fairly silent these days with big rebuilding home programmes, including tennis courts.

VK4RC, VK2ACK, VK2DI — DX Kings of Australia are the only VK's mentioned in the 1948 WAZ Honour Roll.

Newcastle Activity

A report from Newcastle brings the following information about locals:—

VK2CS: L. Swain operates on 14 and 28 M/Cs with a 100 watt signal control by a Rubber Crystal.

VK2FP: E. Baker operates 28 M/Cs with 100 watts held by crystal controller.

VK2ZC: J. Cowan operating on 7, 14 and 28 M/C crystal controlled with 100 watts.

VK2PQ: T. Armstrong, 14 and 28 M/C with 100 watts, complete with VFO.

VK2TE: A. Boyd operating 14, 28 M/C 100 watts complete with VFO.

VK2WU: L. McDonald, 14 M/C running 100 watts crystal controlled.

All Newcastle boys are using home-built receivers and are DX hunters.

VK2TV: Ron Lemin, on a visit to Sydney, a 28 M/C DX hunter, let out a secret by his actions in chasing Dural tubing. A beam looks like sprouting out of VK2TV of Canberra. His transmitter is 75 watts crystal controlled with a home-made receiver built a la super pro.

VK2FE: E. Davies, operating on 7 M/C with 100 watts controlled by VFO, home-built receiver, has XYL who pounds the brass at 25 w.p.m.; very handy in the contests!

W.A. Broadcast

VK2W: The Wireless Institute of Australia broadcasts every Sunday morning on 40 metres at 11 p.m., also on Sunday evening on 144, and 50 M/Cs. This station brings the week's happenings to the amateurs of Australia. The Wireless Institute meets in Science House, Sydney, every fourth Friday night.

A VHF section of the Wireless Institute meets in Science House every second Friday night.

"REMEMBRANCE"

In December, just before Christmas, a group of Amateurs were mindful of the passing of VK2ALD of Canberra, who died 12 months beforehand. The amateurs—the "Home to Lunch Club"— kept alive the memory of Reg. (VK2ALD) by 30 seconds' silence on the air, after which "Monty"—VK2JQ remembered Reg in prayer.

In listening to the whole session on that particular afternoon, I was very much moved by the sincerity and thought by this group of amateurs for a deceased amateur—VK2ALD. Although this network has been most criticised over the past, it must be said that they are a group of amateurs who have thought to use the same channel for all the transmissions have been operated sensibly at all times.

R.S.T. Report System

To request a report send "QRK?" In giving a report the RST (readability, strength, tone), system has been universally adopted. An "X" at the end of the report indicates that the carrier sounds as though it is crystal-controlled. When using R/T give "Readability" and "Strength" reports.

READABILITY:
1. Unreadable.
2. Barely readable.
3. Readable with considerable difficulty.
4. Readable with little difficulty.
5. Perfectly readable.

STRENGTH:
1. Faint, barely audible.
2. Very weak.
3. Weak.
4. Fair strength.
5. Fairly good.
6. Good signals.
7. Moderately strong.
8. Strong.
9. Extremely strong.

TONE:
1. Extremely rough. Not musical.
2. Very rough, not musical.
3. Rough, low-pitched A.C. note, slightly musical.
4. Rather rough, moderately musical.
5. Musical note, modulated.
6. Modulated note. Slight trace of whistle.
7. Near D.C. Smooth ripple.
8. D.C. Slight trace of A.C. ripple.
9. Pure D.C. note. No ripple.

NEWS ITEMS:

All amateurs and Radio Clubs are invited to forward any news items, amateur or club notes for inclusion in these columns. Address all letters to: Box 5047, G.P.O., Sydney, marking the envelope "Amateur Notes."

W.W.V. Schedules

Standard frequency transmissions by WWV (U.S.A.) operate on the following schedules and frequencies:

2.5 MC/s .. 1000 to 0400 Sydney or Melbourne Time.
5.0 MC/s .. Continuously, day and night.
10.0 MC/s .. Continuously, day and night.
15.0 MC/s .. Continuously, day and night.

World's Time

The following are the times in main cities compared to standard time 12 o'clock noon Sydney, Melbourne, Brisbane, and Hobart (E.A.S.T.).

Adelaide, S.A.	11.30 a.m.
Berlin	3.00 a.m.
Bombay	7.30 a.m.
Cairo	4.00 a.m.
Calcutta	7.53 a.m.
Capetown	4.00 a.m.
London	2.00 a.m.
Montreal	*6.00 p.m.
Moscow	4.00 a.m.
New York	*9.00 p.m.
Panama	*9.00 p.m.
Paris	2.00 a.m.
Perth, W.A.	10.00 a.m.
Rangoon	8.30 a.m.
Rome	3.00 a.m.
San Francisco	*6.00 p.m.
Suez	4.00 a.m.
Tokio	11.00 a.m.
Vancouver	*6.00 p.m.
Wellington, N.Z.	1.30 p.m.

* Denotes previous day.

CLUB NOTES

EXPERIMENTAL RADIO SOCIETY OF N.S.W.

Greenwood Hall, 192 Liverpool Road, Enfield, N.S.W.
President: R. A. Blades (VK2VP).

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

This Society meets every alternate Thursday at the above address, and apart from the regular business of the Society, interesting lectures and discussions are held.

The club "shack" which adjoins the Club Room is nearing completion and the club transmitter (VK-2LR) will be operating on 7 Mc in the very near future.

Visitors are welcomed, as are any new members, and we can assure them of an interesting evening. The only qualifications required of new members are an interest in radio or allied subjects.

The Society meetings for February are on the 3rd and the 17th.

Q.S.L. Card Addresses

Amateur organisations in most countries have elected a representative to ensure the receipt or delivery of Q.S.L. cards. Here is an up-to-date list of these addresses, and it is suggested this should be kept as a handy reference.

Alaska:
J. W. McKinley, Box 1533, Juneau.

Antigua:
A. Tibbits, 27 St. Marys Street, St. Johns.

Argentina:
Radio Club, Argentino Av., Alvear, 2750 Buenos Aires.

Australia:
(VK2). J. B. Corbin, 78 Maloney St., Eastlakes, N.S.W.
(VK3): Graham Roper, 26 Lucos St., Caulfield, SE8. (Inward QSL's for VK3 only).
(VK3): Mr. Frank O'Dwyer, 190 Thomas St., Hampton, Victoria. (Outward QSL'S).
(VK3). W.I.A., Box 2611 W, G.P.O., Melbourne, Victoria.
(VK4). Eric Neale, 38 Felix St., Wolloowin, N3., Brisbane, Queensland.
(VK5). G. Luxton, 8 Brook Street, West Mitcham, S.A.
(VK6). J. E. Rumble, Box F319, G.P.O., Perth, W.A.
(VK7). T A. Allen, 6 Thirza Street, Newtown. Tasmania.

Belgium:
Baptiste, 153, Av. Charles-Quint, Brussels.
Reseau Belge, Boite Postale, 634, Bruxelles.

Brazil:
L.A.B.R.E., Caixa Postal, 2353, Rio de Janeiro.

Br. Honduras:
D. Hunter, Box 178, Belize.

Canada:
(VE2). C. W Skarstedt, 3821 Girouard Ave., Montreal, P.Q.
(VE3). W. Bert Knowles, Lanark, Ont.
(VE4). C/- A.R.R.L., Hartford, Conn, (U.S.A.).
(VE5). J. A. Bettin, P.O. Box, 55, Togo, Sask.
(VE6). W. R. Savage, 329 15th St., North, Lethbridge, Alta.
(VE7). H. R. Hough, 1785 Emerson St., Victoria, B.C.
(VE8). Yukon A.R.C., P.O, Box 268 Whitehorse, Y.T.

Chile:
R.C.C., Casilla, 761, Santiago.

Costa Rica:
F. Gonzalez, Box 365 San Jose.

Cuba:
James D. Bourne, Lealtad, 660, Havana.

Czechoslovakia:
C.A.V., Vaclavske Nam 3, Prague 11.

Denmark:
E.D.R., Box 79, Copenhagen K.

Eire:
R. Monney, "Aughnacloy," Killiney, Dublin.
17, Butterfield Cres., Rathfarnham, Dublin.

Finland:
S.R.A.L., Linnankuja, 16A8, Helsinki.
TATU Kelehmainen, Kararminkatu, 25.C12. Helsinki.

France:
R.E.F., 1 Rue des Tanneries, Paris.

Germany:
(American Zone D4), Signal Division, HQ., USFET, APT 757, C/- Postmaster, New York, N.Y., U.S.A.
(British Zone, D2's), Capt. J. T. Blackwood, P. and T. Section, C/- 609 Det. Mil. Gov., Hansestadt. Hamburg, B.A.O.R.

Greece:
C. Tavoniotis, 17A Bucharest Street, Athens.

Great Britain:
Mr. A. O. Milne, 29 Kechill Gdns., Hayes, Bromley, Kent.
R.S.G.B., 28-30 Little Russell Street, London, W.C.1., England.

Italy:
A.R.I., Viale Bianca Maria, 24, Milan

Jamaica:
Thomas Meyers, 122 Tower St., Kingston.

Japan:
Major J. M. L. Drudge-Coates, Brindiv, Signals, B.C.O.F., Japan.

Luxembourg:
R.L., rue Neyperg 33, Luxenbourg.

Malaya:
James McIntosh, Postal Dept. Kuala Lumpur.

Mexico:
L.M.R.E. Av. Jaurez, 104-22, D.F.

Netherlands:
V.E.R.O.N. Postbox 400, Rotterdam.

Newfoundland:
N.A.R.A. Box 660, St. John's.

New Zealand:
N.Z.A.R.T. P.O. Box 489 Wellington C-1.

Norway:
N.R.R.L., Ernst Firing, LA60, Bentzebrogt 29, Oslo.

Paraguay:
R.C.P., Palma, 310 Asuncion.

Peru:
R.C.P., Box 538 Lima.

Phillippines:
G.L. Rickard, 48 Ortega, San Juan, Rizal.

Porto Rica:
E. W. Mayer, P.O. Box 1061, San Juan.

S. Africa:
S.A.R.R.L., P.O. Box 3037, Capetown.

Sweden:
S.A.A. Postgirokonto, 52277 Stockholm 8.

Switzerland:
U.S.K.A. Postbox, 196, Berne-Transit.

Uruguay:
R.C.U., Casilla 37, Montevideo.

U.S.A.:
(W1). Jules T. Steiger, 231 Meadow St., Willimansett, Mass.
(W2). Henry W. Yahnel, Lake Av., Helmetta, N.J.
(W3). Maurice W. Downs, 1311 Sheridan St., N.W. Washington, 11 D.C..
(W4). Edward J. Collins, 1215 North 12th Avenue, Pensacola, Fla.
(W5). L. W. May, Jr., 9428 Hobart St., Dallas 18, Texas.
(W6). Horace R. Greer, 414 Fairmount Av, Oakland, Calif.
(W7). Frank E. Pratt, 5023 S. Ferry St., Tacoma, Wash.
(W8). Fred W. Allen, 1959 Riverside Drive, Dayton 5, Ohio.
(W9). F. Claude Moore, 1024 Henrietta St., Pekin, 111.
(W10), Alva A. Smith, 238 East Main St., Caledonia, Minn.

Venezuela:
R.C.V., Apartado 981, Caracas.

DRY GRINDING CRYSTALS

If you should want to grind a crystal blank into a finished crystal or move the frequency of a present crystal, we suggest a slightly different approach to the grinding problem—grind with dry abrasive powder. This eliminates the mess of water and abrasive paste.

A flat piece of cast iron makes a good surface on which to grind the crystal. A round piece, turned down on a lathe, has been used quite successfully for some time.

The grinding process goes faster than usual because the abrasive particles find their way into the pores of the iron and as the crystal is moved across the surface of the metal the anchored particles of abrasive act like a file under the quartz instead of as friction rollers. For fine grinding and finishing a piece of hard wood or masonite dusted with the fine grinding powder works very well.

A variation of the process, developed when iron was not available, uses an ordinary piece of plate glass covered by a sheet of writing paper. Thus, the surface of the glass is not damaged in the grinding process, but the anchoring action takes place with the abrasive particles finding their way into the pores of the paper. There is some rolling effect, but grinding is fast and satisfactory.

The finish grinding is done on another sheet of paper on the glass. This paper is covered with the fine grinding compound, and because of the smaller pores the file action is more apparent with the finishing process. If the paper shows wear, it should be relaced with a new sheet and the grinding compound shifted from the old sheet to the new. However, a considerable amount of grinding can be done on one sheet before it is necessary to replace it because of wear.

This dry grinding process has proven to be a quicker and much cleaner method of grinding crystals. No more do we have a gritty paste and water mess all over the place. A newly-ground crystal can be wiped clean of the grinding dust with an ordinary piece of cloth, and in many cases the crystals go into oscillation without further cleaning with fluid. However, it is good insurance to clean the crystal with carbon tetrachloride or just plain soap and water.

All the usual rules for grinding crystals apply to this method. Surfaces should be kept flat and proper allowance made for centre grinding with certain types, etc., but the big advantage lies in the elimination of the messy dust and water mixture associated with the *wet* grinding process.

—Courtesy Radio News.

For your note book

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

Bending Copper Tubing

When bending thin-walled copper tubing for transmitter coils, etc., it is often difficult to keep the metal from buckling. If reducing the pressure and bending tension on the tubing does not help matters, try filling the tube with sand.

However, if sand is not available here is another method which works equally as well. Anneal a short length of copper wire that is a loose fit inside the tubing, and push this into the tube. Then as the bending progresses, pull it out bit by bit making sure the wire is free of each bend.

Soldered Connections in S-W Receivers

If you have constructed a short wave receiver and fail to obtain satisfactory results, it is possible that the connecting wires and soldered joints rather than the circuit itself, may be at fault. Short wave circuits are far more critical than those designed for the longer waves and too much resistance in the wrong place may prevent operation.

If the receiver checks with the diagram, trace through the wiring and be on the lookout for unnecessarily long connecting wires and poorly soldered joints. Short wave receivers which have given little or no response when first connected have been known to operate perfectly when long connections were shortened and suspicious-looking soldered joints were opened, cleaned and resoldered.

Stripping Wire Insulation

By cutting two shallow grooves in the jaws of your cutting pliers, you can use them for stripping the covering from insulated wire. Using a file or a sharp-edged oilstone, form a V-shaped notch at the same point in each of the cutting edges. Make the grooves just deep enough to take the diameter of the wire.

To clean the wire, simply place the end in the notch, close the pliers and pull. If you have a pair of long nosed cutting pliers you can provide the jaws with grooves of various depths to take care of several sizes of wire. When the notches are placed at the inner ends of the cutting jaws near the joint, they do not spoil the pliers for ordinary cutting operations.

Cutting Holes in Glass

Occasionally the experimenter or engineer has need to drill a hole in glass or porcelain. Many books suggest the use of a sharp drill with turpentine as a lubricant, or a three cornered file for the purpose.

Whilst these methods will work perhaps the simplest way is to use a soft tube such as copper, and carborundum valve grinding compound. Turpentine may be used as a lubricant but it is not absolutely essential.

The tube is put into the drill chuck just as if it were a drill, and the carborundum valve-grinding compound is smeared on the bottom end. A slow speed is employed and the pressure should not be too great on the glass.

The tube should be stopped every so often, in order that the glass will not overheat and crack. The tube cuts a ring in the glass, the core within the ring passes up into the tube, and when the hole is through, appears as a small plug of glass within the copper tube.

Soft metal is the best in that the carborundum grains embed themselves in the metal, with just a sharp corner or point protruding to scratch or score the glass. However an iron tube will also function quite well.

Locating Mounting Holes

Frequently it is difficult to accurately locate mounting holes on a chassis for large radio components such as transformers, chokes and variable condensers. This can be done quickly and simply by placing chalk dust in the screw holes, or mounting lugs and placing the component in the required position. A sharp tap on the top of the component will leave a clear impression on the chassis, enabling the necessary holes to be easily drilled out.

Repairing Radio Cabinets

Wooden radio cabinets often have dents produced in them by a sharp blow with some blunt instrument or utensil. If the wood has been only compressed and not gouged out, it can be readily repaired like new by the following simple method:

Take a cloth or paper towel and moisten it. Place over the dented portion and apply a hot iron on top of it. A soldering iron will do in an emergency.

Steam will be evolved and as fast as the paper or cloth dries out at any one spot move it around so that another moist portion is placed over the dent. Continue steaming with an occasional glance at the dent. After a few minutes it will be found that the wood fibres have swelled up to their original position and the dent entirely gone. A little varnish or polish will make the erstwhile dent completely invisible.

Measuring Unknown Resistance

By connecting a known resistance, a 0-1 milliammeter and a B battery in series with two binding posts, you can measure the resistance of any unit. Simply connect the unknown resistance across the terminals and note the reading. Then by comparing this with the reading when the binding posts are shorted, you can determine the approximate value of the unknown unit.

For example, if a 45 volt battery and a known resistance of 45,000 ohms are used, the meter will read one milliampere when the binding posts are connected together, then if an unknown unit connected to the terminals swings the needle to half a milliampere, it indicates that the unknown resistance is equal to the known unit (the current is halved when the resistance is doubled).

Volume Control Repair

When a wire-wound volume control gets noisy with age, it is possible sometimes to make an emergency repair with some alcohol, a soft rag and a pair of pliers. Remove the control from the cabinet and rub the resistance wire with a cloth dipped in alcohol. This will remove any dirt or grime that may be covering the contact surface of the wires.

Then if the wires look worn where the rotating arm rubs, bend the arm slightly with the pliers to change the point of contact. Before replacing the unit, check up on the nut that holds the contact arm in place. Of course, if the wires of the winding are loose, this may be causing the noise and it will then be best to replace the entire unit.

AUSTRALIAN BROADCAST STATION LIST

Compiled by R. HALLETT

FREQUENCY (Kc/s.)	WAVE-LENGTH (Metres)	CALL SIGN	POWER	LOCATION
540	556	4QL	200w	Longreach. R.
550	545	2CR	10kw	Orange (Cumnock). R.
560	536	3GI	7kw	Sale (Longford). R.
560	536	6WA	10kw	Minding. R.
580	517	3WV	10kw	Horsham (Dooen). R.
590	508	4QR	10kw	Brisbane (Bald Hills). MN.
600	500	7ZL	2kw	Hobart. AN.
610	492	2FC	10kw	Sydney (Liverpool). AN.
620	484	3AR	10kw	Melbourne (Braybrook). AN.
630	476	4QN	7kw	Townsville (Clevedon). R.
640	469	5CK	7.5kw	Crystal Brook. R.
650	462	2BH	200w	Broken Hill (On S.A. Time).
660	455	2NU	10kw	Tamworth (Manilla). R.
670	448	2CO	7.5kw	Albury (Corowa). R. (Relays usually 3AR and 3LO.)
680	441	2HR	300w	West Maitland (Lochinvar). (Relays 2GB at night.)
680	441	7QT	300w	Queenstown.
680	441	4AT	500w	Atherton (Yungaburra). R.
690	435	6WF	500w	Perth. AN.
690	435	4KQ	1kw	Brisbane (Tingalpa).
700	429	2NR	7kw	Grafton (Lawrence). R.
710	423	7NT	7kw	Launceston (Kelso). R.
720	417	2TR	200w	Taree. R.
720	417	6GF	2kw	Kalgoorlie. R.
730	411	5CL	5kw	Adelaide (Brooklyn Park). AN.
740	404	2BL	10kw	Sydney (Liverpool). MN.
750	400	2NB	1kw	Broken Hill. R. (Relays 5AN and 5CL.)
760	395	4QS	10kw	Toowoomba (Dalby). R.
770	390	3LO	10kw	Melbourne (Braybrook). MN.
780	385	2KA	1kw	Wentworth Falls. (Often in 2GZ network.)
780	385	4TO	200w	Townsville.
790	380	4QG	10kw	Brisbane (Bald Hills). AN.
800	375	6WN	1kw	Perth. MN.
810	370	2DU	200w	Dubbo.
810	370	7BU	200w	Burnie.
820	366	2NA	2kw	Newcastle (Berrisfield). R. (Relays 2FC almost continuously.) Soon to move to 1510 kc.
820	366	6GN	2kw	Geraldton. R.
830	361	5RM	2kw	Renmark. (Often relays 5DN.)
850	353	2CY	10kw	Canberra (Yass Road). R.
860	349	7HO	500w	Hobart.
860	349	4GR	500w	Toowoomba.
870	345	2GB	1kw	Sydney (Homebush). (Relays to 2HR at night.)
880	341	6PR	500w	Perth. (Often relays to 6TZ.)
880	341	3UL	200w	Warragul.
880	341	4WK	100w	Warwick
890	337	5AN	2kw	Adelaide (Brooklyn Park). MN.
900	333	2LM	500w	Lismore.
900	333	7AD	300w	Devonport.
910	330	4QB	2kw	Maryborough (Pialba). R.
920	326	4VL	500w	Charleville.
920	326	2XL	500w	Cooma.
930	323	3UZ	600w	Melbourne.
940	319	4RK	2kw	Rockhampton (Gracemere). R.
940		See 1160 kc.		
950	316	2UE	1kw	Sydney (Homebush).
960	313	3BO	500w	Bendigo.
960	313	4AY	500w	Ayr.
970	309	5DN	500w	Adelaide. (Relays often to 5RM.)
980	306	2KM	300w	Kempsey. (Do.)
980	306	6AM	2kw	Northam. (Often with 6PM.)
990	303	2GZ	2kw	Orange (Amaroo). Studios also in Sydney. Usually broadcast with 2KA.
1000	300	3HA	1kw	Hamilton.
1010	297	7EX	500w	Launceston.
1010	297	4MB	300w	Maryborough.
1010	297	4CA	300w	Cairns.
1020	294	2KY	1kw	Sydney (Lidcombe).
1030	291	3DB	600w	Melbourne. (Relays to 3LK.)
1040	288	5PI	2kw	Crystal Brook. (Often relays from 5AD.)
1050	286	2CA	2kw	Canberra.
1060	283	4SB	2kw	Kingaroy. (Often relays from 4BC.)
1070	280	6WB	2kw	Katanning. (Relays often from 6IX.)
1070	280	2RG	200w	Griffith.
1080	278	7HT	500w	Hobart.
1080	278	4RO	200w	Rockhampton.
1080	278	2LT	100w	Lithgow.
1090	275	3LK	2kw	Lubeck. (Relays from 3DB.)
1100	273	4LG	1kw	Longreach.
1100	273	7LA	500w	Launceston.
1100	273	6MD	500w	Merredin. (Often relays from 6IX.)
1110	270	2UW	1kw	Sydney (Homebush). 24-hour schedule.
1120	268	4BC	1kw	Brisbane (Indooroopilly). (Relays often to 4SB.)
1130	265	6PM	500w	Perth. (Often in 6AM network.)
1130	265	3CS	200w	Colac.
1130	265	2AD	200w	Armidale.
1140	263	2HD	500w	Sandgate (Newcastle). (Do.)
1150	261	2WG	2kw	Wagga.
1160	259	7ZR	500w	Hobart. MN. (Will shortly move to 940 kc.)
1170	256	2NZ	2kw	Inverell (Little Plain).
1180	254	3KZ	600w	Melbourne. (Do.)
1190	252	2CH	1kw	Sydney (Pennant Hills).
1200	250	5KA	500w	Adelaide. (Relays frequently to 5AU.)
1210	248	2GF	200w	Grafton. (Do.)
1210	248	3YB	200w	Warrnambool.
1210	248	6KG	500w	Kalgoorlie.
1220	246	4AK	2kw	Oakey. (Relays from 4BK.)
1230	244	2NC	2kw	Newcastle (Berrisfield). R. (Relays almost continuously from 2BL.)
1240	242	6IX	500w	Perth. (Relays usually to 6WB and 6MD.)
1240	242	3TR	1kw	Sale.
1250	240	9PA	500w	Pt. Moresby (New Guinea).
1260	238	3SR	2kw	Shepparton.
1270	236	2SM	1kw	Sydney (Pennant Hills).
1290	234	3AW	600w	Melbourne (Alphington). (Relays at night to 3CV.)
1290	234	4BK	1kw	Brisbane (Seven Hills). (Relays to 4AK.)
1300	231	2TM	2kw	Tamworth.
1310	229	5AD	500w	Adelaide. (Relays often to 5PI, 5MU, 5SE.)
1320	227	6KY	500w	Perth.
1320	227	3BA	500w	Ballarat.
1330	226	3SH	200w	Swan Hill.
1330	226	4BU	500w	Bundaberg.
1340	224	6TZ	2kw	Dardenup. (Often relays from 6PR.)
1340	224	2LF	300w	Young.
1350	222	3GL	500w	Geelong.
1350	222	4GY	200w	Gympie.
1360	221	3MA	200w	Mildura.
1370	219	2MO	100w	Gunnedah.
1370	219	5SE	200w	Mt. Gambier. (Relays 5AD.)
1370	219	6GE	500w	Geraldton.
1380	217	2GN	200w	Goulburn.

(Continued on Page 42)

SHORT WAVE LISTENER

by TED WHITING

DX'ERS TRANSMISSIONS FROM SWEDEN

From Sweden—one of the most democratic countries of the world and which possesses one of the finest radio organisations in Europe—come details of the special weekly DXers session broadcast over their short wave outlets.

"Radiotjanst"—Swedish Radio—is to be commended on their foresight in including in their transmissions a weekly programme on several of their Short Wave outlets dedicated to Dxers around the world. This special service is heard each Saturday at 5.45 p.m., and is radiated on SBO 6065 kc, and SBT 15155 kc at this time; at 1 a.m. on SDB2 10780 kc and SBT 15155 kc; and finally on SBU 9535 kc and SDB2 10780 kc at 11 a.m. Sunday.

The scripts are prepared by Arne Skoog, President of the "International League of Short Wave Editors" and one of the foremost of DX enthusiasts. They are read by Mr. Bergsten, one of "Radiotjansts'" English announcers.

Mr. Skoog advises that "this new service is a tribute to international goodwill, but will also keep short wave listeners informed regarding broadcasts from Sweden and on DX news from all over the world." The first transmission is intended primarily for the Pacific Area, but also for early morning listeners in Europe and Africa; the second period is most suitable for listeners in Europe and Africa, but can be also heard well in America.

Reception reports will be greatly appreciated by "Radiotjanst" and such reports should be accompanied by an International Reply Coupon.

Second Programme

As a matter of interest, a monthly programme of similar nature is broadcast on the last Sunday of the month on the Swedish National Network and on SBT and SDB2 at 8 a.m. Monday, AEST. This programme is in Swedish, and can be easily recognised by the fact it is preceded by a recording of Vera Lynn.

We strongly recommend our readers to try for these broadcasts as a correct report will most certainly bring back an attractive verification.

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, c/o Hotel Apsley, Walcha, N.S.W.

Radio Batavia

Batavia Radio, which now announces as Radio Indonesia is interested in receiving reports on the reception of the stations operating in their interests—PLD6, 17630 kc, PLA2 19345 kc, KDC 15145 kc, and PLF2 19345. The former three are to be heard at 2 a.m.-2.30 a.m. and the latter at 3 a.m. The address for your reports is Regeerings Voorlichtings Dienst, Koningslein 12, Batavia, Java. D.E.I.

Radio Indonesia

A further report was received from Radio Indonesia, giving the schedules in operation at present.

Radio Indonesia radiates on 9550 kc and 5030 kc on weekdays from 1 p.m.-4.30 p.m., 7 p.m.-11 p.m., 8 a.m.-10 a.m., and on Sunday from 10 a.m.-4.30 p.m., 7 p.m.-11 p.m. Programmes are radiated in Dutch and Indonesian languages, the announcements in the former being "Dit Is Makassar," and in the latter case "Disni Makassar."

Reception reports are desired and these should be forwarded to Mr. A. O. A. Niederer, Director of Broadcasting, Strandwg Zuid, 2 Makassar, Celebes East, Indonesia.

Recent Verifications

For those interested in verification, a letter from Mr. Cushen, Invercargill, N.Z., gives details of verifications he has received during a period of the last few weeks. Radio Africa has sent an air mail letter in verification of the reception of their transmission on 7080 kc, using 1000 watts. Reports should be addressed to: G. Dahlquist, 39 Calle Shakespeare, Tangiers. Radio Africa operates 5 a.m.-8 a.m. in Spanish, French and Arabic.

Danish Brigade Radio has verified, although they are no longer in operation. This station was using 400 watts on 6220 kc.

HOLA, Panama, "Radio Atlantico," verifies with an atractive card, while others which have been received by Mr. Cushen are from: CFVP, Monte Carlo, CR6RB, CR6RF, Munich, on 11870 kc, Singapore on 4895, GSN, GCO, GSG, in UNO broadcasts.

NEWS FROM CORRESPONDENTS

Interesting information received in letter from Mr. Cushen gives the following details gleaned from "New Zealand DX Times," official organ of the N.Z. Radio DX League.

5840kc OAX1B Radio Piura, Peru. Moved to this frequency from 6190kc, closes at 2.30 p.m.

6000kc HJKB, "Emisora Nuevo Granda" Bogota, Colombia. Heard until 2 p.m.

6060kc HORT, "Radio Balboa," new one, signing off at 2.15 p.m.

6065kc HOFA, Panama. Verifies by card, signed by Cristana Jean y Jean.

6270kc HJWO, "Emisora Colombia" Bogota, new station, signing off at 2 p.m.

6460kc "Radio Mundial," Panama. New station, heard in Spanish until 3 p.m.

9520 HJKF, "Emisora Neuvo Mundoo" Bogota, heard well in N.Z. till 2 p.m.

9590kc PCJ will increase power to 100 kw in August, 1949, PHI will increase to 40 kw early this year, and will finally operate on 100 kw later in the year.

9630kc CBFX, Montreal, relays CBC Home service to 7 p.m., signs off in French and English, replacing CBLX.

9765kc OTC2, Leopoldville, are running a new session for DX listeners at 10 a.m. on Thursday.

9770kc PRL4, "Radio Ministerio de Educacat Rio de Janeiro, relays PRA2.

11760kc All India Radio, Delhi, testing at good strength daily from 9 a.m.-10 a.m., and requesting reports, also heard with these tests on 15130kc, 9680kc, and 9565kc.

11820kc GSN, London, broadcasts for UNO to New Zealand 10.30 a.m. for 15 minutes. This transmission is also carried on GSO 15180kc, and a verification has been received for this transmission from Kenneth Boothe, U.N. Radio Division, Palais de Challiot, Paris 16.

11850kc LLK, Oslo, Norway, is used in the morning programme, relaying to Norwegian Home Service, 8.45 p.m.-9.40 p.m., fair signal, 10 note identification.

11950kc PRL5 Ministerio de Educacao, Rio de Janeiro, is the call of the station now being heard till close at 12.30 p.m.

15105kc Berliner Rundfunk, Germany, is heard at 12.30 a.m. in German transmissions.

15150kc Munich, Germany, has a relay unit of the Voice of America on this frequency.

15175kc LKV, Oslo, Norway, is using 100 kw and replaces LLM on this channel.

17890kc HCJB, are using 10 kw in tests on this frequency, 6 a.m.-7 a.m. in Swedish on Wednesday, in French on Thursday, in English on Friday and on Saturday in Spanish.

Batavian Stations

A very welcome letter was received from Mr. R. G. Gillett, Prospect, S.A., who, among a lot of other information, sends along an extract taken from "Pedoman Radio Gids," a Batavian Radio publication. The following lists of stations are those active in that area.

Batavia Oosters 2240kc, 4910kc, 11770kc.
Batavia Westers 2600kc, 4865kc, 10365kc.
Batavia Geonongd en Buitenland 7270 kc, 15150kc, 17630kc, 19345kc.
Bandoeing Oosters, 4945kc, 6170kc.
Bandoeng Westers 3040kc, 4370kc.
Batavia Geonongd en Buitenland 7270
Sourabaya Oosters 4370kc, 7295kc.
Sourabaya Westers 3240kc, 4340kc.
Samarang 2510kc, 11030kc.
Pontianak 8090kc.
Medan 7210kc.
Padang 3270kc.
Palembang 4855kc.
Makassar 5030kc, 9550kc, 11084kc.
Menado 9800kc.
Ambon 3380kc.

Radio Dalat

A letter of confirmation was received by Miss Sanderson from Radio Dalat. Signed by M. Aubouy, Direction des Postes et Telecommunications, Radio Dalat, French Indo-China. This letter states that Radio Dalat is on the air daily from 9 a.m.-11 a.m., 11.30 p.m.-12.30 a.m. on the frequency of 6180 kc, 48.54 metres.

The original power used was only 4 kw, but since July 20th the power used has been reduced to 240 watts. In the near future it is hoped to rectify the trouble in the transmitter, and so enable a return to the former power.

No doubt this station will be only too pleased to verify on receipt of your reports.

New Reporter

A new reporter in Mr. J. Stephens, West Brunswick, Victoria, is doing some good work with a small receiver which he has constructed. It consists of a regenerative detector (19), followed by a stage of audio amplification (1L5G).

With this equipment he has received many stations, and holds verifications from VLB3, VLC7, VLO, VLH3, VLR2, ZLE, and All India Radio. Reports are also out to several overseas stations from which it is hoped to receive verifications in the near future.

It is often surprising the results achieved by such a small receiver on these bands, and as there are many listeners who operate similar receivers, why not send us along your reception reports for inclusion in these pages.

Listen For These Stations

Europe

11030kc **CS2MK** is heard well at 7.45 a.m. with news in Portuguese; a very consistent station at most locations.

17766kc **PHI**, at 10.15 p.m., is good listening in Dutch and English transmissions.

15220kc **PCJ**, with News of the Netherlands at 8.15 p.m., good musical programme following.

9590kc **PCJ**, another outlet heard at good level at 8.45 p.m., same service.

21480kc **PCJ**, at 8 p.m. is heard very nicely on this frequency with yet again the same programme.

8035kc **FXE**, Beirut in News in French and music, signal is suffering from interference, but can be followed.

9465kc **TAP**, Ankara, as usual, at 7.30 a.m., good signal.

15122kc **Rome**, is a good one at 8.15 p.m. in news transmissions in English and Italian, but suffers at 8.30 p.m. when Seac makes an appearance.

11810kc **Rome**, is also using this frequency at 8.15 p.m., same service.

9630kc **Rome**, at 7.15 a.m. with similar news broadcasts.

15190kc **OIX4**, Finland, heard at 8.45 p.m. and at better level at 10.12 p.m. with news broadcasts in English.

9730kc **Leipzig**, heard at 4.45 p.m. well, news and music.

6220kc **Warsaw**, is another one heard at fine level in the mornings at 6.30 a.m.

11710kc **HE15**, fine transmissions are heard from Berne at 7 p.m., the recordings used from this station are among the best to be heard.

Africa

4910kc **CR7B4**, request programme at 8.30 a.m., verifies by air mail usually.

9767kc **OTC2**, Leopoldville with news in English for European listeners at 6.45 a.m.

4878kc **Durban**, fair signal here at 6.35 a.m. Closes at end of news.

5880kc **Capetown**, good programme, but signal only fair here at 6.30 a.m.

South and Central America

9727kc **HI2T**, Trujillo City, Dominican Republic heard well in Spanish at 6.45 a.m.

9625kc **VP4RD**, Barbados, "Church in the Wildwood" at 8 p.m., very popular session.

9370kc **COBC**, Havana, Cuba news in Spanish at 9.20 p.m., improving.

9430kc **COCH**, Havana is another heard but Morse is bad on this frequency.

15370kc, **ZYC9**, a further Spanish-speaking station heard at 8.45 p.m., noise also bad on this one.

15140kc **ZYK2**, identifies with Bugle Call, then Spanish news at 10.15 p.m.

9500kc **XEWW**, Mexico, is excellent in afternoon, closes at 4 p.m. This one is among the most consistent stations heard from this area.

9620kc **XEBT**, Mexico, not as loud as XEWW, but heard fairly well in afternoons at 4 p.m. close.

10130kc **HH3W**, French-speaking station heard opening nightly at 9.30 p.m., but is better later.

9545kc **LRY**, Argentina, another fair signal in Spanish at 8.15 p.m.

U.S.A.

15250kc **WLWK**, with news to European listeners at 7.30 a.m.

15150kc **WRCA**, New York at 7.45 a.m. in a A.F.R.S. programme, fine strength.

11890kc **WNRX**, New York, News from Home for troops overseas, fine at 8.30 a.m.

6120kc **KCBA**, San Francisco, has been heard recently at 9 p.m.

15350kc **WRUL**, New York, at 7.15 a.m. is at excellent level in American Business Forum.

17750kc **WRUS**, New York, with notes on the N.Y. Stock Exchange at 7.20 a.m.

11730kc **WRUS**, New York, same service as WRUS at same time.

15330kc **WGEO**, Schnectady is operating at 7.30 a.m. with English news service to Europe, fine signal.

15280kc **WNRE**, News summary at 7.15 a.m., heard well.

11770kc **WNRA**, New York also has News Summary at 7.30 a.m.

9650kc **KCBF**, San Francisco, 7.45 p.m., with news from California, fine transmission.

9700kc **KGEI**, San Francisco, News bulletins for the Far East at 8.15 p.m.

15250kc **KRHO**, Hawaii, another excellent signal at 8.30 p.m.

15130kc **KCBR**, Dixon, Cal., Good signal in early afternoon, news and usual type of programmes heard from these stations.

Far East

9500kc **KZPI**, Manila, News in English and musical programme at 7.45 p.m.

6005kc **KZMB**, Manila, carries sponsored programmes for local listeners at 8.45 p.m. and is heard well throughout night. Closes about 2 a.m.

6100kc **KZBU**, Manila, quite a good signal, prone to interference at night.

9690kc **KZOK**, Manila, heard frequently at 8 p.m.

11840kc **KZFM**, Manila, one of the best of these stations, 7.45 p.m. is the best time.

11780kc **Saigon**, French Indo-China is a regular station, heard nightly but not at former level.

6190kc **Hanoi**, at 9.15 p.m., with news and music, Chinese and other dialects are used.

9840kc **Radio Sario** is a fair signal at 10 p.m. with Dance Music and news in Dutch.

6000kc **H8SPD**, Bankok, Siam. A very consistent signal, can hear very well in most locations. Best time from 9.15 p.m.

6035kc **Rangoon**, Burma, with news in Burmese and dialects at 10 p.m., English announcements at times.

15300kc **Singapore**. This unit of the British Far Eastern Broadcasting Service is heard from 7.30 p.m., also to be found on 11850kc and 6770kc.

15120kc **SEAC**, Ceylon, excellent signals and programmes for the forces in the East, often relays the B.B.C. during evening, also heard on 17730kc and 9520kc at equally good strength.

17760kc **VUD8**, Delhi, heard recently in broadcasts of the cricket, India v. West Indies, very interesting at 7.30 p.m.

15350kc **VUDS**, Delhi, listen at 2 p.m. for full programme schedules.

15290kc **VUD11**, Delhi, News in English and programmes at 6 p.m.

15160kc **VUD7**, Delhi, at 6.15 p.m. with news and followed by cricket broadcasts.

11850kc **VUD4**, Delhi. News and usual type services at 10.15 p.m.

9670kc **VUD3**, Delhi, News heard in Hindustani, little English from this one.

9590kc **VUM2**, Madras, heard well at 8.45 p.m. with news and usual programme. Good signal at most locations.

AUSTRALIAN BROADCAST STATION LIST

(Continued from Page 40)

FRE-QUENCY (Kc/s.)	WAVE-LENGTH (Metres)	CALL SIGN	POWER	LOCATION
1380	217	4MK	100w	Mackay.
1390	216	4BH	1kw	Brisbane (Chermside).
1400	214	5AU	200w	Port Augusta. (Relays from 5KA.)
1400	214	2PK	200w	Parkes.
1410	213	2KO	500w	Newcastle (Sandgate).
1420	211	3XY	600w	Melbourne.
1430	210	2WL	500w	Wollongong (Unanderra).
1430	210	6CI	500w	Collie. (Relays from 6PR.)
1440	208	4IP	200w	Ipswich.
1440	208	2QN	200w	Deniliquin.
1450	207	2MG	100w	Mudgee.
1450	207	7DY	200w	Derby.
1460	205	2CK	300w	Cessnock (Neath).
1460	205	5MU	200w	Murray Bridge. (Relays from 5AD.)
1470	204	2MW	500w	Murwillumbah.
1470	204	3CV	500w	Maryborough (Carrisbrook). Relays from 3AW at night.
1480	203	2AY	200w	Albury.
1490	201	2BE	500w	Bega.
1490	201	4ZR	500w	Roma.
1500	200	2BS	200w	Bathurst.
1500	200	3AK	200w	Melbourne. All-night station, seldom on during daylight. Hours generally 11.30 p.m. to 7 a.m.
1500	200	5DR	200w	Darwin (Nthn. Territory).
1510	199	See 820 kc.		
1530	195	5AL	50w	Alice Springs (Central Australia).

Frequencies up to 1560 kc. have already been reserved for new A.B.C. Regional stations, while others are due to open shortly on channels on the main section of the band.

TRANS-TASMAN DIARY

By J. F. FOX

(Special N.Z. Correspondent)

AMATEURS ASSIST IN AIR DISASTER OPERATIONS

At Mount Ruapehu, scene of New Zealand's most tragic air disaster, amateurs—often operating under arduous and makeshift conditions once again demonstrated their efficiency and resourcefulness by maintaining constant communication with the base stations.

Mount Ruapehu, North Island's highest mountain towering 9175ft., was on October 23 the scene of the most tragic air accident in New Zealand's civil aviation history. The aircraft involved was the Lockheed Electra, Kaka, of the National Airways Corporation, which was on a routine flight from Palmerston North to Hamilton with 11 passengers and a crew of two.

A most intensive air and ground search was carried out over the area, one of the wildest and roughest in the Dominion. Then almost a week later news was received that a Dakota of the Royal New Zealand Air Force had sighted the wrecked air liner on the western slopes of Mount Ruapehu, some 700 feet below the summit. Immediately ground search parties were formed at Ohakune to go out to the scene of the wreckage.

During this recovery operation radio played an important part with amateurs and army personnel providing the wireless facilities. Altogether, eight stations in two networks were active in handling the traffic and providing communication between the different parties and camps.

Huge Task for Hams

Radio amateurs always in the fore to offer their services in any emergency again demonstrated their efficiency in the air crash operations. When the air liner was first reported missing ZC1's and portable equipment were packed in readiness for a hasty trip to provide communication if required. When news of the finding of the aircraft was received in Ohakune early on the Friday morning, local amateurs reported to the police station.

It was arranged that Mr. D. R. Prime (ZL2JL) and Mr. T. Teehan (ZL2SK) would establish a forward base at a point as far as the car could be taken and relay messages back to ZL2MP, Mr. W. H. Powell, whose set was installed in the Ohakune Courthouse. Mr. Powell's base station was equipped with two transmitters, the main one using a 6V6 crystal oscillator which worked into 6L6G final. Normal modulation was obtained and the power input was 30 watts. The second transmitter was a FS6 battery operated set which was installed in case of any failure of electricity. However, both sets were used.

Later in the morning the convoy of police, army, Public Works and amateurs moved off and eventually passed through Horipito to Cowern's Mill site, nine miles from Ohakune. This was as far as cars could go; the various parties going up to the plane then set off walking along an antiquated tramway which ran about four miles inland to the base of the mountain.

The ZC1 was installed in a cottage nearby and a channel opened with ZL2MP at Ohakune. The Army station took over communication with a portable No. 48 set which was operated on 7950 kilocycles. Owing to the wooden nature of the terrain, and the frequency used communication was extremely poor.

Meanwhile schedules were being maintained with Ohakune and a few messages were passed on a frequency of 3552 kilocycles. As the cottage at the Mill was connected to the mains, an A.C. operated ZC1 was brought in from Raetihi, some 12 miles away.

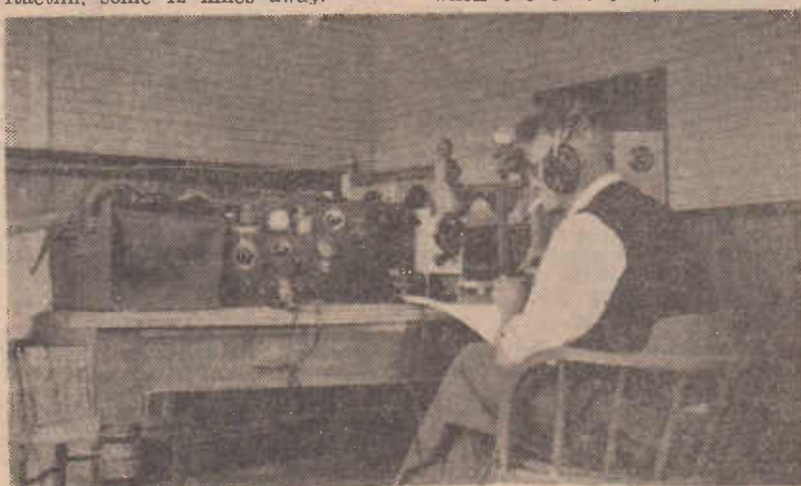
Advance Base Opened

The following morning the other ZC1 was packed and transported by horse-drawn trolley to the Air Force Dropping Zone Camp at the end of the tramline. The tramline was far from the modern type seen in the cities, for it consisted of the most irregular wooden rails nailed across sleepers. When the equipment reached the Dropping Camp, Messrs. Prime and Teehan opened a channel with ZL2VA (Mr. D. L. Vaughan), who took over the station at Cowern's Mill.

Traffic commenced to flow briskly over the amateur network, ZL2SK establishing contact with the No. 48 sets and the Army base station KHA at Horipito. A busy time was experienced by the operators at the Advance Base station changing frequencies twice each quarter-hour and maintaining continuous watches. In addition they contacted the aircraft dropping the supplies, tuning the ZC1 hurriedly to 3105 kilocycles (New Zealand aircraft frequency).

Hams Make Trip to Wreckage

Two radio amateurs who made the strenuous trip up to the wreckage were Messrs. H. D. Sandford (ZL2AI) and C. Gregory (ZL2AGI), with other members of a party sent out on the Monday and Tuesday to search for and bring back the 13th body which was missing when the first party reached the



The base radio station at Ohakune Courthouse during the air disaster operation. Note the witness-box in the background.
—(Photograph courtesy W. H. Powell.

plane, Messrs. Sandford and Gregory were equipped with a portable No. 48 set which had been obtained from the Raetihi High School cadets. Communication was kept with a ZC1 relay station at Horipito operated by Messrs. Teehan and McLean (ZL2AFN).

During this expedition the amateur radio network handled only police messages and operated with Police Department call signs, namely, ZLKQ1, ZLKQ2, and ZLKQ3. Frequencies used were 7000 kilocycles from the portable to the relay station at Horipito, and 3500 kilocycles from the relay to the base station at Ohakune Courthouse operated by Mr. Powell. It was found that reception was excellent during the daytime on 7000 kilocycles, though at night heavy interference was experienced.

Some idea of the hardships endured by those who took part in the search was told to us by Mr. Sandford. On the first night at the mountain base there were no blankets; the members kept warm by wrapping themselves in old parachutes and sitting with their backs against the trees. Several storms were experienced this night and little sleep could be obtained.

Army Network

While amateurs were busy handling police messages another network was being operated by Army personnel of the Royal New Zealand Armoured Corps from Waiouru, Lieutenant P. H. Bell being in charge of the wireless stations. The Army operated a base station under the call sign KHA with a No. 19 set in a wireless van at the edge of the bush at Horipito base camp. A channel was opened with another No. 19 set at Karioi Air Field, 15 miles away. A frequency of 3105 kilocycles was used for this link. Contact was also maintained with Army 48 sets at the mountain base and wreckage on a frequency of 7950 kilocycles; speech was used throughout.

Lieutenant Bell told Radio Science that communication from the wreckage was good considering the dense bush through which the Army was operating. Army personnel had to traverse rough country carrying the No. 48 sets and batteries right up to the wreckage. One soldier operating a portable set had to be lowered by rope down to the site of the air liner.

CONSOL — RADIO NAVIGATION AID

(Continued from Page 12)

character sequence. This adjustment is not particularly critical.

The differential phase-shifter is used to shift the phases of the currents in the outer aerials smoothly and in equal amounts, reducing one and increasing the other (Fig. 1). It consists of a goniometer and phase-shifting bridge network (Fig. 4). The goniometer rotor is driven by the same motor which actuates the cams previously mentioned. The phase shifter is thus synchronised with the keying cycle. (The change over to omnidirectional radiation and transmission of the station call sign is also effected by this motor).

It will be seen that the equipment of a Consol station is reasonably straightforward. Provided remote control of the matching units at the aerials is used, the station can be operated by a staff of two. Monitoring equipment is installed at a point a short distance from the station, enabling the operator to make an overall check of the station performance, including the radiation diagram of the aerials.

The necessary equipment in an aircraft for taking bearings from a Consol station is merely a suitable receiver together with a chart listing bearings in terms of "*character-counts*," or alternatively a special map on which bearing lines corresponding to different counts are drawn. Because of this simplicity of the airborne equipment the Consol system is very attractive to civil airline operators, and is likely to be used extensively in the North Atlantic region, where proposals for the installation of a number of stations have been made.

The range to be expected from a Consol Station depends, amongst other factors, on the degree of atmospheric noise prevailing. Under favorable conditions a range of 1100 miles might be expected; at night-time this may be increased to 1700 miles because of ionospheric reflection. The accuracy of bearing information depends on several factors. In daytime typical accuracy is between + ¼ and + ½ degree depending on the bearing of the receiver from the station. At night greater errors are to be expected, because of sky-wave transmission which occurs simultaneously with or in place of ground-wave transmission.

For further information on the Consol system reference should be made to a paper on the subject by A. H. Brown in the Journal of the Institution of Electrical Engineers, Vol. 94, No. 16, to which the author is indebted for much of the material here presented.

BASIC ELECTRICITY AND MAGNETISM

(Continued from Page 23)

and negative charges exist at C and B, respectively. The nearer BC is to A the larger these charges at C and B. They disappear as soon as BC is moved from the vicinity of A.

The ability of A to charge BC is called *inductive action*, the movement of charges along BC is known as *inductive displacement*, and the charges which appear at B and C are called *induced charges*, and the phenomenon as a whole is called *electro-static induction*.

The phenomenon of electro-static induction is due, as we can readily see, to the electric strain existing in the dielectric around A, being altered by the introduction of the conductor. Negative charges are attracted toward A, positive charges are repelled from A, so that B, nearest to A is charged negatively, while C, remote from A is charged positively.

Since B is nearer to A than C, the force of attraction between A and B is greater than the force of repulsion between A and C. There is a mechanical force of attraction exerted between the charged body A, and the conductor BC.

Next month we will see how it is possible to plot out the shape and characteristics of an electric field, despite the fact that it is indiscernable, and how lines of electric force and electric induction are used to enable us to predict the effects we will get from electric fields in practice.

Technical BOOK REVIEW

VACUUM TUBES

By Karl R. Spangenberg, Published by McGraw-Hill Book Company. Stiff cover, 890 pages. Price approx. 58/- plus postage.

This is the first book in the new McGraw-Hill "Electrical and Electronic Engineering Series" with F. E. Terman as the consulting editor.

As the author states in the preface "this book is the outgrowth of a course in vacuum tube design given for many years at the Stanford University to senior and graduate students in electrical engineering and physics." Comprising some 890 pages, divided into 21 chapters, this text gives a comprehensive survey of all physical laws which contribute to the understanding of vacuum tube behavior.

The outstanding types including Magnetrons, klystrons and ultra high-frequency tubes are dealt with individually and the fundamental techniques of analysis required for the understanding of such tube behavior is dealt with in considerable detail. Recent advances in the field are covered thoroughly and the book will be found to contain much material not previously available—such as space charge flow, noise, and specific characteristics of triodes, tetrodes and pentodes.

The general approach to the whole subject has been from the mathematical and theoretical rather than the descriptive point-of-view. Reference to commercial practice or specific types has been reduced to a minimum as the author has been exclusively interested in detailing the phenomena taking place inside the vacuum tube. Complex notation is used freely throughout the text and consequently for a complete understanding of the material presented, a thorough knowledge of mathematics, including the calculus is necessary.

Essentially for the radio engineer, this volume covers the entire vacuum tube field in a comprehensive manner, and can be regarded as an invaluable standard reference text on the subject.

PHOTO-ELECTRIC CELLS IN INDUSTRY

By R. C. Walker, B.Sc., A.M.I.Mech.E., A.M.I.E.E. Published by Sir Isaac Pitman and Sons Ltd. Price 58/- plus postage.

An authoritative text dealing specifically with the industrial use and operation of photo-electric cells has been long overdue. This oversight now seems to be remedied by this recent volume on the subject, as it is written by an expert in the field who has stressed the practical rather than the theoretical application of these valves.

After lucid explanation of the operational theory of these devices, the text covers such topics as: Relay Circuits, Measuring Circuits, Source of Light, Counting and Recording Impulses Controlling Devices, Alarms and Indicators and Photo-electric Measuring Equipment. In addition there are comprehensive chapters dealing with the: Reproduction of Sound, Fascimile Picture Transmission and Television Transmissions, with emphasis being placed on the P.E. Cell usage.

Written in an easy readable style, the material presented can be considered modern and up-to-date. A comprehensive list of references at the end of each chapter greatly enhances the value of this book, which should be of particular interest and value to all engineers interested in the rapidly expanding field of P.E. Cells and associate equipment.

RADIO DATA BOOK

By W. F. Boyce and J. J. Roche. Published by Boland and Boyce, Inc. Semi-stiff cover, 1148 pages. Price 50/-, plus postage.

Representing some 18 months intensive and careful research by the authors, this data book provides the reader with a veritable mine of technical information. Containing over 1100 pages, and profusely illustrated with line drawings it will provide a ready reference to most of the everyday problems encountered by the radio technician, experimenter and enthusiast.

There are twelve main sections in the book and these give complete information on such subjects as: Basic Circuits, Test Equipment, Tests and Measurements, Antennas, Sound Systems, Sound Recording, and Radio Equipment circuit diagrams. In addition there are chapters on Receiving and Transmitting Tube Data, various formulae, graphs and tables, complete color code lists and symbol data and a dictionary of electronic and radio terms.

Of particular interest to the radio enthusiast is the basic circuits section, which details the operation of some 150 circuits ranging from crystal receivers to klystron oscillators. Typical circuit arrangements are given together with an explanation of their operation, although it is considered these could have been made even more valuable by indicating usual circuit constants.

Equally valuable to experimenter are the many formulae graphs and tables, as these contain the type of reference data every radioman must refer to from time to time.

In conclusion this book will be found to contain much information not readily accessible in other texts, and consequently should prove most valuable to all having an interest in any phase of radio.

EXPERIMENTS IN R-F HEATING

(Continued from Page 8)

In this case, therefore, the heat generated is proportional to the quotient of power factor and dielectric constant; and it follows that an increase of both properties causes a much smaller increase in heat generated than it does for the former arrangement, where their product is the controlling factor. It follows from these considerations that in order to approach as closely as possible to the ideal of uniform heating, the blocks must be prevented from touching the electrodes and also one another, and the layers in which the differing portions tend to lie should be in series with respect to the current, and therefore parallel to the electrodes.

Horizontal Electrodes

These conditions were easily secured by using horizontal electrodes, standing the blocks in piles on the lower electrode, with sheets of paper interposed to prevent actual contact. It was important to have a clear air gap between the upper electrode and the blocks, and between the piles of blocks, and to blow air through the gaps in order to remove the water liberated. With this arrangement it was found that the drying could be done in about one-fifth of the time required by the ordinary method, a considerable improvement, but not so great as to leave any doubt about the economic advantage in view of the more complicated equipment required.

A further improvement was obtained by applying the dielectric heating in a low vacuum (Fig 2). If the pressure is reduced below a certain point, discharges between the electrodes become troublesome but an air pressure of 15 cm., of mercury presents no great difficulty, and since water boils at 60 deg. C. under this pressure, one would expect to be able to boil off the water without exceeding the scorching temperature. However, even at this pressure, internal scorching again set the limit to the permissible power-input, and the shortest time of drying achieved without deterioration was about one-eighth of that for the ordinary method. Again the economic advantage was doubtful, in view of the increased cost of the installation required.

Sterilising of Ham

A somewhat similar state of affairs was revealed by experiments directed towards the sterilisation of hams as a preliminary to canning for export. Such material can, of course, be satisfactorily sterilised by steam heat so long as the depth to be penetrated is fairly small; but with whole hams, for example, the depth is so large that it is difficult to ensure adequate heating of the inmost portions without excessive heating of the outer parts.

Dielectric heating certainly overcomes the difficulty in some measure, but the first tentative experiment pointed forcibly to the factors requiring consideration. The ham, which rested on a china dish, was placed between the parallel-plate electrodes that had served for the experiments on the vegetable blocks. The dish stood on the bottom electrode, so that the high-frequency current passed from that electrode through, first the dish, then the ham, and then an air-gap to the upper electrode, these several components all being in series.

It was certain that the power factor of the ham would be very high at the working frequency of 13 Mc. per sec., and rapid heating at a fairly low voltage was looked for. What happened was that the china dish became hot, while the ham remained cold, a striking example of selective heating, but not at all what was wanted. Measurements of dielectric properties were attempted, but they showed that ham must be regarded as a poor conductor rather than a dielectric; its conductivity is rather greater than that of tap water, and it was about 20 or 30 times as great for the lean portions as for the fat.

Irregular Heating

Given these facts, it became clear that the reason why the ham did not heat up was that nearly the whole of the voltage-drop must have occurred in the china dish and the air gap, leaving none for the ham. When the electrodes were in actual contact with the ham, heating was rapid; but then the difference in resistivity between the fat and lean caused very uneven heating. Where the current flow is transverse to the layers, the material of highest resistivity heats more rapidly, where the flow is along the layers, the material of highest conductivity heats most rapidly. The distribution of fat and lean is, of course, irregular so that although the heating is uneven it is impossible to say that the fat is consistently hotter or colder than the lean.

Since the ham is a conductor, it can also be heated by induction, and this process was also tried, by simply placing the ham inside a coil carrying the high-frequency current. In this case also the heating depends on the resistivity of the material and for a given rate of the heating it was found to be as uneven as for dielectric heating. The general conclusion was that while internal heating is certainly practicable, it is not sufficiently uniform when applied rapidily to make sure that every part reaches the sterilising temperature before any part is overheated. A short period of internal heating followed by a period in steam-heat, which would allow the internal heat to distribute itself uniformly, might be successful; but the advantage to be gained is not so obvious as to leave no doubt about the economic value of the process.

Wood Gluing

Experiments on the rapid gluing of wood (Fig. 3) showed that similar considerations arise when the wood to be treated is far from uniform in its dielectric properties. It will, however, be obvious that for its successful operation the material to be treated must be standardised, especially in moisture content and density, since these two properties largely determine the dielectric constant and power factor of the material.

Reprinted Courtesy "British Science News"

MARCONI—A TRIBUTE TO A PIONEER

(Continued from Page 15)

Charles Franklin, inventor of the Franklin beam aerial, directed the Poldhu station in 1923-24, when Marconi commenced his world tour on his yacht Elettra. These were the most successful of all his experiments, the human voice being heard on the yacht on all corners of the earth including Australia.

Poldhu had opened the door to world-wide radio telephony, and within a few years nation was talking with nation, amateur radio was becoming a great hobby and so international broadcasting began.

The station closed in 1933. Now Poldhu is a solitary space again—a lonely point on one of the oldest and most romantic coasts of England. But Poldhu and Lavernock will never die. Marconi's work will live for ever and help forward that great ideal of the human race—the brotherhood of man.

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★

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All these issues, plus those you will receive in the months to come will form a valuable reference library covering the latest developments in the radio and electronic fields.

This summary of some of the main feature articles contained in earlier issues indicates the wide scope of subjects covered and should enable you to select those copies of direct interest.

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Speaker Network Design Data.

MARCH, 1948

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APRIL, 1948

High Frequency Heating.
Dual Purpose Amplifier.
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Versatile Signal Tracer.

MAY, 1948

Surveying by Radar.
Dual Wave Seven.
Multiple Track Radar Range.
All Wave Battery Two.
F-M Antenna Transmission Lines.

JUNE, 1948

Scope of Electronics in Industry.
The Caravan Five.
U.H.F. Techniques-Klystron.
Multiple Track Radar Range.

JULY, 1948

Mobile Radiotelephone Communications.
T.R.F. Tuning Unit.
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Airport Approach Control.
Receiver Tuned Circuits.
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SEPTEMBER, 1948

Power Line Carrier Communication.
Dual Wave Five.
Three Way Speaker System.
High Fidelity Amplifier.
Pickup Resonance effects.

OCTOBER, 1948

The Countryman's Five Battery Receiver.
Modern Atom Smashers.
Transistor—New Crystal Amplifier.
Troubleshooting Receiver Distortion.
New Overseas Circuits.

Limited copies of the above issues are still available and can be obtained by writing direct to the Subscription Department, Box 5047, G.P.O., Sydney. The price in each case is 1/-, post free.

SEND OFF THIS FORM TO-DAY!

RADIO AND SCIENCE PUBLICATIONS,
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Please send me the following issues of RADIO SCIENCE:

- ☐ **February, 1948**
- ☐ **March, 1948**
- ☐ **April, 1948**
- ☐ **May, 1948**
- ☐ **June, 1948**
- ☐ **July, 1948**
- ☐ **August, 1948**
- ☐ **September, 1948**
- ☐ **October, 1948**

Remittance for........................is enclosed.

NAME..

ADDRESS..

CITY—STATE..

The Mail Bag

H.W.A. (Darwin, N.T.) forwards a change of address and asks some questions.

A. Your new address has been noted by the Subscription Dept., and this took effect from the January, 1949, issue. We are pleased to hear you enjoy reading the magazine and like the "For your Notebook" page. There were two errors in the Signal Tracer circuit, namely the A minus lead should not be connected to the B minus as shown, and one of the 500 ohm resistors should have been the potentiometer so as to provide the meter balancing circuit. Apparently you have remedied these faults in your own unit now. It may be possible to describe a small signal generator along the lines you suggest in a future issue. There would probably be no objection to the phono-oscillator if radiation did not extend beyond the house it was being used in. To date little interest appears to have been shown in this type of equipment. We reciprocate the Season's Greetings, and would be pleased to hear from you anytime you may care to drop us a line.

M.H.H. (Reservoir, Vict.) enquires about several back issues of RADIO SCIENCE and mentions he is particularly interested in high fidelity sound equipment.

A. Your enquiry re the earlier issues has been attended to by the Subscription Department. We note your interest in sound equipment and would be pleased to hear of your experiences in this direction. Your remarks about the magazine are appreciated, and are pleased to note you have now placed a standing order with your newsagent.

J.E.S. (Canning, W.A.) forwards a two year subscription, some technical queries on Television and says: "I find your publication extremely interesting and written in an excellent style. The series of articles on UHF techniques and developments, and on the latest developments in radar as aids to navigation were very good. Also the last two articles on the latest in atom smashers were well worth reading. . . ."

A. Thanks for the letter, J.E.S., and we appreciate your remarks concerning the magazine You may rest assured that the standard of the magazine will be kept as high as in previous issues. It is impossible to list all the reasons for the use of magnetic deflection in television circuits but the following may be of interest. The main advantage of magnetic deflection is that at high beam voltages only a small increase in deflecting field is necessary. This is because the electrostatic deflection is inversely proportional to the beam voltage, whereas with magnetic deflection this is inversely proportional to the SQUARE ROOT of the beam voltage. This means if the beam voltage was raised from say 1000 to 4000 volts, four times the voltage would be necessary to give the same electro-static deflection, whereas only TWICE the magnetic coil current would be required in the case of magnetic deflection. "Shunt-peaking" in video circuits is a means of compensating for the effects of shunt capacitance composed mainly of stray circuit capacitance effects. This compensation is brought about by connecting a small inductance in series with the output resistor of the video amplifier. The value of the coil is chosen to resonate at a frequency slightly above the highest frequency to be amplified. This results in a build up in the amplification at the high end of the range. We trust these remarks will be of some value to you. No doubt by now you will have seen the television article in the January issue, and hope this is 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 endeavor 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."

D.R.Y. (North Sydney) is interested in building up test equipment and asks about the operation of a multivibrator.

A. A multivibrator is simply an oscillator consisting of a two stage resistance coupled amplifier with the output feeding back into the input. The value can be either a twin triode type or two separate triodes. The frequency of oscillation depends on the resistance and capacitance values of the interstage coupling elements, with the 180 degree phase shift in each valve providing the correct regeneration voltages on the grid of the input valve. It is actually a form of relaxation oscillator which has the valuable property of being readily stabilised and controlled by a frequency from another source. Should this control frequency be slightly higher than the fundamental of the multivibrator it falls in step and generates submultiples or subharmonics of the control frequency. As a consequence a multivibrator is essentially a frequency divider which makes it very useful as a reference in standard frequency equipment. The description of the unit in this issue should be of interest to you, D.R.Y., and we appreciate your remarks about the magazine.

1.ALL. (Lewisham, N.S.W.), in forwarding a subscription, mentions he has appreciated all issues to date, and suggests we continue publishing articles of interest to the serviceman.

A. Your subscription is appreciated, C.A.L., and this has been passed on to the Subscription Department for attention. We are pleased to hear you enjoy reading RADIO SCIENCE, and you may be assured articles of the type you mention will be regularly featured in these pages.

F.H.D. (Garbutt, Q'ld.) forwards a two year subscription and says:—"I would like to take this opportunity of congratulating you on the excellent quality of RADIO SCIENCE; its standard has been consistently high over the past 11 months. I have enjoyed all the articles by Roth Jones on amateur radio and considered the articles on "Approach Control" and "UHF Techniques" excellent.

A. Thanks for the letter and subscription, F.H.D. This latter has been attended to by the subscription department, and the early issues requested have also been forwarded. No doubt they will have reached you by now. We appreciate your remarks about the magazine and are pleased to hear that you enjoy reading it each month.

"WORLD WIDE SIX"

(Continued from Page 20)

Keep these as short as possible, remembering to twist the heater wires to reduce hum effects. If a centre tap is not provided on the heater winding one lead should be earthed.

Next wire in the various condensers and resistors, taking each stage in turn. Mount each component as close as possible to its section of the circuit, keeping all leads to a minimum. An earthing busbar run around the chassis will provide a convenient earthing spot for these components. The position of most of these components can be seen in the underneath chassis photograph.

The alignment of the receiver is carried out according to the printed instructions, and for maximum results these should be adhered to.

RED LINE

TRANSFORMERS of DISTINCTION

HEAVY DUTY AMPLIFIER TYPE

The transformers listed in this section comprise a wide range of types suitable for practically any circuit requirements. Careful attention has been given to their design and construction to produce robust, economical and reliable units of maximum dependability.

Temperature rise conforms to accepted practice for electrical apparatus of this nature, and will not exceed 35-40 degrees Centigrade for continuous operation under full rated load. Unless otherwise stated, current ratings are based on their use in choke input circuits, and while insulation is ample to cover the added peak voltages involved in condenser input systems, H.T. secondary current ratings should be reduced by approximately 20% to allow for the severe heating effect due to the poor form factor of rectified current. The approximate DC voltage available at the input to the filter system is given for rectifier valves normally used.

All Red Line units are baked and impregnated with super insulating varnish and are specifically made for use under adverse climatic conditions.

Item 12. TYPE No. 15353.

Prim: 200-230-240v. .. .. 110vA. .. .. 50 cps
H.T. 350 CT 350v. 150mA Cond. Input.
Fils: 5v-3A 2.5v-5A 6.3v-3A
Base: 4½ x 4 x 4¼in. H. .. .. Wgt. 9lb. 4ozs.
Mntg: V11 .. ..“S” is 2⅛in.

D.C. Volts	Choke Input	Cond. Input
5V4	285v	350v
83	290v	
5Z3	260v	350v

Item 13. TYPE No. 15403.

Prim: 200-230-240v. .. .. 110vA. .. .. 50 cps
H.T.: 400 CT 400v. 150mA. Cond. Input.
Fils: 5v-3A 2.5v-5A 6.3v-3A
Base: 5 x 4½ x 4¾in. H. .. .. Wgt. 10lb. 12ozs.
Mntg: V15 .. .. “S” is 1¾in.

D.C. Volts	Choke Input	Cond. Input
5V4	320v	405v
83	335v	
5Z3	290v	400v

Item 14. TYPE No. 20353.

Prim: 200-230-240v .. .. 140vA .. .. 50 cps.
H.T.: 350 CT 350v. 200 mA. Cond. Input
Fils: 5v-3A 2 5v-10A, CT 6.3v-3A.
Base: 5 x 4¾ x 4¾in. H. .. .. Wgt. 12lb. 8ozs.
Mntg: V15 .. .. “S” is 2in.

D.C. Volts	Choke Input	Cond. Input
5Z3	240v	320v
83	300v	

Item 15. TYPE No. 17503.

Prim: 200-230-240v. .. .. 145vA. .. .. 50 cps
H.T.: 500 CT 500v. 175mA. Cond. Input.
Fils: 5v-3A 6.3v-3A 6.3v-2A
Base: 5 x 4¾ x 4¾in. H. .. .. Wgt 12lb. 8ozs.
Mntg: V15 .. .. “S” is 2in.

D.C. Volts	Choke Input	Cond. Input
5V4	410v	470v
83	425v	
5Z3	375v	480v

Item 16. TYPE No. 20453.

Prim: 200-230-240v .. .. 150vA. .. .. 50 cps
H.T. .. .. 450 CT 450v 200mA, choke input
Fils: 5v-3A 6.3v-3A CT 6.3v-3A.
Base: 5 x 4¾ x 4¾in. H. .. .. Wgt. 12lb. 8ozs.
Mntg.: V15 .. .. “S” is 2in.

D.C. Volts	Choke Input	Cond. Input
83	380v	
5Z3	345v	460v
5V4	340v	450v

Item 17. TYPE No. 25503.

Prim: 200-230-240v .. .. 190vA. .. .. 50 cps
H.T.: 500 CT 500v 250mA Choke Input.
Fils: 5v 3A 6.3v-3A, 6.3v-3A
Base: 5⅜ x 5 x 4¾in. H. .. .. Wgt. 15lb. 8ozs.
Mntg.: V15 .. .. “S” is 2½in.

D.C. Volts	Choke Input
5Z3	355v
83	400v

Item 18. TYPE No. 25563.

Prim: 200-230-240v. .. .. 200vA .. .. 50 cps
H.T.: 565 CT 565v 250mA Choke Input.
Fils .. .. 5v 5v-4A 6.3v-3A 6.3v-3A.
Base: 5⅜ x 5 4¾in. H. .. .. Wgt. 15lb. 8ozs
Mntg.: V15 .. .. “S” is 2½in.

D.C. Volts	Choke Input	Cond. Input
83	475v	
5Z3	430v	
5R4GY	430v	600v

Item 19. TYPE No. 5176.

Prim: 200-230-240v .. .. .. 240vA .. .. 50 cps
H.T.: 730 CT 730v. 200mA
330 CT 330v. 100mA
Fils: 5v-3A 5v-2A 6.3v-3A 6.3v-4A
Base: 4 x 5¼ x 5¾in. H. .. .. Wgt. 16lb. 12ozs
Mntg: V12 .. ..“S” is 3in

RED LINE EQUIPMENT PTY. LTD.

TRANSFORMER ENGINEERS

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2 Coates Lane, Melbourne.

CITY OFFICE: MU6895 (3 lines), 157 Elizabeth St., Melbourne.

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