RADIO SCIENCE

Vol. 2—No. 5

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MAY, 1949

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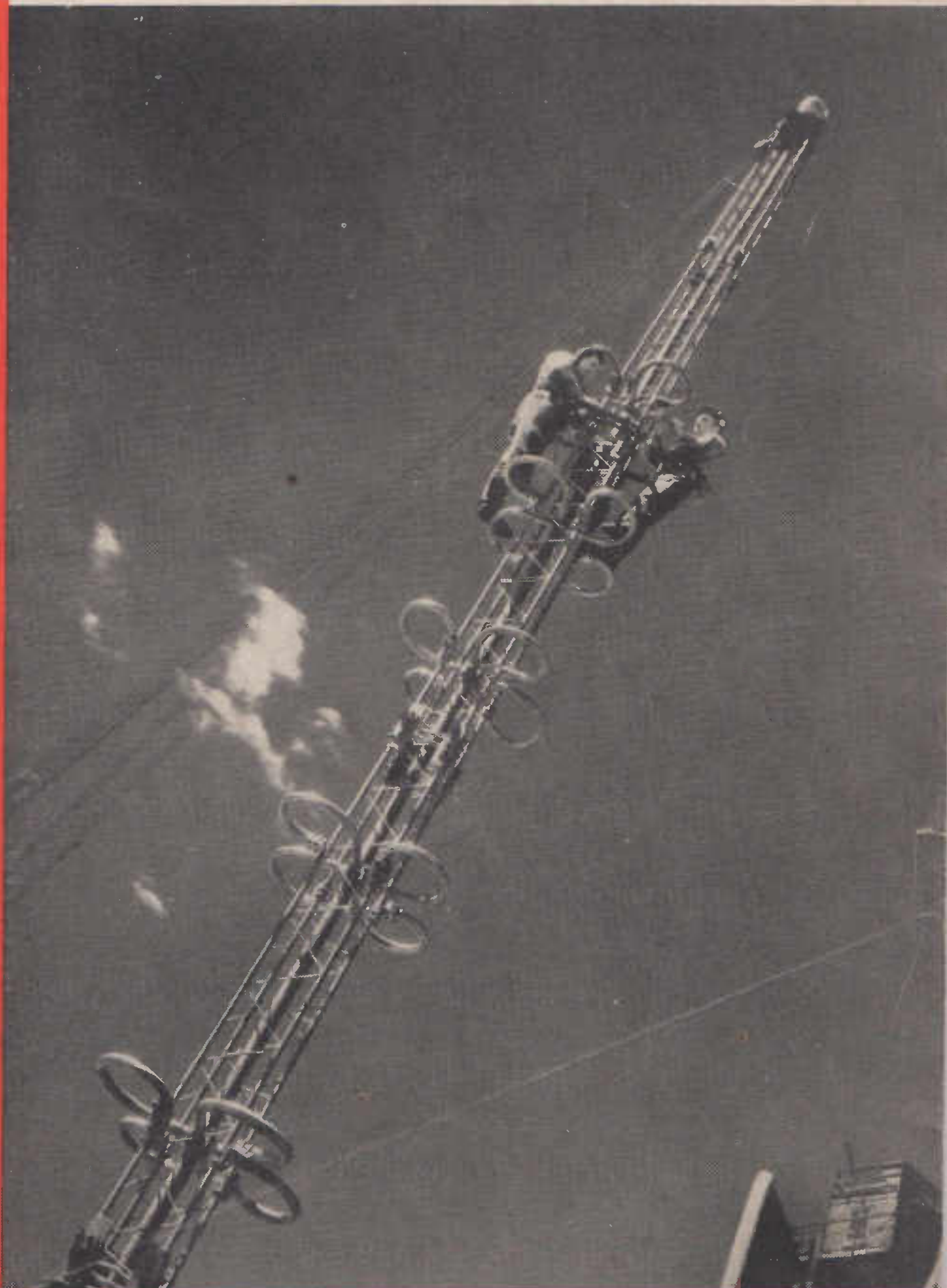

RADIO — ELECTRONICS — F.M. — TELEVISION

editorial.

Will Television Affect You?

The recent demonstrations of complete Television screenings in Melbourne and Sydney have done much to quicken and enliven public interest in this new and most advanced of the electronic sciences.

Pending the Government's decision on the technical aspects of the future transmissions, these demonstrations differed only from overseas techniques in that coaxial cables were used to carry the televised image signal from the "cameras" to the viewing screens in place of the more usual method of transmission. On the latest forecast it appears possible that full television services will be in operation in this country within the next two or three years, although in view of the recent demonstrations, it is to be hoped that this time may be considerably shortened.

Whilst there is no denying that Television is undoubtedly one of science's greatest developments and can, if properly handled, provide unlimited educational and entertainment value, a point frequently overlooked when mentioning the benefits of the system is its possible effect on the owner of a television receiver. In view of this, it may be fitting at this juncture to review some overseas opinions as to the change that Television has made on the community life in general.

From a recent copy of "Successful Servicing", we quote a typical report on the impact of television on the everyday family in America, and it makes interesting and thoughtful reading.

To quote: . . ."Families who have Television are already feeling a sense of confusion—restraint—of confinement and even frustration. The women are beginning to object to staying in every night, although they are the ones who want to see the programmes. As a facility, Television is changing people's lives—changing the way they live in their homes.

"At the outset people stay in and watch everything which can be seen on a single receiver, but after a while they have not done the normal amount of reading or they don't get together with their friends (who also have TV receivers) until comparatively late in the evenings. Yes, people are watching Television, but they also realise that they have lost the independence of action in the home because of the attraction of Television.

"The net result is that in homes where television receivers have been in use for several months, members of the family are beginning to return to normalcy little by little. They are becoming more and more critical and selective of Television programmes and use their AM receivers more than they did shortly after they acquired the TV receiver. This is no reflection on the merits of Television; instead it is a habit fighting back.

"In our opinion it is even more than a habit—it is a way of life which is striving to stave off a transition. Ultimately many years in the future—the way of life, which was born of what we can call blind radio, will go down in defeat, but for years to come it will survive. . . ."

These statements are no mere figments of imagination, but typical reactions taking place in many of the areas being served with television stations. Undoubtedly similar reactions will take place in this country with the advent of this new service. However, despite these deleterious effects on the social and cultural atmosphere of the home, the advantages offered by television services can more than outweigh any of its disadvantages, and such receivers will be eagerly sought by the public.

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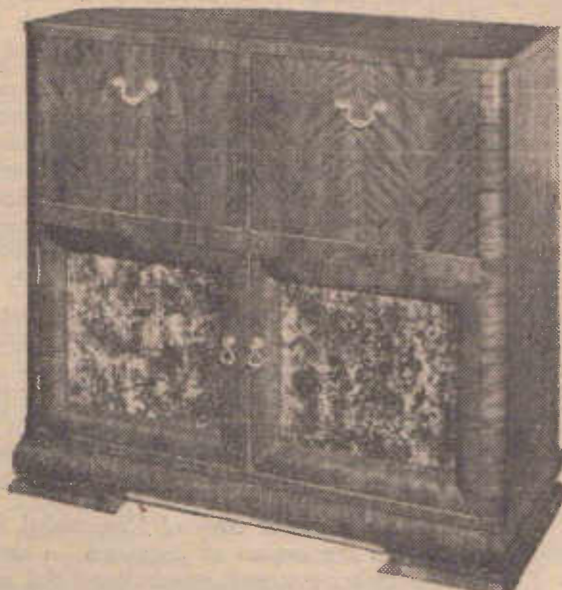

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RADIO SCIENCE

For the Advancement of Radio and Electronic Knowledge

Vol. 2, No. 5 — MAY, 1949

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OUR COVER. Workmen installing a "clover-leaf" element on an FM Broadcast antenna. This antenna when completed is an eight element array, with all radiating elements being connected by means of simple clamps at half wave intervals to a 3-inch diameter feed conductor which is centrally located within the tower structure.

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DIELECTRIC HEAT
WOOD FABRICATION TOOL

Two non-related but simultaneous developments—resin glues and dielectric heating—form a team that is making possible improved products of wood, an increase in production rates, and the transformation of low-grade woods or wood-wastes into articles of market value.

If your favorite brassie has a laminated head, if you rode home from the golf club in a station waggon, if your new radio has a wooden cabinet, or if you had dinner last night on the new dining-room table—radio-frequency heating is a factor in your life. To-day, radio-frequency heating is playing a major role in the fabrication of practically all types of articles made of wood. This is a companion development to the introduction of superior glues of the resin type, which are highly resistant to heat and moisture and which develop a strength greater than that of wood itself.

These glues are synthetic, being compounded from basic raw materials. Unlike the earlier wood glues, which are mostly of animal origin and set by evaporation of solvents, these glues set through a chemical change that is accelerated by heat. They do not depend on the evaporation of water or other solvents for setting.

This table model radio cabinet has 28 joints, all glued and cured by r-f heat. No pins, nails or fasteners are used. The heating time is 20 seconds, and three 5-kw. and two 2-kw. r-f generators are used, giving a production of 400 cabinets in eight hours.

Basic Principles

For many years, the electrical engineer had been striving to perfect dielectrics (the separating material between the plates of a capacitor) that would not heat when alternating voltages are applied. For dielectric heating the goal is exactly reversed. The plates of the capacitor are electrodes and the dielectric is the material to be heated.

The rate of heating is proportional to certain electrical characteristics of the material called the loss factor, the frequency, and the square of the applied voltage. To achieve rapid heating requires frequencies in the megacycle or millions-of-cycles-per-second range because the voltages must be held below certain limits to prevent breakdown or flashover of the material being heated.

This form of heating is a revolutionary departure from most previous methods. No longer is it necessary to apply heat to the outside of solid materials and wait for the heat to flow into the material, which generally has a low thermal conductivity. With radio frequencies, heat energy is established within the material itself by friction between molecules stressed by the swiftly alternating voltage. The heat is therefore generated in each particle of the mass, and no actual transfer of heat between two points is necessary.

By
T. P. KINN
and
R. E. KIRBY
Westinghouse Electric Corporation

Types of R-F Gluing

To apply radio-frequency heating to wood bonding with resin glues, it is necessary only to locate the electrodes strategically so that the power is delivered to the desired section. This has led to the application of power by three techniques:

In *through-heating*, illustrated in Fig. 1 (a), the glue lines are parallel to the electrodes and the dielectric mass heats uniformly. This method, most widely used, is applied to mould laminated plywood sections, to form plywood, to glue some types of panels and doors, to glue special assemblies, and to remove moisture from wood.

In *edge-gluing*, Fig. 1 (b), the glue lines are perpendicular to the electrodes. The large difference in

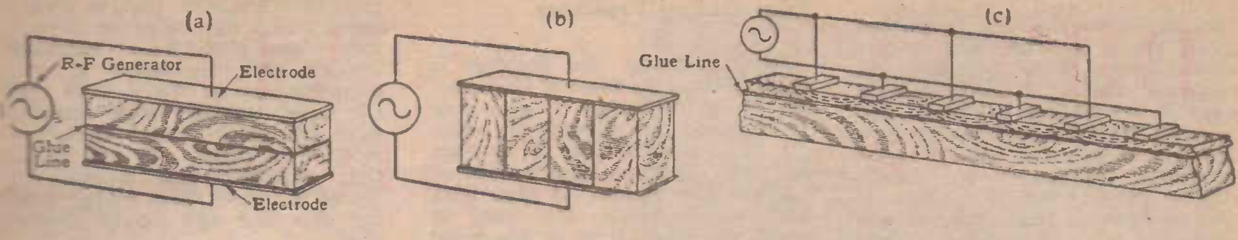

Fig. 1. Arrangement of electrodes for (a) through-type r-f heating, (b) glue-line r-f heating, and (c) stray-field, r-f heating.

effective conductivity between the wood and the glue line causes most of the power to be absorbed by the glue lines. This method is used for assembly gluing, core and open-face stock production, lamination of narrow glue-line assemblies, and veneer splicing. In general, it is faster than through-heating because heat is generated directly in the glue line.

Stray-field heating, Fig. 1 (c) utilizes the fringing or stray field between adjacent electrodes and is used for heating inaccessible joints where edge-gluing is not possible and where through-heating is not economical. It is used for patching of damaged or knot-hole sections in plywood, some assembly work, and for laminating outsides of thick assemblies.

Types of Glues

Resin glues, which have been found to be the most satisfactory for radio-frequency gluing, fall into three general classifications: phenolic, resorcinol, and urea. Joints made with phenolic glues are the strongest and most durable, and can stand alternate soaking in water and drying and continuous boiling in water without appreciable loss of strength.

They are not affected by fungi, bacteria, most chemicals, or by heat even beyond the charring point of wood. They usually require a high-setting temperature. They are not normally used in edge-gluing techniques, but are generally confined to special applications such as exterior-grade plywood and exposed parts of boats or airplanes.

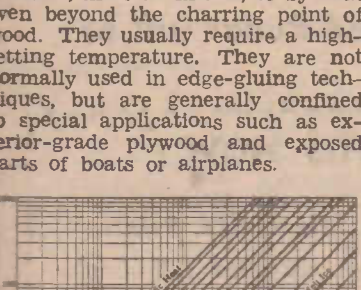

Fig. 2. R-f generator rating for dielectric-heating applications.

Resorcinal glues have the same heat — chemical — and moisture-resistance properties of the phenolics without the high-temperature disadvantage. They set at room temperature and curing is accelerated by radio-frequency heating. They are a fairly recent product and their cost is relatively high compared to the other types.

The most satisfactory glues for general purposes are the urea glues. These glues have water and moisture resistance far in excess of the animal-type glues, but not as good as the phenolics and resorcinals. They are satisfactory for all indoor uses regardless of ambient temperatures and extreme changes in temperature and humidity. Urea glues are available for setting at high or at room temperature.

Low temperature glues, where setting can be accelerated by heat, are preferable for use with radio-frequency heating. As an example of the acceleration, at room temperatures some ureas require six to eight hours to set, but at 200 degrees F., only twenty seconds.

Advantages of R-F Gluing

The combination of the radio-frequency generator and the resin glues provides the industry with the proper tools for production at a high level. A uniform, high-quality product results because automatic processing can be used. The moisture content of the wood is not affected because moisture is neither added nor removed. Because the panels or assemblies are ready for immediate further use after the heating, storage space ordinarily required for time setting is eliminated. In many applications the brute strength and physical labor of operating hand clamps are eliminated and the productivity per man-hour is greatly increased.

This process permits maximum utilization of materials in the face of diminishing supplies of virgin timber, since panels of any width can be readily built up from boards of random width, providing a strong, finished stock with low-cost materials. Stacking of stock on separators to remove moisture from glue is eliminated, since no air flow is necessary after the radio-frequency treatment. Tongue-and-groove joints are unnecessary because a resin-glued joint is stronger than the wood itself.

In assembly work, pins, nails, and fasteners are eliminated, and, with them, the attendant problem of rendering them invisible. In moulding curved sections, the costly steam or electrically heated dies are not needed, only wooden dies with thin metal faces to act as electrodes. The working conditions are clean and cool, since production line techniques are used, and the curing process gives off no external heat. This is high-speed production at low operating cost, producing a stronger and more uniform product.

Application of R-F Gluing

To analyse a radio-frequency heating application for time and power requirements, it is first necessary to determine the type of heating to be used. In through-heating the time and power requirements are calculated as in any heating problem:

$$T = \frac{0.0176 \times M \times c \times (T2 - T1)}{Kw.}$$

where T equals time, minutes.
- M equals Mass to be heated, pounds.
- c equals specific heat of mass.
- T2 equals glue setting temperature, degrees F.
- T1 equals initial temperature of mass, degrees F.
- Kw equals kilowatts of power into mass.

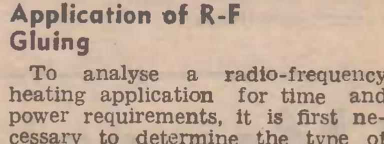

Fig. 3. Electrode arrangements for various types of joints encountered in assembly glueing. Production rates vary depending on the efficiency of electrode location; for estimating, 100 square inches per kw. per minute can be assumed for generator power requirements. A minimum heating time of 20 seconds should be used to insure proper curing of the glue.

Curves calculated from this equation for different specific heats are given in fig. 2. For wood of approximately 6 to 10 per cent. of moisture, which is normal, specific heat of 0.4 should be used. For example, if a 50 pound load of plywood is to be cured with a 10-kw generator, the pounds per minute deg. F. rise, by fig. 2, is 1400. If the glue used is fast setting, it will require a final temperature of 180 deg. F., so the rise is from room temperature (80 deg. F.) to 180 deg. F., or 100 degrees.

$$\text{Pounds per minute} \times \text{degrees F. rise} = 1400$$

$$\text{Pounds per minute} = \frac{1400}{100} = 14$$

It will require, therefore, 50/14 = 3.57 minutes (3 minutes and 34 seconds) heating time. If the amount of glue used is more than 10 per cent. of the total mass, it should be calculated as additional water.

The moisture content of the wood should always be calculated separately if the final temperature will exceed the boiling point of water. In wood-drying calculation, the conversion of water to steam represents the major portion of the power requirements.

Edge-Gluing Problems

In edge-gluing, the problem is calculated on the basis of the number of square inches of glue area to be cured per kilowatt per minute. This basic number varies from 35 to 750, depending on a number of factors: the number of glue lines per inch of width, the kind of wood, the preparation of the wood joint, the type of electrodes, the pressure, the type of glue, and the amount of glue used.

As the glue lines per inch of width increase, the square inches of glue line cured per kilowatt per minute increases, because less wood area is exposed per unit length of glue line and less power is lost to the wood; this reaches an extreme when thin veneers are bonded to form laminations, as in the manufacture of tennis rackets.

The denser the wood, the more power it absorbs and diverts from the glue line. More area of glue line is cured per kilowatt per minute when soft woods are glued.

The quality of the preparation of the joint, the pressure, and the amount of glue used are interdependent. Smooth, parallel board edges permit the use of lower pressure, less glue and eliminate stresses that necessitate a more complete cure of the glue to hold the panel together when removed from the press. These techniques result in a higher rate of production. Excessive glue squeeze out causes a loss of heat energy from the glue line and lowers production.

Effect Of Electrodes

The rate of heating is affected by the type of electrodes. With flat plate electrodes as in figure 1 (b) the glue line is heated uniformly. An electrode arrangement widely used is a staggered arrangement of bars, as shown in figure 4, which gives a zig-zag cure pattern, if the panel remains stationary while being heated. The area cured is from one-third to one-half of the total glue-line area with the remainder curing from the residual heat in the adjacent sections of the glue-line a short time after removal from the radio-frequency field. The bond is sufficiently strong to withstand immediate, subsequent operations, such as sawing or planing.

Other factors, such as the length of time the glue has been mixed and ambient temperature, have only a small effect on the heating rate. For the purposes of estimation, when using the staggered-grid electrode urea formaldehyde glue that cures at room temperature, and well prepared boards with an average width of three inches, the rate of heating for soft wood can be taken as 250 square inches of glue line per KW per minute. For hardwood the figure is about 125.

The continuous type of r-f heating press which makes wide boards from narrow slats.

Types of Applications

The ways in which r-f heating can be applied to setting of glue in woodwork operations have already become numerous. Its use in assembling complicated and curved products, replacing the conventional fastenings, is shown in the illustrations.

The formation of panels from narrow boards has developed further than any other r-f application, largely because it was one of the first problems attacked. Today press-generator combinations that require small floor space are easy to operate, and speed production from three to five times over the old glue reel or hand-clamp systems.

Basically, there are two types of presses, *batch* and *continuous*. The batch-type press is operated by pushing the pre-cut panels into the press where, automatically, side pressure and top pressure are applied. The r-f generator is turned on at the right moment, also automatically, and is turned off at the end of the curing cycle by a process timer.

The glues panel is then removed and a fresh panel started through the cycle. Production rates on these presses run up to 15,000 board-feet of softwood panels per eight-hour day and up to 10,000 board-feet of hardwood, where the average board width is three inches.

Press Adjustments

These presses are equipped with adjustments for side and top pressure so that many different types of stock can be handled. The largest standard-size press accommodates panels up to 50 by 100 inches, but special presses for larger sizes have been built. Most presses are equipped with 10-kw generators which permit heating times from 20 to 40 seconds.

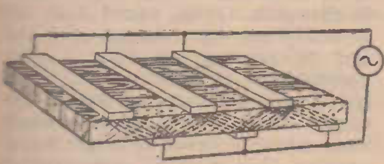

Fig. 4. Staggered arrangement of electrodes produces zig-zag glue cure pattern for partial curing of glue-line area. Area cured immediately is approximately one-third of total glue-line area, providing sufficient strength for subsequent operations.

With previous equipment the time was four to eight hours. Time for loading and unloading requires about one-fourth of the complete cycle. The generator is operating, therefore, about three-fourths of the time, or on a 75 per cent. duty cycle.

Continuous-type presses have a 100 per cent. duty cycle for the generator, and are capable of turning out an average of up to 20,000 board-feet of panels per eight-hour day. The stock is fed on to clamp carriers which exert side pressure as well as carry the panel through the press. Top pressure rolls are located at the feed end and apply the proper pressure to produce flat panels.

After leaving the top pressure rolls, the panel passes under the electrode where the heating of the glue line occurs. Due to the movement of the wood, the high-voltage electrode is separated from the top of the panel by a small air gap. This has no effect in the efficiency of the heating operation. These presses can be easily adjusted to handle panels up to 8 inches wide and from 2½ inches thick. The lineal speed can be varied from 4 to 30 feet per minute.

This type of press is more complex and hence more expensive than the batch type. However, because of the continuous flow of panels and the 100 per cent. duty cycle for the generator, production is higher.

Edge-gluing techniques can be used where the width of the glue-line, or the maximum path between electrodes, is less than six inches. Examples are tennis rackets, skis, golf-club heads, and wooden beams. For example, formerly individual hand-tightened clamps and forming blocks were used for each tennis racket. Glue was cured by placing these clamped assemblies in hot ovens for three hours at 200 deg. F.

Multi-Unit Operation

By adapting the press for heating by a 5-kw r-f generator, four rackets can be cured in about 45 seconds. Comparison of rackets produced by the old and new method showed several interesting things. The natural stress in the r-f cured racket opposes the stress imposed by the stringing of the frame, while the old method leaves the racket with stresses additive to those of the subsequent stringing operation. Bounce tests, used to test resiliency, show that r-f cured rackets are two to three times better.

Furthermore, because the results are so uniform, r-f cured rackets can be processed in subsequent operations by automatic equipment not possible with oven-cured rackets. Hence, r-f heating has not only increased the quantity but has also improved the quality.

Bonding of plywood offers an example of through-heating by the use of radio frequencies. The usual method is to build up a sandwich of plywood panels on both sides of a central high-voltage electrode. The top and bottom platens of the press act as the ground electrodes. Since heat is not being forced from the outside into the centre, many panels can be stacked for one press load.

The finished product is uniform in moisture content, because the

(Continued on page 46.)

RADIO ASTRONOMY

Astronomical observations during recent years have been restricted to only a small section of the total frequency band. It now seems certain that the observations will be extended to other wavelengths to augment the present information.

Until the last few astronomical observations have been restricted to a very narrow band of wavelengths near the visual region of the electromagnetic spectrum. The wavelengths which have been explored occupy only about four octaves of the total band of forty octaves for which measuring techniques are available.

Whilst these observations have supplied an immense amount of information on the structure of the sun and other heavenly bodies, it seems certain that an extension of observations to other wavelengths would release a new store of information.

Unfortunately, unless observations are carried out with apparatus carried in high-altitude rockets it is only possible to make use of those wavelengths which can penetrate the earth's atmosphere.

"Windows" In Atmosphere

The atmosphere presents a surprisingly opaque barrier, and over the whole range of usable wavelengths there are few *"windows"* in which the absorption is sufficiently small: one *"window"* covers the visual and near-visual wavelengths; another extends from about 1 cm. to 10 metres (above which the ionosphere reflects the incoming radiation). It can be seen that the long-wave or "radio" window covers nearly 10 octaves, and in the last few years the opportunity of extending astronomical observations to this band of wavelengths has been taken by several groups of workers.

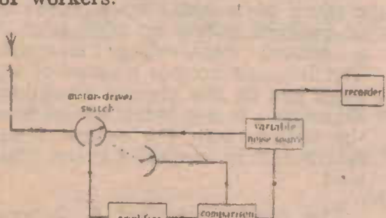

Fig. 1. System used for the measurement of small radio-frequency powers.

In particular it should be possible to examine the outer layers of the solar atmosphere, where many phenomena of great interest may have their origin; the emission of corpuscular streams and the intense ultra-violet radiation which give rise to magnetic storms and radio "fade-outs," the structure of sunspots and the support of the solar corona are some of the unsolved problems of the solar atmosphere. It is also likely that radio wavelengths will be sensitive to relatively weak magnetic fields, and by examining the polarisation of the radiation emitted or absorbed by such regions it might be possible to investigate magnetic fields which are too weak for observation of the Zeeman shift.

On the other hand observations at radio wavelengths are restricted by the impossibility of achieving a resolving power comparable with even the smallest of telescopes, and many experiments which are simple at visual wavelengths will not be practicable. As a result of this limitation, the most interesting results which have been obtained so far have been concerned with the sun, for which a resolving power capable of selecting an individual star is not required.

by

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Cambridge.

Before considering the experimental difficulties of making observations in the *"radio window"* it is interesting to consider what information is likely to be obtained from such observations. The most significant difference between these long waves and the visual waves is their much greater absorption by low-density ionised gases; this high absorption should make it possible to observe regions which are too diffuse for visual observation.

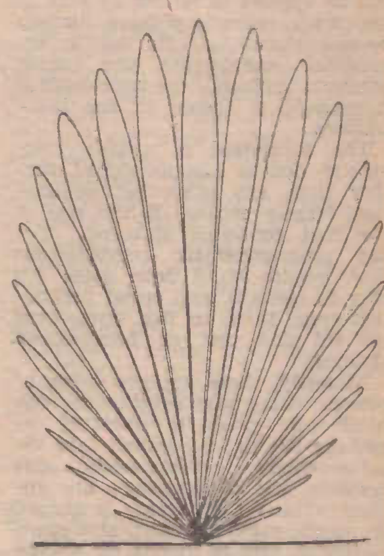


Fig. 2. Interference pattern produced by two aerials separated by 10 wavelengths.

The First Observation In The Radio Window

In spite of the theoretical possibility of obtaining completely new astronomical information by exploring with wavelengths between 1 cm. and 10 metres, it is doubtful if any great interest would have been shown if Jansky (1932) had not found that the intensity of long-wave radiation from the Milky Way was very much greater than was expected theoretically.

More recently, observations of solar radiation have been made; Southworth (1945) found that the intensity on wavelengths of 3 cm. and 10 cm. agreed with a solar temperature of 20,000°K (as compared with the value of 6000°K obtained from visual observations). Measurements made at longer wavelengths (1-5 metres) showed that under normal conditions no radiation could be detected, but that during the passage of large sunspots across the solar disc very intense radiation was emitted. Appleton (1945) showed that on such oc-

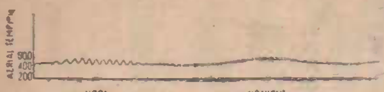


Fig. 3. 24-hour record of 1.7 metre radiation.

casions the sun was radiating as if it had a surface temperature of between 10^8 and 10^9 degrees K.

The Experimental Difficulties Of Observing Solar Radiation At Radio Wavelengths

Whilst observation of the intense radiation associated with sunspots can be made with relatively simple receiving apparatus, the detection of the radiation under normal conditions is difficult on the long wavelengths of 1-5 metres, because the sun occupies such a small fraction of the total solid angle over which the receiving aerial is sensitive (about 1/10,000 for aerials of reasonable size). As a result the power which is available from the aerial is extremely small, and may only be a small percentage of the random noise signals which are generated in the input circuit of the receiver. The measurement of the small additional random signal requires a special type of receiving apparatus.

A system has been developed in which the input of the receiver is switched alternately from the aerial to a local source of random noise. By comparing the output of the receiver in the two positive positions it is possible to determine whether the aerial power or the power from the noise source is the greater, but in order to reduce the random fluctuations in the result it is necessary to take a very large number of such comparison readings (about a million).

Use Of Wide Band Receiver

By using a receiver of wide bandwidth, it is possible to complete this number of observations in less than 1 second. The result obtained by this process is then used to correct automatically the output of the local source of noise until it is exactly equal to the aerial power. By this *"null"* method the receiver is only used as an indicator of balance, and variations of its gain or internal noise do not cause errors in the final adjustment.

The output reading of the local source of noise then provides a measure of the aerial power, and may be used to operate a recording milliammeter. A diagram of the system is shown in Fig. 1.

The next problem is to separate the solar radiation from the radiation due to the galaxy since, except at times of great solar activity, the signal induced in a simple aerial by the galactic radiation at wavelengths of 1-5 metres is greater than that due to the sun. An increase of the directivity of the aerial would enable better discrimination but would limit the time during which observations could be made, unless provision were made for rotating the very large aerial structure throughout the day.

Alternative System

An alternative system has therefore been devised which uses two aerials of low directivity separated by 10 wavelengths. Such an arrangement produces the interference pattern shown in Fig. 2, having minima separated by about 6°. When a source, such as the sun, which subtends a small angle, moves across this interference pattern, the power received varies in a periodic manner from nearly zero up to twice that obtained from a single aerial.

On the other hand, a source subtending a large angle, such as the galaxy, gives rise to a relatively constant power. The solar contribution then appears on the trace as a periodically varying signal whose amplitude may be determined accurately even when it is smaller than the galactic component.

The Results Obtained On Wavelengths Of 1.7 and 3.8 Metres

Making use of the methods described in the previous section, measurements of solar radiation have been made on wavelengths of 1.7 to 3.8 metres. Fig. 3 shows a typical 24-hour record obtained on 1.7 metres, at a time of low solar activity.

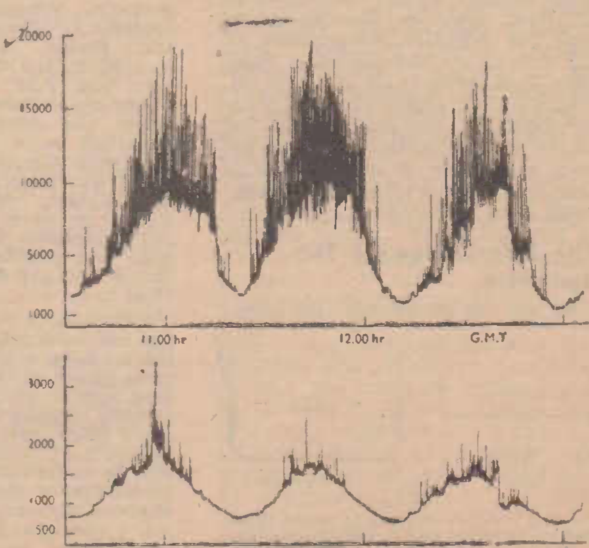
The periodic variation due to solar radiation can be seen superimposed on the slowly varying galactic background. (The two broad maxima at 11.00 and midnight occurred when the aerial system was directed into the plane of the Milky Way.) Fig. 4 shows part of a record obtained on both wavelengths during a period of increased solar activity.

The short "bursts" of radiation—which only last for 1-20 seconds—are characteristic of the increased intensity associated with sunspots. There is apparently no correlation between the times of occurrence of these bursts on the two wavelengths

At times there are sudden large increases of intensity (of up to 100 times) which may last for many minutes. Large disturbances of this type are usually observed on both wavelengths and they often coincide with solar flares and short-wave radio fade-outs.

The day-to-day variation of intensity over the year 1947 has been plotted in Fig. 5. The intensities are given in terms of the equivalent temperature of a "black body" radiator subtending the same solid angle as the sun. It can thus be seen that at 3.8 metres the sun radiates as if it had a surface temperature which never fell below about a million degrees, and sometimes exceeded 5 x 10^8 °K. At 1.7 metres, the equivalent temperatures were slightly less, but at times reached nearly 10^8 °K.

Fig. 4. Part of record showing "sunspot radiation."



The Measurement Of Source Diameter

From a theoretical point of view it is clearly of great importance to find the maximum equivalent temperatures for the sources of the radiation. It has so far been assumed that the radiation is emitted uniformly from the whole of the solar disc; if the radiation is emitted from a smaller area, the equivalent temperature in the source region must be correspondingly higher.

In July, 1946, the solar radiation became, for a short time, unusually intense, and the opportunity was taken to measure the diameter of the source of the 1.7 metre radiation. The method adopted was an extension of the spaced-aerial system used for eliminating the galactic radiation. By increasing the spacing of the aerials, the angular separation of the minima can be progressively decreased, and when the separation becomes comparable with the angular diameter of the source, the received power no longer falls to zero at the minima. By measuring the maximum to minimum ratio for a number of different spacings, the effective diameter of the source can be determined. The arrangement is shown in Fig. 6.

Methods Of Determining Stellar Diameters

The method is analogous to Michelson's method for determining stellar diameters, the spaced aerials taking the place of the spaced mirrors, and the observed values of maximum to minimum power corresponding to the "visibility" of the optical fringes. Spacings of 25, 90 and 140 wavelengths were used, and the results indicated that the diameter on this occasion was less than 10 minutes of arc, a diameter not much greater than that of the large sunspot which was visible at the time. Such a diameter means that the effective temperature of the source on this occasion must have been between 10^9 and 10^{10} °K. Owing to limitations of space, measurements of the diameter of the source at 3.8 metres have not yet been made, but it seems probable that even higher effective temperatures must be involved.

The Polarisation Of The Radiation

As well as measuring the intensity of the radiation, frequent observations of the polarisation have been made, and it has been found that on nearly all occasions of great intensity the polarisation is circular. The sense of the polarisation is different for different active regions, and at times of lesser activity the polarisation is incomplete and sometimes appears completely random. This may be due to radiation from two or more regions having polarisation of opposite sense, or it may be due to a permanent randomly-polarised component associated with the undisturbed sun.

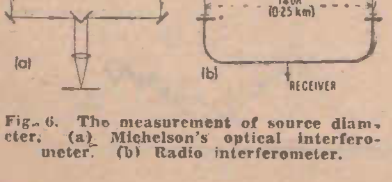


Fig. 6. The measurement of source diameter. (a) Michelson's optical interferometer. (b) Radio interferometer.

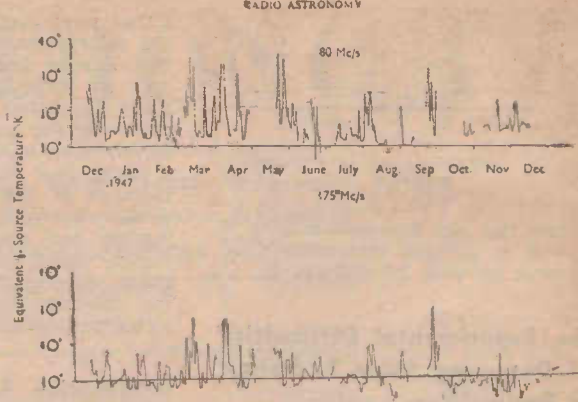


Fig. 5. Day-to-day variation of solar radiation on 3.8 metres (80 Mc) and 1.7 (175 Mc).

Future Developments

The results obtained have already shown that an extension of astronomical observations to radio wavelengths is likely to provide much new information. Observations of solar radiation have demonstrated the existence of quite unforeseen conditions in the solar atmosphere, and it is to be hoped that further work will help to provide the solution to the processes involved. It is also possible that more refined measurements of the polarisation of the radiation may assist in the determination of the permanent magnetic field of the sun.

The development of more precise methods for the study of galactic radiation may open new fields of great significance to theoretical astrophysics, although the experimental problems are likely to be considerable.

NEW FREQUENCY MODULATION AND RADAR COURSES

In accordance with the recently-amended P.M.G. Syllabus for the Commercial and Broadcast Operators' Certificates, the Marconi School of Wireless announce that the subjects of Frequency Modulation and Radar have now been added to their curriculum.

The Wireless Branch, P.M.G's Department, recently advised that the subjects of Frequency Modulation and Radar were to be incorporated in the Commercial Certificates and F.M. in the Broadcast Operators Certificate. In the initial stages, the questions on these subjects will be of an elementary nature, with the standard being progressively raised each year until March, 1951, when the questions will be in direct relation to standard equipment as found on board Ship and Aircraft (Radar) and in the Mobile and Entertainment Field (F.M.).

Although to date, no official ruling has been made as to the effect these changes will have on certificates issued prior to March, 1949, it does appear obvious that personnel seeking employment in either of these fields, even though in possession of a First Class Certificate, will still be required to have a working knowledge of the general principles of these subjects. In view of the proposed changes, the Marconi School has decided to introduce personal classes for both of these subjects as from July, 1949.

Both the new courses have been prepared by experts on the subjects and are presented in a simplified form. Mathematics have been kept down to an absolute minimum, and in each case the subject matter contained therein is not in relation to any specific type of equipment, but to the general principles and practices of each category.

For the time being the new classes are being treated as postgraduate classes, and designed mainly for personnel who are actively engaged in the radio industry, and who can produce sufficient evidence of this, either by examination or the production of a certificate that will be eligible for entry to such classes.

Technicians, and present holders of the above-mentioned P.M.G. Certificates who are desirous of undertaking these courses, can obtain further particulars by writing or calling at the Marconi School of Wireless, 47 York St., Sydney.

ATOMIC ENERGY

INDUSTRIAL ENGINEERING PROBLEMS

The jump from the realisation of the atomic bomb to the idea of commercial use of fission energy is easy. But ahead of the actual accomplishment lies a vast, tangled, little known jungle of problems. Some were suggested in the Smyth report, others were little anticipated. As we come closer to them, all become more formidable than was earlier believed. Confidence in the eventual outcome has not changd, but the concept of the size of the job definitely has.

No one questions that it is technically possible to achieve the controlled release of atomic energy in a form that can be converted into heat or electricity. However, before this is actually an accomplished fact there is a great amount of work to be done. This work falls into two general classifications: namely, research and engineering development.

At present there is under way in this country a research programme, co-ordinated and directed by the Atomic Energy Commission, which, as time goes on, will uncover fundamental knowledge of this new science that is essential before industrial applications of atomic energy are practical. Undoubtedly, therefore, as the store of available knowledge increases there will come a time when answers to the many questions relating to practicality of atomic energy in industry can be determined with reasonable certainty.

That the application of atomic energy in industry will eventually be proved practical is assumed. What then are the engineering problems that must be solved before the first practical electric power generating station can be built?

Chain-Reaction

The method by which a chain-reacting pile or nuclear-reactor operates has been discussed. It is known, for example, that when a *neutron*, whose kinetic energy lies within a certain range, strikes the nucleus of a uranium-235 atom in such a way as to be absorbed, fission of the U-235 atom results. Products of that fission are two elements each of substantially lower atomic weight, gamma-ray radiation, the discharge of one to three neutrons, and the release of extremely large amounts of energy. Further, some of the neutrons released eventually strike the nuclei of other U-235 atoms, whereupon the process is repeated, i.e., a chain-reaction is established.

However, the chances of a neutron striking the nucleus of another atom of U-235 are subject to several factors. Obviously other kinds of atoms are present in a reactor. For example, there are those of the reactor coolant or heat-transfer medium, the structural material and surrounding shielding, those of the many control elements and devices essential to the operation of the reactor, as well as atoms of the many other elements that are the products of previous fission of U-235 atoms.

By
Dr. J. A. HUTCHESON
Associate Director, Westinghouse Research Laboratories

A few materials are partially *"transparent"* to neutrons. In some, such as carbon, absorption of a neutron is relatively unlikely. A neutron that enters such a material may collide with atoms of the material and be slowed up or lose part of its energy as a result, but in general it does not combine with these atoms and therefore is not absorbed. Again, the chances of absorption of a neutron depend in a complex way on the energy of the neutron. For example, it is much more likely that a neutron possessing an energy of a few tenths of an electron-volt will be absorbed by the nucleus of a U-235 atom with resultant fission than a neutron of a few hundred or more electron-volts energy.

Absorption Effects of Materials

These facts were employed in designing the reactors at Hanford, Washington. In these reactors the fission-produced neutrons released with high energy are slowed down by collisions with atoms of carbon in the moderator to the point that the average energy of the neutrons that re-enters the U-235 is most favorable to their absorption.

Most materials investigated show a marked tendency to absorb neutrons, a characteristic that disqualifies them for structural uses in reactors. This is dramatically demonstrated by the use of cadmium in control devices. Cadmium has such an affinity for neutrons that a very small amount stops completely the operation of a reactor. Cadmium absorbs enough neutrons to reduce the ratio of the number of neutrons available for fission, to the number of fissions required to maintain operation to less than one.

When this occurs action ceases, since a single neutron can produce but one fission. Obviously such a material is useless as a structural material in a reactor. Unfortunately, the same is true of the common structural materials such as steel. This also explains why the materials must be of unusually high purity. The existence of impurities to the extent of a few parts per million in materials in which neutron absorption is relatively low makes these materials unsuitable for use in a reactor.

Similarly the fact that the fission

products act as neutron absorbers explains the necessity for removal of these products from time to time during continued operation of a reactor. As more and more of these products are formed, an increasing percentage of the available neutrons is absorbed. This requires a reduction in the amount of control material in the reactor.

Ultimately there comes a time when this process cannot be continued, i.e., when all of the control material has been removed. Unless means are provided to remove *"poisoned"* charges during operation, the reactor must thereupon be shut down and the fuel charge replaced. In any power-generating application it seems essential, or at least highly desirable, that continuous operation be possible.

From considerations such as the foregoing, one type of engineering problem appears. Once complete information is obtained as to the neutron-absorption characteristics of materials it, will then be necessary to obtain the structural characteristics of those that appear applicable in reactors. This is an engineering problem that can and will be handled by engineers.

High Temperature Operation

Another element that will require engineering consideration arises from the fact that the reactor will in all probability be required to operate at high temperatures, where heat engines are more efficient. This requirement creates additional problems for the engineer. For example, questions will arise as to the corrosion of materials subjected to high temperatures. Probably data must yet be obtained relative to the corrosive effect of various gases or liquids used as coolants or heat transfer media in contact with materials suitable for use within a reactor. These are typically engineering problems.

The high temperatures expected in power reactors introduce additional unknowns that must be determined prior to practical use. The mechanical properties, particularly at high temperatures, of those materials that now appear practical for use in construction of a reactor are largely unknown. Acquisition of the required data is possible by well-known methods but the job is lengthy.

Radiation Problems

Radiations incident to the process of nuclear fission pose a large number of new problems for the engineer. The need for adequate shielding for operating personnel has been mentioned many times. This problem is more complex, however, than may be first realised.

Consider, for example, the probable electric-power generating system. Heat generated in the reactor is transferred by a suitable gas to a heat exchanger in which water is boiled to produce steam for use with a conventional turbine generator. The possibility of leaks through which radioactive material might pass poses a serious problem. At first glance it might be assumed that the only radiation problem is that concerned with the reactor. However, this is not the case.

Radioactive Substances

The gas coolant itself may become radioactive and in addition probably would gather other radioactive substances such as dust from the reactor. Presumably the heat-transfer unit in which steam is formed is such as to prevent transfer of radioactivity to the steam by direct radiations. However, a leak would permit radioactive material to contaminate the steam. Depending on the magnitude of this effect, it might be necessary to shield the turbine and piping also. Obviously, this is undesirable, therefore much engineering effort would be expended in assuring the absence of leaks.

Continuous operation of a nuclear power-generating equipment is desirable if not essential. This means that the *"fuel"* must be replaced at intervals during operation. Because of the intense radiation with the reactor, extraction of the *'ash"* laden nuclear fuel can be accomplished only by remote control. The detail problems connected with the mechanical design of such devices are determined by the particular requirements of the reactor with which they would be associated.

Trouble-Free Operation Necessary

However, several general types of problems arise. Presumably the fuel will be distributed throughout the reactor, therefore the device must be so designed as to permit selection, removal, and replacement of fuel elements in any section. The device itself will be continuously bombarded by radiations so that it in turn becomes radioactive. This suggests the impracticability of servicing the device once it has been placed in operation. Trouble-free operation will require extreme care in design.

Factors such as the effect of radiation on lubricants are at present unknown. These must be determined prior to the use of lubricants with the equipment. Also, assuming that it will be found desirable to have electrical elements in the fuel-handling equipment their reaction to radiations must be fully explored. For example, it would be fatal to use equipment in which the electrical insulation deteriorates under long-continued radiation bombardment to the point of failure.

Another matter is important, although little has been said regarding it. For many years radiations such as X-rays have been known to affect the properties of certain materials. For example, crystals of potassium chloride change color under X-ray bombardment but return to normal upon removal of the radiations.

Radiations within a nuclear reactor are many times more intense than any previously available. The possible effect of such radiations upon the crystal lattice of materials used in a reactor when exposed continually for long periods is yet to be determined. It is likely that the properties of materials will be altered sufficiently to bear on their suitability for use in a nuclear-energy reactor. This problem, if indeed there be one, rests squarely today in the hands of the research worker.

Future Possibilities

The foregoing has touched on some of the problems that become apparent when one considers the application of atomic energy to generation of electric power. Many will require additional knowledge, to be obtained by fundamental research work, before the engineer is able to tackle the design problems to be expected.

The speed with which these and other problems are solved depends, obviously, in large measure on the number of men that can be applied to the work. Most of the fundamental work will have to be done by nuclear physicists and chemists working in government and industrial research laboratories. However, as these men progress with their work many problems will arise that can be turned over to engineers and scientists not necessarily specialists in the field of nuclear physics.

Members of the Atomic Energy Commission have recently stated their realisation of this possibility and propose to take advantage of it. This is indeed encouraging. If the limited pool of nuclear physicists and chemists now available had to do all the work necessary for the practical application of nuclear energy in the electric power field, many years would pass before

(Continued on page 47)

A TECHNICAL SURVEY OF LATEST OVERSEAS DEVELOPMENTS

NEW 45 r.p.m. REPRODUCING SYSTEM

Latest addition to the record field is a 45 r.p.m. system developed by R.C.A., and which may become a standard for future recordings.

Engineers who have examined this equipment report the discs to be approximately seven inches in diameter with a two-inch central hole from which the disc itself extends. Thus when stacked, the playing surfaces of the records do not come into contact, so there can be no injury through scratching.

In addition, this type of "doughnut" construction is said to greatly facilitate the operation of a simplified mechanical changer which can be manufactured at a cost of about one half that of the present record changer types. High fidelity is claimed for the records that are microgroove recorded and which promise to cost less than either the 78 or 33. 1-3 rpm types now in use.

A considerable difference of opinion exists over the launching of this reproducing system. Some set manufacturers are protesting that the use of still another speed will result in the utmost confusion at retail level, and with others indicating that they will bring out equipment to play the "doughnut" discs on sets within a few months.

In the event that new instruments incorporate facilities for all three systems, it is likely that some of the players will have two compartments, one to play both the conventional and the L.P. discs and the other for 45 rpm equipment.

Reports also indicate that a single turntable speed changing mechanism is being considered to enable owners of 78 or 33 1-3 rpm players to adapt their equipments to the new system. This would be quite possible through the addition of a superimposed turntable with a planetary gearing link between its large central hole and the original centre pin.

Some Disadvantages

This conversion may, however, also necessitate changes in pickups since needle pressures and stylus diameters will vary from system to system. Users of this new system will also confront a new record storage problem and possibly experience record warpage trouble since the doughnut design appears to lend itself to "cold-flow dishing" effects.

In reviewing the available data on this new reproducing system it appears that it may eventually replace the conventional 78 rpm records and equipment because of reduced costs and because, even though the microgroove system of recording is employed, the design appears to have been aimed only at getting a playing time equivalent to present records.

The latter point is important when it is realised that the vast majority of records sold last year were of the popular variety. It follows that the 33 1-3 rpm long playing record will still retain a place in the home, and in other services requiring fine quality from records that do not have to be changed every few minutes.

Courtesy—Tele-Tech.

Determining Nuclear Threshold Voltages

Although scientists have produced an atom bomb, have done years of research on the atom and its structure and behavior, the surface of atomic research has hardly been scratched. The reactions that occur in many given instances are known, but as yet their causes, or for that matter, even the true nature of the reactions is not apparent. Years and years of careful investigations lie ahead before highly accurate results and figures will be available to all researchers.

One investigation now being pursued is the accurate determination of the threshold voltages of elements—i.e., the voltage at which artificial radioactive transformations commence in a nuclear reaction. For some nuclear materials this is a sharply defined point. The location of these threshold points is important to the scientist in that they can be used to aid in determining the masses of elements, and in similar experiments energy levels may be determined.

New Methods

Nuclear voltage thresholds have been measured before, but not to the high degree of accuracy that scientists require. The procedure used in the new method developed by the Westinghouse Research Laboratories gives a heretofore unobtainable preciseness. The equipment used consists of a 70-megacycle resonant tube, through which the ion stream from a Van de Graaff generator is fed. Inside the tube is a second and smaller tube, arranged such that the ends of the two tubes form sets of parallel plates. The intensity-modulated ion beam produces an r-f voltage in each gap by induction. A probe is inserted in the side of the outer tube and connected to a receiver and instruments.

When the two gap voltages are 180 degrees out of phase a minimum receiver signal results. At these points the voltage can be calculated from known values and instrument readings by a relatively simple formula.

A scientist, using this device, can watch for the first release of neutrons in the nuclear reaction, then note the meter reading, and calculate the threshold voltage. Already determined to an extremely accurate degree is the threshold voltage of lithium—1.882 megavolts. In the near future many other thresholds will be determined by this precise method.

Investigations of such things as threshold voltage—although not glamorous or spectacular—are a very necessary part of the accurate determination of the construction and reactions of the various particles that make up the atom, and of the forces that bind them together.

Rocket Telemetering Equipment

A miniature telemetering system weighing only a few pounds and capable of continuously transmitting scientific information from a rocket roaring through space at nearly 3000 m.p.h. was recently tested at the White Sands Proving Grounds, New Mexico.

During this test flight and subsequent tests it radioed the ground recording instruments, motor performance, and missile aspect, data on cosmic ray intensity, the quality of sunlight above the atmospheric blanket and changes in strength of the earth's magnetic field. The system which utilises six radio channels, has been used to transmit 24 different kinds of information.

This is accomplished by converting the information to be telemetered into an audible tone of some frequency between 2000 and 13,000 cps. The receiving instrument converts these frequencies into graphs.

Television

Television tube production may soon be stepped up substantially as a result of new manufacturing techniques developed by the Pittsburgh Plate Glass Company. Older methods of moulding glass blanks to obtain spherical perfection have been replaced by a method whereby the meticulous grinding polishing operations are reduced to a standardised process which is completed while the glass is still flat. A newly developed bending process permits perfect sphericity. The new type face plates may be applied to glass and the alloy cones of the metal-type picture tubes soon to appear in television models.

Great Sporting Event

The great sporting event of 1948, the Olympic Games, was the scene of one of the largest broadcasting setups of the year. This involved eighty-five lines leading to the BBC house in London, fifty-two transmission circuits to the sites of the games, sixteen lines from the local studios, multiple intercom lines, etc.

In an intriguing report from Geneva the International Broadcasting Union has disclosed how the BBC operated this giant network from the Wembley Olympic Stadium, where were located listening booths for checking recordings, a record library, a room for correspondents of American and European stations, and thirty-six studio-type programme control desks.

Fifty-two reporting positions were provided in the stadium, with lip microphones and two pairs of headsets at each station. In the studios, of which there were eight, partially sound-proofed, there were ribbon microphones and dual turntables with vernier groove indicators. These studios could be transformed into auxiliary broadcasting sites through the use of lip mikes. Six trucks and twenty fixed positions were used for disc recording work. The fixed points were equipped with reproducing heads for checking records during recording. To enable reporters to listen to their recordings, eleven special playback booths were provided.

The room for the foreign and local correspondents, with provision for 150, was a novel one, with every convenience provided, including ten telephone booths, a special manual telephone board for international traffic, and outlets from the control desks of the stadium so that any broadcast could be audited.

Television, which played quite a role during the games, was covered extensively by BBC, with two mobile units each equipped with three cameras.

Courtesy—Radio and Television News.

WANTED . . . TECHNICAL ARTICLES

YOU can be an author, a man of distinction if you heed these words. As the policy of this magazine is to provide a coverage of the radio and electronic fields, articles of a suitable nature dealing with any phase of these topics will always be considered for publication in this journal.

All you need do is to write about 2000 to 2500 words dealing with some item of interest or describe equipment you may have constructed, and which should be of interest to our readers. Whilst we prefer double spaced typewritten copy, this is not absolutely essential providing your ideas are sound. Just send the copy along, and if necessary we will decipher your writing and rework it into readable English. Put in any sketches and diagrams required, and these will be drawn up by our own draughtsman.

All manuscripts should be forwarded to the Editor, Box 5047, G.P.O., Sydney, and payment will be made for all accepted material on publication.

NEW AID FOR THE BLIND

A recently-developed experimental reading aid for the blind can pronounce printed letters at the rate of 60 words per minute.

This new reading aid, at present only in the form of a laboratory model, is the result of intensive research sponsored by Government and private companies for aids to assist the blind. The device can convert printed letters into their individual spoken names as the scanning head moves over the page of printed matter.

Basic Units

The reading machine consists of three basic units, namely, the scanner, which looks at the printed letter, an electronic analyser or "brain," that determines which of the 26 letters it is, and an amplifier unit, which speaks the desired letter. In use the scanner, which consists of a miniature cathode ray tube, with eight flying spots of light that flash on and off 600 times per second, is moved across the text. Light from these spots is interrupted when the scanner passes over a letter. These interruptions are noted by a photoelectric cell, which passes the information on to the electronic analyser.

The eight spots of light are strung out vertically so that each spot picks up a different part of the letter. The top spot catches the end of letters like "l," the lower spots catch the ends of letters like "g," and the middle spots are arranged to pick up details like the crossbar of an "e." In this manner each letter causes different spots to be interrupted a different number of times, creating a characteristic signal for itself.

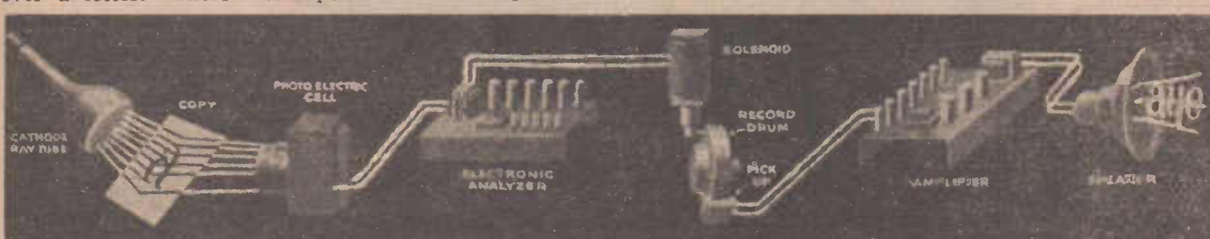
Analyser Section

The analyser section, which may be considered the "brain" of the unit, is an electronic computer similar to the machines used for complex scientific calculations. It counts the number of times each spot has been interrupted, thus identifying which letter the electric eye has seen, and tells the voice which letter to speak.

The photoelectric reading head which converts printed letters into their individual sounds. In addition to reading all 26 letters, thus spelling out any word, the new machine can read a few whole words.

The voice is 40 magnetic tape phonographs—one phonograph for every letter and word in the machine's vocabulary. The brain switches on the phonograph corresponding to the letter seen by the scanner. The phonograph speaks that letter and then switches itself off.

Much experimentation remains to be done with the device to determine the applications, which are suitable for use in institutions rather than in the home. One possibility is that it could be used as a master reading station to serve several persons reading different books. In addition to its use as a reading device, the principle can be extended to translation of coded patterns such as to teletype signals.



This diagram indicates the basic operations of the reading machine.The scanner passes over the letter, and reports its shape to the electronic "brain." This analyser identifies the letter and signals solenoid to play it aloud from voice recording. Courtesy P.S. Monthly.

Synthetic Mica

A synthetic mica with the desirable characteristics of natural mica is now being produced under a co-ordinated research programme in the U.S.A. Known as fluorine-phlogopite mica, the synthesis has the properties of perfect cleavage into thin sheets, good electrical and mechanical characteristics and chemical stability.

From developments to date it would appear that further research may reveal ways of directly fabricating mica components thus eliminating the time consuming and laborious tasks of sorting, grading, splitting and trimming natural mica. The production of this synthetic mica will now make the United States independent of foreign sources for this strategic mineral that is widely used in communications and electrical equipment.

Mind Functions as a CR Tube?

Something new in "communications" are electronic devices now being developed in several American laboratories to aid the blind to see. In general, each is making use of the radar principle whereby an instrument carried by a blind person will emit signals and register back in the form of a mild electric shock.

Science's goal is to train the mind to interpret electronic impulses into a picture pattern so that a blind person can identify objects in his mind and thus receive directional guidance, RCA has already developed a device which scans black letters and emits specific sounds which can be identified for reading purposes. To "televise" pictures or positions on a blind person's mind will be an achievement of the first order.

Magnetic Recording Standards

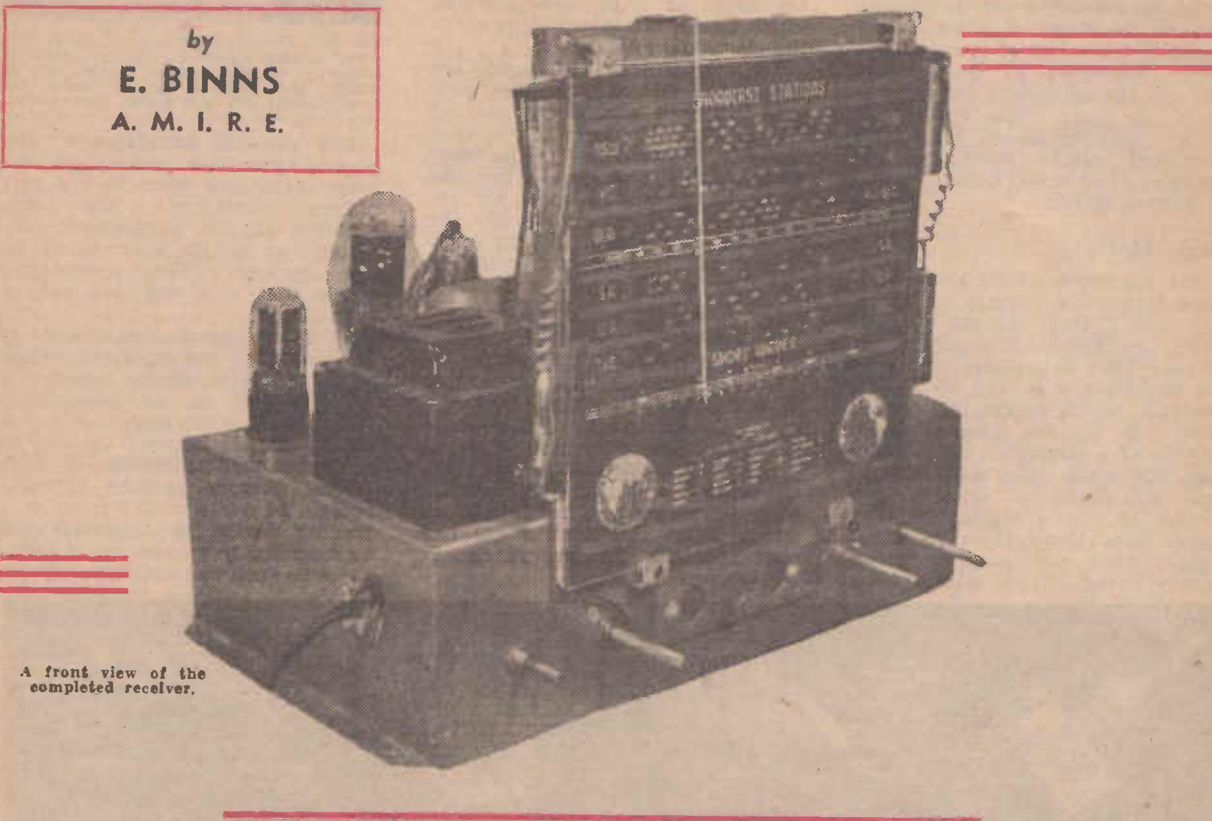
Adoption of standards for magnetic recording is foreseen by the NAB Recording and Reproducing Standards Committee which has formulated a final project group proposal of three recording speeds for magnetic tape; primarily standard tape speed of 15 in. per second, a secondary standard of 7.5 in. per second and a supplemental standard of 30 in. per second.

EMI Adopts Scott Suppressor

Electrical and Musical Industries Ltd., the leading British manufacturers of radios and records will feature the H. H. Scott dynamic noise suppressor in all new model phonograph and combinations. This results from a contract recently signed by Sir Ernest Fisk, E. M. I. Managing Director and H. H. Scott, inventor of the suppressor and President of Herman Hosmer Scott, Inc. The licence agreement covers Great Britain and Australia.

DIRECT COUPLED FIVE

by
E. BINNS
A. M. I. R. E.



A front view of the completed receiver.

Full constructional details of a five valve dual wave receiver which will give a really fine performance. Direct coupling and triode output stage contribute to a high quality, low distortion output.

From the economy and performance point of view, the five valve type of receiver is probably the most widely used set these days. This popularity is mainly due to the ease with which satisfactory results can be obtained without the necessity of complicated circuits or a large monetary investment. Although this type of receiver has been described in previous issues, we feel justified in detailing this new circuit, since it is capable of providing a high quality output and yet only requiring a minimum of parts in its construction.

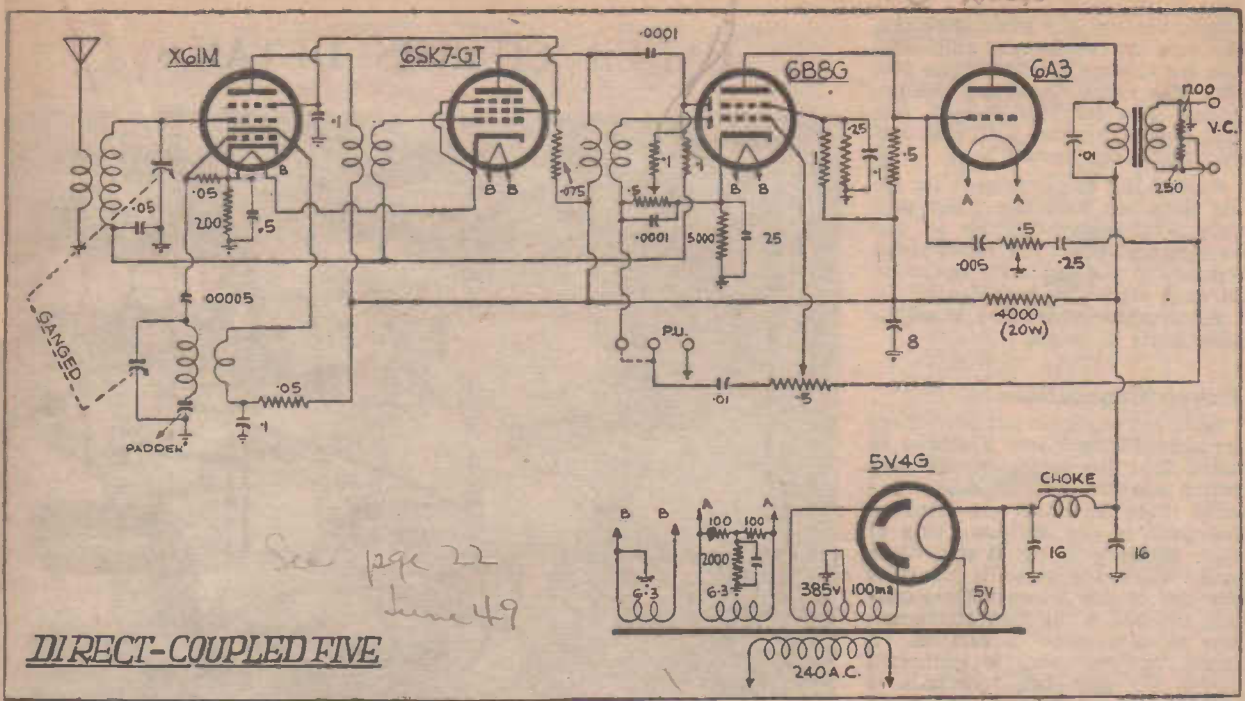
Triode Output Stage

The high quality reproduction in this design has been achieved by a combination of two factors—the use of a triode in the output stage and by direct coupling between the first audio stage and output stage. In view of the generally accepted tetrode or pentode in the output stage, the inclusion of a triode valve in this position may appear strange to some readers. Whilst we do not wish to enter into a triode vs. pentode controversy at this stage, we think it is sufficient to say that the harmonic distortion is lower with the triode than in the case of the pentode. Although in this latter instance, the inherent higher distortion factor can be reduced by the application of inverse feedback, this also has the effect of reducing circuit gain.

Direct Coupling Used

The second factor entering into this design is the use of Direct Coupling between the driver and output stage. This method of coupling the plate of the driver valve to the grid of the output stage has been known for many years, but of late has fallen into disuse and is not very often encountered in present-day receivers.

It was first introduced in the early mains operated receivers, when triode valves were the order of the day. However, to obtain sufficient gain from these valves it was necessary to use very high voltages, and with direct coupling



The circuit is not complicated and uses standard components. The use of direct coupling and a triode output stage results in a high quality reproduction. Provision is made for connecting a pickup into the circuit.

this necessitated very high voltage power transformers. This in turn called for high voltage filter condensers. For these reasons direct coupling was unpopular and became more or less forgotten.

"Why Direct Coupling"

However, with the high gain valves available today, it is possible to use medium voltages and still obtain excellent results. Some readers will probably ask the question, "Why use direct coupling instead of resistance capacity coupling or transformer coupling?" The answer to that question is simply that both resistance capacity coupling and transformer coupling have limitations from a fidelity point of view.

In the case of resistance coupling, the coupling condenser has a different reactance at different frequencies. As a result this limits the response of the output stage and introduces other circuit losses. Transformer coupling depends for good fidelity on the capabilities of the transformer, and it is difficult and expensive to design the perfect transformer with no losses and a straight line response. Because of these limitations direct coupling has been used in this receiver—for its simplicity and ability to provide good fidelity without expensive equipment.

The Circuit

As can be seen from the circuit a simple design has been followed. A dual wave bracket has been incorporated to provide broadcast and short wave band operation. For the slight extra cost this addition is warranted. By using one of the commercial brackets, instability troubles especially on the SW band will be reduced, due to the good coil layout.

The converter valve is the type X61M, which gives maximum conversion gain, and is excellent on short waves. The i-f amplifier is a 6SK7GT—a single-ended r-f pentode. For simplicity the cathodes and screens of these two valves are connected together and a common dropping resistor used to provide the requisite bias and screen voltages. It should be noted the cathode circuit is bypassed with a .5 mfd condenser.

As the 6SK7-GT is a single-ended type, it will be necessary to bring the grid lead of the first IFT (which is brought out through the top of the can) down under the chassis to the appropriate socket pin.

Second Detector

The second detector and first audio valve is type 6B8G. This was

PARTS LIST

1 Chassis 14 x 9 x 4.
1 Two gang tuning condenser.
1 Tuning dial to suit.
1 Dual Wave tuning unit.
2 465 kc I.F.T's.
1 Power Transformer .385vHT, 100 ma, 2-6.3v, 1-5.0v. winding.
1 Filter choke 100 ma.

CONDENSERS.

2 25 mfd electrolytic.
2 16 mfd electrolytic.
2 8 mfd electrolytic.
1 .5 mfd tubular.
3 .1 mfd. tubular.
1 .05 mfd. tubular.
2 .01 mfd. tubular.
1 .005 mfd. tubular.
2 .0001 mfd. mica.
1 .00005 mfd mica.

RESISTORS.

3 1 meg.
2 .5 meg.
1 .25 meg.
1 .075 meg.
2 .05 meg.
1 5000 ohm.
1 4000 ohm 20 watt.
1 2000 ohm 20 watt.
1 1200 ohm.
1 250 ohm 3 watt WW.
1 200 ohm 3 watt WW.
2 100 ohm.

VALVES: 1 X61M, 1 6SK7, 1 6B8G, 1 6A3, 1 5V4G.
SPEAKER: Permag. with 2500 ohm output transformer.
SUNDRIES: 5 octal sockets, 1 4-pin socket, 5 terminals, 4 knobs, nuts and bolts, hook up wire, etc.

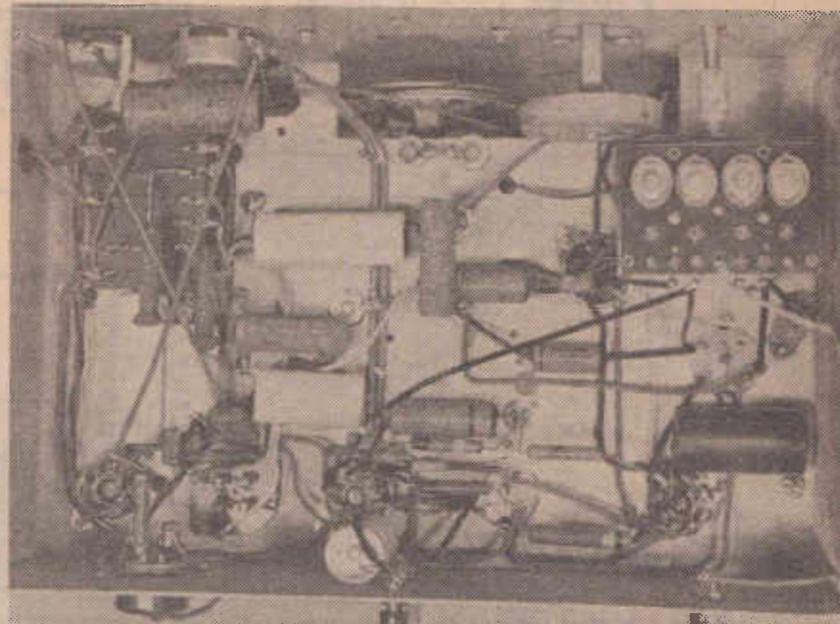
chosen because the pentode section will give increased audio amplification for driving the 6A3. The 5000 ohm bias resistor provides the necessary bias for this pentode section, and is bypassed with a 25 mfd electrolytic condenser.

One of the diodes is used for diode detection and the other provides AVC voltage for the i-f and converter stages. The small delay voltage, to prevent AVC operation on weak signals, is provided by the 1 meg resistor connected from the diode plate to earth.

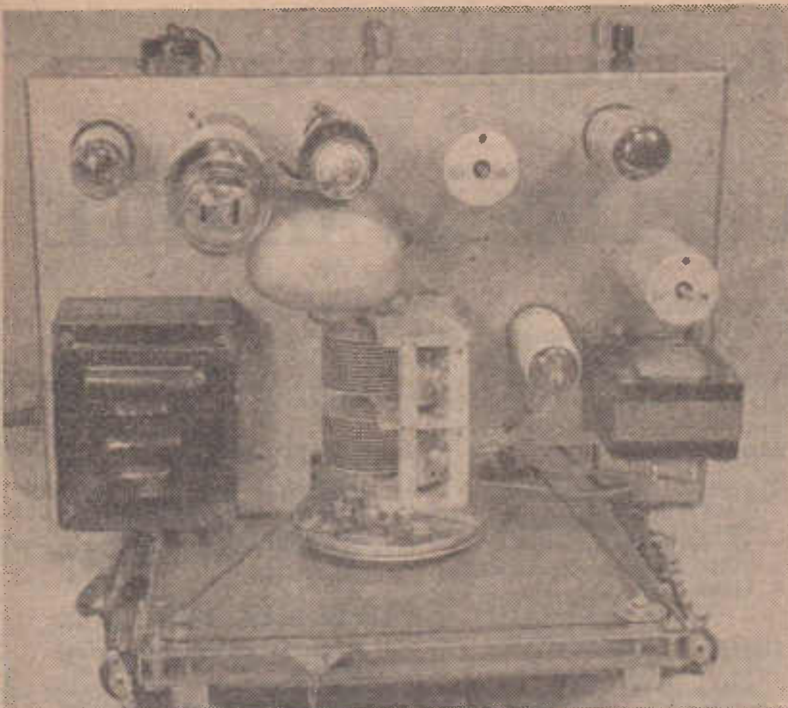
Pickup Connections

Although provision has been made for pickup connections it should be noted that the usual change over switch has not been included. Instead three terminals are fitted on the back of the chassis. One of these connects to the .5 meg diode load, whilst the other is wired to one side of the .5 meg volume control through a .01 mfd condenser. The third terminal is earthed. A small "jumper" wire is connected across the first two terminals to provide radio reception, and when gramophone is required, this wire is removed, and the pickup input terminals connected across the second and third terminal.

UNDER CHASSIS DETAILS



This underchassis photograph shows how the components were fitted in. All leads are kept short with components being mounted as near as possible to associated valve circuit.



The top chassis layout is shown in this excellent photograph. This should be followed to ensure maximum results and prevent any instability troubles.

The output from the 6B8G is then taken to the grid of the 6A3 output valve. In this case it should be noted that the plate connects DIRECT to the 6A3 grid.

No Coupling Condenser

With resistance capacity coupling and transformer coupling the DC voltage applied to the plate of the driver valve is isolated from the grid of the output valve. In the first instance this is done by means of the coupling condenser, and in the second by virtue of the insulation between the primary and secondary windings of the transformer. However, in the case of direct coupling the plate is connected direct to the grid. As a result a high positive voltage is applied to the grid of the output valve.

Therefore, to have the output valve working under its correct conditions with the requisite negative grid bias, a higher positive voltage than that on the grid must be applied to the filament centre tap resistor. This voltage should be equal to the voltage on the grid plus the bias voltage required for the valve concerned. Consequently it can be seen that direct coupling presents no difficulties as regards the applied voltages.

As mentioned previously, the output valve is a 6A3 triode, and this gives good output with medium voltages. Although the gain may not be so high when compared to a typical pentode, it is still more than sufficient for the average home, and coupled with the lower harmonic distortion will provide a better total response.

The speaker transformer is mounted on the chassis to provide short leads, for the tone control circuit. This consists of a resistor network connected across the voice coil leads. The tone control consisting of the .005 mfd condenser, .5 meg potentiometer and .25 mfd condenser in series is connected from the junction of the two resistors to the 6A3 grid circuit.

Tone Control Operation

The operation of this tone control is very effective and works as follows: When the centre moving arm of the potentiometer is set in the mid position, both the high and low frequencies are available. When the moving arm moves towards the .005 mfd condenser, the high note response is attenuated, with a consequent boosting of the low frequencies. Then on moving the centre arm towards the .2 mfd condenser, results in a low note cut and boost in high notes. It will be found to give a fairly uniform control, suitable for most listeners, but those with experimental traits will find that by varying the values of the two condensers, different degrees of cut and boost will be obtained.

The power supply is conventional, and requires a 385 volt high tension winding with a 120 ma rating. In addition two 6.3 volt windings, and a 5.0 volt winding will be needed. It is essential that a separate 6.3 volt winding be used for the 6A3 output valve. The filter choke is

(Continued on page 45.)

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Basic Electricity and Magnetism

A discussion on the meaning of capacitance, together with some practicol circuit applications.

The idea of capacitance arises from the relationship which exists between the potential of a body and the charge which it carries.

Since potential difference is defined in terms of the work done in moving a definite quantity of charge against the repulsive forces of a like charge, it is evident that any variation of charge must vary the forces and, hence, the amount of energy expended. The potential difference between the charges must also vary.

It is clear that the potential difference between two or more charged bodies can be varied by altering the amount of charge distributed on them. However, *the potential difference between two bodies can also be altered by changing the shape and/or the size of one or both bodies.*

To understand why this is so, let us suppose that a quantity of charge Q is distributed on a sphere of radius r cms. and that we move unit charge Q' toward Q and in so doing expend 1 joule of energy. If we expend 1 joule of energy the potential difference between the charges must have been 1 volt.

Suppose now that the same quantity of charge Q is distributed over a sphere of radius r/2 cms. The surface area of this smaller sphere is only one quarter of that of the larger one so that the field intensity about the smaller sphere will be four times greater than the field established about the larger sphere. In moving a unit charge Q' toward the smaller sphere we must move through a field of four times the original intensity and thus do four times as much work.

The potential difference between the two charges is now 4 volts despite the fact that the actual quantity of charge is the same as in the former case. This simple example shows that the potential difference between two bodies depends on the *size* of the bodies as well as the quantity of charge involved.

Effect of Corners

When bodies having sharp corners —such as cones and cubes—are charged the electrical charges do not distribute themselves uniformly but tend to concentrate at the corners so that the field established about such bodies is very intense about the various points on the bodies and less intense about the flat surfaces. The field established about such bodies is thus of a non-uniform character so that the potential difference between two such bodies when charged is, in general, a difficult matter to calculate.

It should be clear, however, that the *shape* of a charged body also affects the potential it acquires with respect to neighboring bodies.

In the electrical sense, the capacitance of a body is its ability to acquire a potential difference with respect to neighboring bodies when it is given an electrical charge. The greater the charge for a given potential difference, so greater is the capacitance of the body said to be.

In the mathematical sense, the capacitance of a body is the ratio of the charge given the body and the potential it acquires by virtue of this charge. Thus, if Q is the quantity of charge given a body, and its resultant potential is E volts, the capacitance C, of the body is,

$$C = \frac{Q}{E} \quad \ldots\ldots\ldots\ldots\ldots \; 6.1$$

The unit of capacitance is the *farad* and a body has a capacitance of one farad when a charge of 1 coulomb of electricity raises its potential by 1 volt.

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

The Physical Meaning of Capacitance

The word *capacitance* has supplanted the earlier term *capacity*. The word *capacity* was coined by the early experimenters who thought of electricity as a fluid and regarded a charged body as storing electricity in much the same manner as water could be stored in a tank. Any arrangement designed for the deliberate storing of electricity was called a *condenser*. The word *condenser* derived from the notion that *electric fluid* was stored or "condensed" on a body in a manner similar to the way that steam condensed to water in a condenser in a boiler plant.

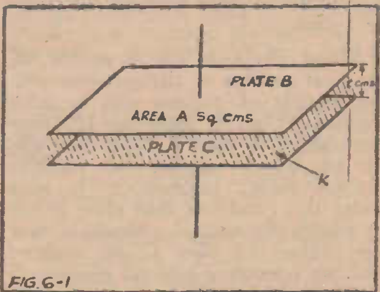


FIG. 6-1

The words *condenser* and *capacity* inspire the notion that electricity is a fluid and tend to promote entirely wrong ideas as to how "condensers" function. Because of this their use is discouraged, and the word *capacitor* instead of condenser, and the term *capacitance* rather than capacity, recommended.

Unfortunately "condenser" and "capacity" are still used frequently in electrical literature. Those who use them do so out of habit and evidently assume that the reader dissociates the terms entirely from their traditional meaning and significance. It is hard to discover whether the reader does this or not, but anyone who thinks of a "condenser" storing electrical charges is giving the term its traditional meaning and will consequently find it hard to follow advanced electrical literature dealing with capacitors.

Capacitor Charges

We must discard the notion that "condensers" store electrical charges. *Capacitors do not store electrical charges. The total charge in an uncharged capacitor is the same as that in a charged capacitor.*

We can hardly accept this statement without satisfactory proof of its truth. Let us assume for the moment that it is true. If it is true, then what does a capacitor "store?" If it does not store anything, then how does it work anyway?

We have defined *capacitance* as the ability of a body to acquire a potential when charged. According to this definition, any suitably insulated conductor, since it is capable of being charged, possesses the property of capacitance, because any insulated conductor suffers a change in potential with respect to neighboring bodies when electrically charged.

If two conducting plates B, C, are arranged as shown in Figure 6-1 with some insulating material, having a dielectric-constant K, between them, they will constitute a *capacitor*. Let the area of each plate be A sq. cms. and let the distance between the plates be t cms.

When the capacitor is uncharged, the total number of charges must consist equally of positive and negative charges. Thus, if there are 100 positive charges on plate B, there must also be an equal number of negative charges there, because it is only under this condition that plate B can be electrically neutral. Similarly, half the charges on plate C are negative and the remaining half are positive. If we assume that the total number of charges on plate C is the same as on plate B then, the total number of charges on both plates is 400 units of charge; 200 on plate B and 200 on plate C.

Since each plate is electrically neutral no potential difference can exist between them but *because it is possible* to establish a potential difference, capacitance must exist between the plates. It is important to note that capacitance is an intrinsic property of a body, or a system of bodies and is *independent* of its or their electrical condition.

Figure 6-2 shows the capacitor in Figure 6-1 connected across a battery E, with plate B connected to the positive terminal and plate C connected to the negative terminal. When the capacitor is connected thus, negative charges will migrate from plate B because they are attracted toward the positive terminal to which B is connected, and, *simultaneously*, negative charges must migrate from the negative terminal of the battery toward plate C.

Instantaneous Current Flow

This momentary flow of charge around the circuit at the instant the latter is closed constitutes an electric current and this current must be the same value at any point in the circuit at any given instant. Therefore, the number of charges flowing from plate B must at every instant be equal to the number of charges flowing toward plate C.

This transfer of charge around the circuit causes inequality between the number of charges on B and C, and this inequality, in turn, establishes a potential difference between the two plates, and sets up an electric field between them. The transfer of charge ceases when the potential difference is equal to that of the battery, E.

The electric field set up between the plates causes the dielectric between the plates to be electrically strained and *work has been done* in straining the dielectric. Now, since work done and energy expended are identical terms, and since energy cannot be created nor destroyed, it follows that the energy expended in straining the dielectric must exist in the dielectric as *strain energy*, and we can, conveniently, regard this energy as being stored in the dielectric.

The storing of energy in the dielectric is similar to the manner in which energy is stored in a piece of rubber that is stretched or compressed, or in a spring subjected to compressive or tensile forces. The energy expended in deforming either the rubber or spring is converted into strain energy which is stored in these bodies while they are kept in a deformed state. If allowed to return to their original condition the bodies deliver up their stored energy which can, if desired, be used to do useful work.

On the original assumption that the *total* units of charge on both plates is 400, and if we further assume that 100 units of charge flow from B to the positive terminal of the battery, then 100 units of charge must flow from the negative terminal of the battery to plate C, so that, in its charged condition, the capacitor has 100 units of charge left on B, but has 300 units of charge on plate C. *The total units* are the same in the charged state as *in the uncharged state.* 100 units of charge have simply been transferred from B to C.

The essential difference between a charged and an uncharged capacitor is that the charges, in the case of a charged capacitor, are so distributed as to produce a potential difference between the conductors that make up the capacitor, while, in the case of the uncharged capacitor, the charges are so distributed as to produce no potential difference between the conductors.

Effect of Potential Difference

The effect of the potential difference between the plates of a charged capacitor is to electrically strain the dielectric separating them, and energy delivered by a charged capacitor is given up by the dielectric as it assumes its normal unstrained electrical state.

When we think of a charged capacitor we do not think of charges stored on its plates; we think of its dielectric as being electrically strained and deformed. It is then clearly evident why the nature of the dielectric used not only determines the amount of energy stored under any given condition, but is also the governing factor as to the service for which the capacitor may be used and the life we may expect from it.

It is rare in practice to find conditions under which the current in an electric circuit is absolutely uniform. When it is necessary to keep the current as uniform as possible, a so-called "smoothing" capacitor is connected across the circuit. Any variation of current causes a variation of potential difference between the plates of the capacitor, and this varying p.d., in turn, varies the degree to which the dielectric between the plates of the capacitor is strained. Any increase in p.d. increases the strain on the dielectric while any decrease in p.d. relieves the dielectric of a certain amount of strain so that it tends to assume its normal unstrained state.

In so doing the dielectric returns to the circuit some of its strain energy in the form of electrical energy so that the p.d. across the capacitor tends to remain constant. The overall effect is a tendency to "smooth" out any inequalities caused by current variation.

The action of the dielectric under these conditions is similar to the action of the body springs of a car when the latter is in motion. The body springs are continually flexing as they absorb or deliver energy and so tend to isolate the body of the car from the inequalities in the road. Also, if the springs are too flexible, they are likely to break easily, and in a similar way, if the dielectric used in a capacitor is too electrically flexible, it is likely to "breakdown" readily in service. The necessary qualities of the material used between the plates of a capacitor will be discussed when we deal with nonconductors.

The Mathematical Meaning of Capacitance

We have seen that capacitance is intimately connected with the charge we give a body and its resultant potential difference with respect to other bodies. We have also seen that the p.d. we get for a given charge depends on the shape and size of the body as well as the size, and shape and charges given neighboring bodies. The matter of calculating the capacitance of a body can therefore be very complex.

Fortunately, we seldom find complicated systems of bodies in practice; in most cases the bodies are simple geometrical shapes, like cylindrical conductors, or flat plates, and they are disposed geometrically about each other. Calculations then are not so difficult.

Perhaps the most common case—and certainly the most simple—is that of two flat plates as shown in Figure 6-1. Let us suppose that we are required to calculate the capacitance between these plates in terms of their area, their distance apart, and the dielectric between them.

Reference to Figure 6-1 shows that the area of each plate is A sq. cms., the plates are spaced t cms. and the substance between the plates has a

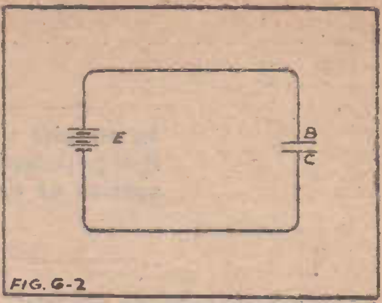


FIG. 6-2

dielectric constant K. Suppose the charge given each plate is Q, so that the amount of charge per unit area, or the *charge density*, is Q/A or q units per sq. cm.

Since each unit of charge contributes 4π lines of flux to the total field between the plates, the flux leaving every sq. cm. of surface must be $4\pi q$ lines of flux.

If we neglect the slight distortion of the field near the edges of the plates and regard the entire field as uniform, the field density per sq. cm. is $4\pi q$, and since field *intensity* is equal to K x field density, it follows that the

$$\text{Field intensity} = \frac{4\pi q}{K} \quad \ldots\ldots\ldots \; 6.2$$

so that the force acting on a unit charge placed between the plates is,

$$\text{Force on unit charge} = 4\pi q \text{ dynes} \; . \; 6.3$$

The work done in moving a unit charge *against* the field is equal to the product of the force and distance through which the charge is moved. The distance through which the charge is moved is t cms, i.e. the distance between the plates. The force is given by equation 6.3.

$$\text{Work done} = \overset{\text{force}}{\frac{4\pi q}{K}} \times \overset{\text{distance}}{t} \text{ ergs} \; .. \; 6.4$$

You will recall that the work done in ergs is numerically equal to the e.s.u. of potential between the plates, so that Equation 6.4 yields, numerically, the e.s.u. of potential between the plates.

That is,
$$\text{P.d. in e.s.u.} = \frac{4\pi qt}{K} \text{ e.s.u. of potential} \; \ldots\ldots\ldots\ldots\ldots \; 6.5$$

$$\text{By equation 6.1 } C = \frac{Q}{E} \; \ldots\ldots\ldots \; 6.1$$

In this particular case, Q represents e.s.u. of charge, E represents e.s.u. of potential, and C represents e.s.u. of capacitance. Substituting equation 6.5 for E in equation 6.1, we get,

$$C = \frac{KQ}{4\pi qt} \text{ e.s.u. of capacitance} \; . \; 6.6$$

(Continued On Page 46)

3S4 & 3V4 FILAMENT OPERATION

In circuits where power output is not of prime importance, it is permissible to operate types 3S4 and 3V4 using only one section of the two-filament section as a means of reducing battery consumption.

When it is desirable to minimise power consumption in a receiver or other equipment at the expense of power output, operation of types 3S4 and 3V4 utilising only one section of the two section filament is permissible.

These types, designed for dry-battery operation, are power output tubes with two filmament sections arranged so that they may be heated either in series with 2.8 volts and 50 milliamperes, or in parallel with 1.4 volts and 100 milliamperes. One filament section is connected between pins 1 and 5, and the other is connected between pins 5 and 7.

Valve operation utilising one section heated with 1.4 volts and 50 milliamperes is permissible subject to the following recommendations:

(1) Use only filament section between pins 5 and 7. Make no connection to pin 1.

(2) Apply the filament voltage so that pin 7 is positive and pin 5 is negative.

(3) Do not switch from single-filament operation to series or parallel filament operation, or from one filament section to the other.

Recommendations 1 and 2 are made primarily to insure consistency between testing results and valve operation. Recommendation 3 is made because prolonged operation of a valve with only one filament section utilised may result in deterioration of the other section. Subsequent use of the other section, therefore, would not give results predictable from initial ratings.

Ratings, typical operating conditions, and characteristics for types 3V4 and 3S4 with single-section filament operation are given in accompanying paragraphs.

Filament Arrangement.

Pin 7 connected to Filament positive, Pin 5 connected to Filament negative, Pin 1 No external connection.

Maximum Ratings:

	Type 3S4	Type 3V4*	
PLATE VOLTAGE	90 max.	90 max.	volts
GRID-No. 2 (SCREEN) VOLTAGE	67.5 max.	90 max.	volts
TOTAL ZERO-SIGNAL CATHODE CURRENT	4.5 max.	6 max.	ma
TOTAL MAXIMUM-SIGNAL CATHODE CURRENT	5.5 max.	6 max.	ma

Typical Operation and Characteristics:

	Type 3S4	Type 3V4*	
Filament Voltage	1.4	1.4	volts
Filament Current	0.050	0.050	amperes
Plate Voltage	90	90	volts
Grid-No. 2 Voltage	67.5	90	volts
Grid-No. 1 Voltage	-7.0	-4.5	volts
Peak AF Grid-No. 1 Voltage	7.0	4.5	volts
Zero-Signal Plate Current	3.7	4.8	ma
Zero-Signal Grid-No. 2 Current	0.7	1.1	ma
Plate Resistance (approx.)	0.2	0.2	megohm
Transconductance	800	1100	umhos
Load Resistance	16000	20000	ohms
Total Harmonic Distortion	12	7	per cent.
Maximum-Signal Power Output	135	135	mw

* Data for type 3V4 apply also to type 3Q4.

A comparison of characteristics given above with the published characteristics of type 3V4 and 3S4 for parallel-filament operation shows that (1) the plate and Grid 2 currents, the transconductance, and the power output have values approximately one-half of the values given for parallel-filament operation; and (2) the plate resistance and recommended load resistance have values approximately twice those given for parallel-filament operation. These results indicate that the two filament sections function almost independently in their contributions to the performance of these valve types.

—Data from RCA Application Note.

Precaution with Oscillators employing filament type tubes

Experience with filament-type acorn tubes as oscillators in transmitting equipment has shown that, under some conditions of operation, oscillation may continue after the filament voltage has been removed unless the plate voltage is also removed. When the filament voltage is removed from an oscillator tube having particularly low filament power consumption, continued oscillation frequently takes place because of continued heating of the filament by the plate current.

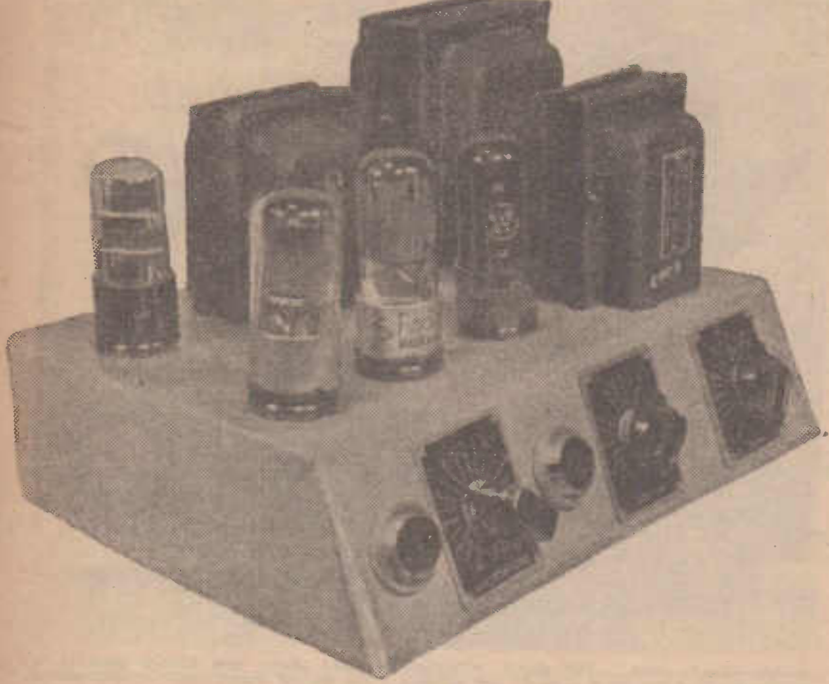
Continued oscillation has been found most likely to occur (1) with a tube having high emission capability, (2) with an exceptionally well-designed circuit, and (3) with a high value of oscillator plate current; it has been observed with oscillator tubes operated at moderate values of plate voltage and current.

Because of these results in the laboratory and in the field, it is recommended that both the filament voltage and the plate voltage of filament-type miniature, GT, and acorn oscillator tubes used for transmitter purposes be removed when equipment employing these types is "shut down." Usually, a convenient method is to break the minus filament and the minus plate supplies with a single, double-pole switch.

The recommended procedure insures that the oscillator will always stop functioning in the "off" position, saves B power, and avoids interference with reception in combined transmit-receive equipment.

Data reprinted from RCA Application Note.

HIGH-QUALITY AMPLIFIER



MAIN FEATURES

★ Incorporates a wide range output transformer having a separate feedback winding.

★ Effective tone control giving choice of five positions.

★ Has provision for microphone and gramophone pickup inputs with separate volume controls.

Details of a small amplifier thot is admirably suited for home use or as a small P.A. unit. Featuring a special tone control circuit, it also has provision for a microphone and gromophone pickup input.

There is always a demand by readers for the description of small amplifiers, which are suitable for use in the average home. In general, only a low power output with a good frequency response are the main requirements in these cases, and consequently we feel sure this small unit, will be of interest to many such enthusiasts.

Whilst no claims are made that this is a high fidelity amplifier, it will be found that the tonal response is exceptionally good, and the overall performance is far in excess to that obtained with the usual single valve output stage. This is largely due to the inclusion of a special tone control circuit, and wide range output transformer having a separate feedback winding. This output transformer is now available with secondary windings of either 2.2 and 6.5 ohms, to suit most speakers now available, whilst in other cases the two windings can be connected in series or parallel arrangements to give other ratings.

Circuit Details

The circuit used for this amplifier follows standard practice and should offer little difficulty to the constructor. For those that may require it, a microphone preamplifier stage has been included, but in cases where the unit is to be used for gramophone operation only, this stage can be conveniently omitted.

The preamplifier stage consists of a 6SJ7-GT connected as a pentode, and this type was chosen mainly from the convenience point of view of having all connections to the valve under the chassis. If you have a sharp cut off pentode such as a 6C6, 6J7, or even a 57, then this can be used in the circuit without any change in component values. In each case from an electrical point of view, the type is practically the same as the 6SJ7-GT.

Mixing System

The output from this stage is taken to the grid of the second 6SJ7-GT, via the .5 meg potentiometer acting as the microphone gain control. To provide a simple but effective mixing system, for the microphone and pickup without the necessity of another valve, it will be noticed that a second .5 meg potentiometer is connected across the pickup input. This is the pickup gain control.

The centre moving arm of each control is taken to the grid of the valve through .5 meg fixed resistors. The object of the fixed resistor is to minimise any interaction between the two input circuits, and so permit either the microphone or pickup to be faded in or out at will without interfering with the other unit.

This system is simple, but very effective and also more convenient than providing a twin triode type as a mixer unit.

The second 6SJ7-GT is connected as a pentode amplifier, and here the component values chosen are in keeping with the valve manufacturers' recommendations. It should be noted that decoupling has been provided in the plate circuit of this valve by means of the .02 meg resistor and 8 mfd electrolytic condenser.

The output stage is a 6V6-GT, and this will be found to provide more than enough output for the average home. The output transformer is a special Ferguson unit, having a separate feedback winding.

One side of this winding is earthed, with the other connection providing the necessary feedback via the tone control circuit into the cathode of the second 6SJ7-GT.

More will be said of this tone control network later on.

The power supply is a conventional arrangement consisting of the 5Y3-GT rectifier and a 285 volt HT 80 ma transformer. The usual filter choke and associate filter condensers complete this circuit.

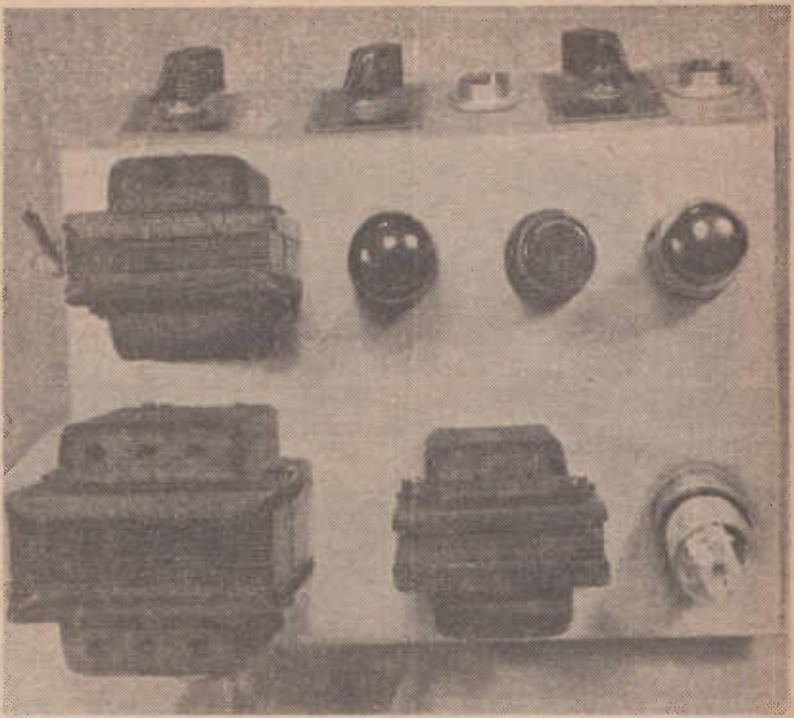
Tone Control Details

The tone control circuit used is the one designed by Fergusons Transformer for use with the special output transformer. This consists of the 5 position 2 pole rotary switch, and provides the following position: Wide Range, Bass, Normal, Speech and overseas. Whilst this latter position is not required with the amplifier, it will be found invaluable should this amplifier be used with a dual wave tuner at a later date.

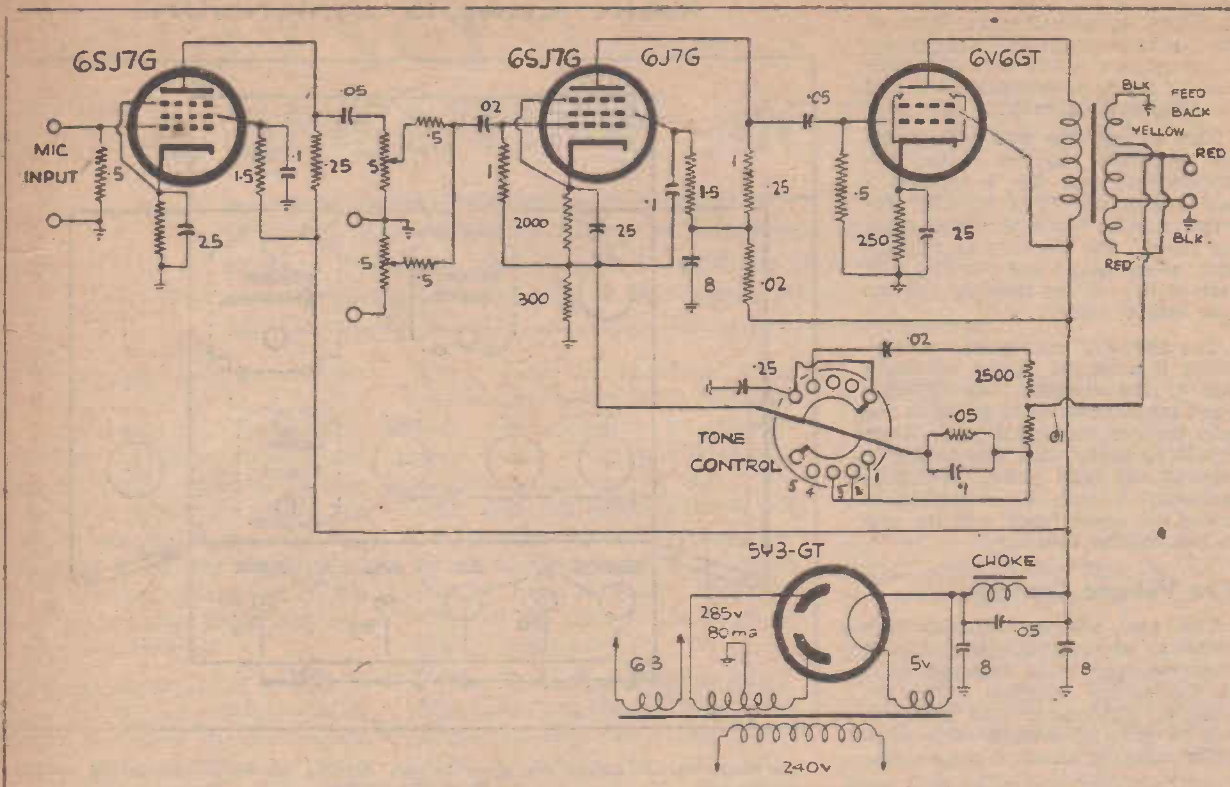
To assist in connecting up the various condensers and resistors, the switch positions have been numbered from 1 to 5, looking at the switch from the rear. In the lower bank Pin Nos. 1, 2 and 3 are wired together and taken to the feedback winding (yellow lead) of the output transformer through a .01 meg resistor. The two remaining pins on this section are left blank.

In the upper section, Pin 1 and 5 are wired together, and a .25 mfd condenser connected from this point

TOP CHASSIS DETAILS



A top chassis view. The power transformer, filter choke and 5Y3GT rectifier are mounted along the back edge of the chassis. The output transformer is immediately in front of the power transformer.



The main feature of the circuit is the special tone control circuit arrangement. Used in conjunction with a special output transformer, this provides excellent results although only a single valve output stage is provided. The circuit has provision for microphone or pickup.

to earth. Pin 4 is taken to the feedback winding through a .02 mfd condenser and 2500 ohm resistor in series. Next the two moving arms are wired together and connected across pins 1, 2 and 3 of the lower bank through a .05 meg and .1 mfd condenser in parallel.

Although at first glance the operation of this switch may appear difficult, it is simple enough if traced out in a logical manner. Commencing with position 3, which is the Normal position, it will be seen that the feedback winding is connected through the .01 meg resistor direct to the 300 ohm resistor in the cathode circuit. Under these conditions there is approximately 12 db of feedback, and the frequency range, using a 1 watt reference level is from 30 to 15000 cps, within ± 0.5 db.

Switching the control to position 4—Bass lift, this basic circuit is now changed by the inclusion of the .05 meg resistor and 0.1 mfd condenser in series with the .01 meg feedback resistor. This gives a bass boost of approx. 3 db below the reference level of 400 cps, down to cone resonance after which the curve drops off rapidly.

In position 5, the wide range position, the previous circuit is only changed by the inclusion of the .25 mfd condenser across the cathode resistor, thus effectively bypassing it.

Reverting to position 2, the overseas position, the .01 meg feedback resistor is effectively shunted by the 2500 ohm resistor and the .01 mfd condenser in series. This results in a high note cut. The remaining position, is for speech, and is basically similar to the Normal position, except that now the .25 mfd condenser is connected across the 300 ohm cathode resistor.

Mounting the Parts

The amplifier has been built up on a special chassis measuring 12 x 10 x 2½ inches. The valve sockets are the manufacturers' type, which are held in place with a locking ring.

The power transformer, filter choke and 5Y3GT rectifier are mounted along the back edge of the

PARTS LIST

1 Chassis.
1 Power transformer, 285v at 80 ma; 6.3v at 2 amps; 5.0v at 2 amps.
1 Filter Choke 80 ma. 15H.
1 Output transformer (Ferguson OP24).
1 2 pole 5 pos. switch.

CONDENSERS.

3 25mfd Electrolytic	3 .1 mfd tubular
3 8mfd Electrolytic	2 .05 mfd tubular
1 .25mfd tubular	1 .02 mfd tubular

RESISTORS.

2 1.5 meg	1 .02 meg
4 .5 meg	1 .01 meg
2 .25 meg	1 2500 ohm
1 .05 meg	2 2000 ohm
	1 300 ohm
	1 250 ohm

VALVES
2 6SJ7-GT, 1 6V6G-GT, 1 5Y3-GT.
SUNDRIES
4 octal sockets, 1 4 pin socket, 3 pointer knobs, 2 input jacks, 3 nameplates, power flex, hook up wire, nuts and bolts, etc.

chassis, with the output transformer fitting immediately in front of the power transformer. This places it alongside the 6V6-GT, thus permitting short connections to it and the tone control switch.

The microphone and pickup input terminals, the two .5 meg potentiometers and the 5 position 2 pole switch are fitted in their respective holes along the front sloping panel. For the sake of appearance, name plates are placed under each of the volume controls and the tone control switch.

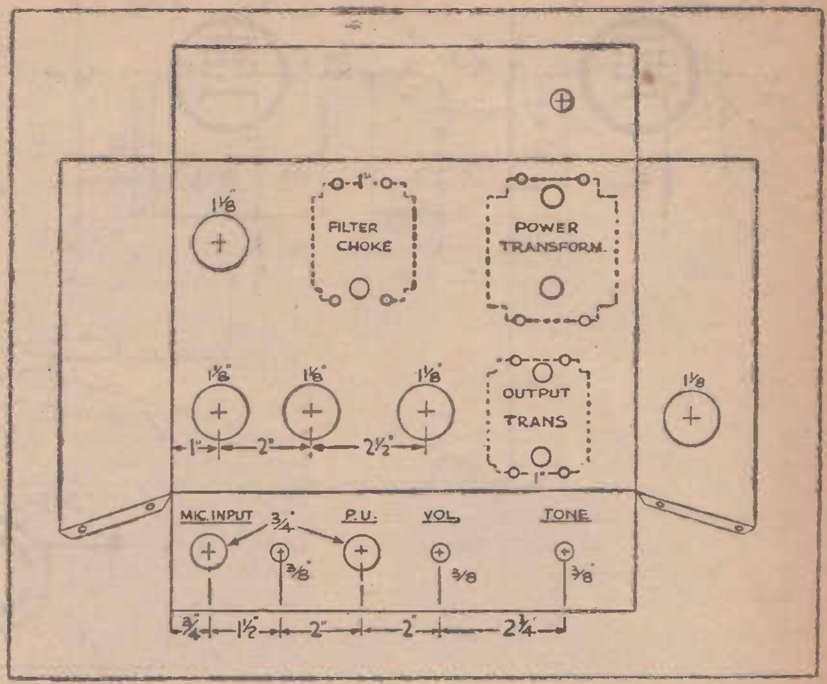
The 6SJ7-GT microphone preamplifier is mounted at the left-hand side of the chassis, thus enabling short connections to be made to the gain control and input jack. Care should be taken with this wiring to prevent any hum pickup, and consequently it may be advisable to shield the input leads, and the one to the volume control.

Two Volume Controls

The two volume controls are wired as shown with the .5 meg fixed resistors being soldered right at the centre terminal. The remaining condensers and resistors can be grouped around each valve socket, making all earth connections

(Continued On Page 46)

MAIN CHASSIS DIMENSIONS



The main chassis details are given in this drawing for those who intend cutting their own chassis.

FREQUENCY *VERSUS* AMPLITUDE MODULATION

In this article the author makes an interesting comparision between frequency and amplitude methods of modulation, with particular attention to the signal-to-noise ratia.

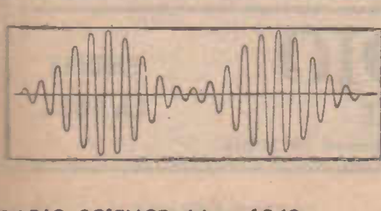
With frequency modulation coming to the fore, it will be of interest to compare this form of modulation with amplitude modulation. Although rather involved mathematics is required to derive the various relationships and comparisons, quite a lot can be gleaned from a physical comparison of the two types, and some interesting conclusions can be made.

First we must define frequency. For a periodic or repetitive wave, this can be defined as: **the number of times per second that the wave completes its cycle of events**. Thus one can speak of a thousand-cycle square wave, triangular wave, or sine wave. However, in circuit analysis it has been found that if the sine wave is used as the standard of comparison, then the various relationships between the current and voltage are expressed relatively simply, such as the impedance, the transfer constant, admittance, etc. This is because the current wave form is sinusoidal too, regardless of whether the circuit contains resistances, inductances, capacitors, or combinations of all three.

Sine Wave as Standard

So we find it convenient to use the sine wave as the standard, and we define frequency as the number of sinusoidal variations per second. If we have some other shape of periodic wave, we convert it into a Fourier series of sinusoidal components, and treat each separately by means of complex algebra.

This tendency persists even in the case of a modulated sine wave. For example, the sinusoidally amplitude-modulated wave of Fig. 1 is resolved



into a carrier and upper and lower side bands; the latter are displaced from the carrier by an amount equal to the modulating frequency. A closer inspection of Fig. 1 reveals that the actual wave at all times crosses the axis in equal intervals of time; hence it might be said to have a single frequency (that of the carrier) but be variable in amplitude.

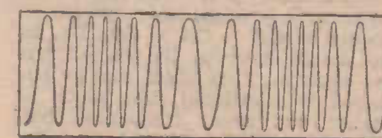
However, the fact that the amplitude varies precludes it from being a true sine wave (which has a constant amplitude by definition), hence on the basis of sinusoidal shapes, it is found—by a trigonometric analysis—to consist of three sine-wave frequencies.

In the case of the frequency-modulated wave (Fig. 2) the resulting wave form is also not sinusoidal in shape in that it does not cross the axis in equal time intervals, although it does have a constant amplitude. The mathematical analysis is now more involved; nevertheless, it is found that it can also be resolved into sinusoidal components. Now, however, the number of components or side bands are far more numerous, and the total band they occupy is in general much greater than for amplitude modulation.

by
A. PREISMAN

Vector Representation

An alternative and very revealing vector viewpoint is given in Fig. 3 (a) and (b). The sinusoidal carrier can be represented by a vector rotating at the carrier frequency. The upper side band is then a vector that rotates at a faster rate, and the lower side band is a vector rotating at a slower rate than the car-



rier. If we imagine ourselves as rotating in synchronism with the carrier vector, then it will appear to be stationary in space, and the upper side band will appear to rotate counterclockwise at a rate equal to the difference between its frequency and that of the carrier; i.e., at the modulating frequency rate, while the lower side band will appear to rotate clockwise at a corresponding rate.

In Fig. 3(a) are shown the conditions for an amplitude-modulated wave. OA is the stationary carrier vector; AC is the lower side band, and AB is the upper side band, each making an equal angle a with OA at some moment of time. The resultant of AB and AC is AD; this is proportional to the instantaneous amplitude of the modulating frequency.

Note that AD is in line with OA. The sum of the two, or OD, is the overall resultant, and represents the instantaneous peak amplitude of the modulated wave. As AB and AC rotate in opposite directions, angle varies accordingly, as does also AD, but AD will always remain collinear with OA, and so the peak amplitude of the modulated wave, or OD, will vary at the modulating frequency rate from a maximum at $a = 0$ deg. to a minimum when $a =$ 180 deg. We thus have amplitude modulation.

Suppose the side bands are shifted 90 deg. leading in phase to the position shown in Fig. 3(a). We then have Fig. 3 (B); side bands AB and AC now make equal angles a with a line DD' perpendicular to OA, and their resultant is now along this line DD.'

The overall resultant is now no longer collinear with OA; instead, its tip varies along the line DD as the side bands rotate, and oscillates through an angle $\pm \theta$ with respect to OA. This represents a varying phase shift $\pm \theta$ of the resultant wave with respect to its unmodulated position OA. The wave represented by vector OD is now said to be either phase or frequency modulated.

However, vector OD also varies in amplitude, from a maximum of OD = OD to a minimum length of OA, so that it also has some amplitude modulation. For true phase or frequency modulation its length should be OE = OA = OE; i.e., its tip should describe the dotted line arc shown. This effect can be obtained if additional side bands of higher and lower frequency than AB and AC and of suitable amplitudes are added to the two shown. This indicates vectorially what can be derived mathematically: a true, sinusoidally frequency-or-phase-modulated wave has a large number of side bands compared to a sinusoidally amplitude - modulated wave.

Concept of Instantaneous Frequency

It was stated that the overall vector OD in Fig. 3 (B) varies in phase by the angle θ with respect to the unmodulated carrier vector OA. The question arises, **"Does this represent phase of frequency modulation?"** To answer this question, we must determine what we mean by frequency, even though we are thinking in terms of sine waves.

The sine wave was originally generated by rotating machine, whose armature rotated at a constant speed, and whose conductors thereby cut the field flux at varying angles, thus generating a sine wave. The phase angle referred to the angle through which the armature turned from a given initial position; for constant rotation, equal phase angles were swept out in equal intervals of time.

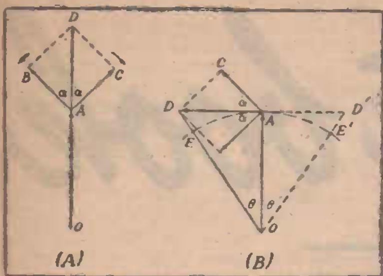
Each time 360 deg. or 2π radians were swept out (for a two-pole machine), one cycle was completed. The number of cycles per second is the frequency. Thus, frequency is really the rate of change of phase angle with respect to time or angular velocity, analogous to linear velocity of an automobile or train.

Suppose the armature of the above alternator rotated in an irregular manner so that it turned faster during one part of the revolution and slower during another part. Applying the above concept at rate of change, we can say that the frequency was higher during one part of the revolution and lower during the other part. One can go **further and define the instantaneous frequency** as the rate of change of phase angle at any given moment of time. Students of the calculus will recognise this as the derivative of the phase angle with respect of time. In Fig. 3 (B) we have a phase angle θ that varies with time, and hence a frequency that varies with time; that is the rate of change of θ with respect to time or d^{θ}/dt.

Phase and Frecuency Modulation

Hence, in Fig. 3 (B) we have both **phase** and **frequency modulation.** Which we shall call it depends upon which is made proportional to the amplitude of the modulating wave. Suppose we desire frequency modulation. Then, if various modulating frequencies, all of constant amplitude, are applied to the transmitter, it is necessary that no θ but the rate of change of θ with respect to time be the same for all modulating frequencies.

Suppose the modulating frequency is 100 c.p.s. Then θ must vary from the positive to a negative



value and back, 100 times per second. Assume its range is from + 30 deg. to —30 deg. Suppose next that the modulating frequency is 200 c.p.s. but of the same amplitude as before. The angle θ must vary through its range 200 times per second. But if the range is still from + 30 deg. to —30 deg. or a total of 60 deg. swing, then the rate of change of θ or the frequency excursion, will be twice tude as for the 100-cycle wave, θ as great as before and will represent a 200-cycle modulating frequency of **twice the amplitude**. In order to represent the same amplimust vary through half the previous range from + 15 deg. to —15 deg.

This then determines whether we have phase or frequency modulation; is θ or d$^{\theta}$ proportional to the amplitude of the wave. In the Armstrong system, where the side bands originally obtained from amplitude modulation are rotated with respect to the carrier by 90 deg. to give frequency modulation, it is necessary to make the resultant AD (which is proportional to the amplitude of the modulating wave) vary inversely as the modulating frequency. This is most conveniently done by giving the modulating amplifier a drooping high-frequency response. (This ignores the use of pre-emphasis, which is a pre-distortion of the frequency response to obtain certain beneficial effects that cannot be discussed here for lack of space).

Signal-To-Noise Ratio

One of the most important characteristics of a communication system is its received **signal-to-noise ratio**. Frequency modulation is capable of giving a much higher ratio than amplitude modulation under the proper conditions; namely, if the frequency swing or excursion is sufficiently great and a limiter is employed.

It can be shown mathematically that ordinary noise is composed of sine wave components, all of the same amplitude, and having frequencies that extend continuously throughout the useful spectrum. Consider one of these components, somewhat higher in frequency than that of the carrier, and of relatively small amplitude. In Fig. 4, AB is such a noise component rotating counterclockwise, and OA is the carrier. It will be recognised as being similar to the upper side band shown in Fig. 3 (A) or (B), but now it cannot be paired with a corresponding lower side band, because the noise components are entirely random in phase. Hence its resultant with OA must be studied separately from the resultants of other noise components with OA.

It is clear from Fig. 4 that the resultant OB has both amplitude and phase (and frequency) variations. The amplitude variation is from a maximum of OA + AB to a minimum of OA-AB. If the carrier were 100 per cent. modulation with a desired signal, the amplitude of OA would vary from zero to 2 OA. Hence the signal-to-noise ratio would be in the ratio of OA to AB.

Noise on F.M.

If the carrier is to be frequency modulated, then the signal-to-noise ratio is not so simply expressed The amount of frequency modulation produced by AB depends not only upon its amplitude, but also upon how much it exceeds OA in frequency, since an increase in either will increase the rate of change of θ that is, will increase d$^{\theta}$/dt.

However, for a given noise amplitude, length AB is fixed. Therefore, if AB exceeds OA considerably in frequency, d$^{\theta}$/dt, or the noise frequency modulation will be higher, whereas if AB is close to OA in frequency, the noise frequency modulation will be lower. Since there are noise components throughout the spectrum it may be expected that those differing considerably from the carrier frequency will produce considerable noise frequency-modulation.

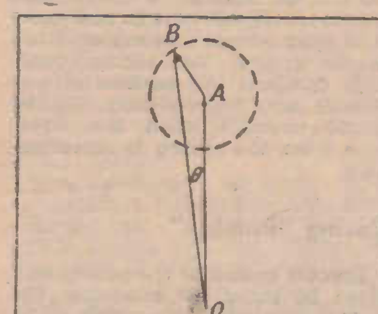
Effect of Noise Frequencies

Fortunately, there is a limit to this. If a noise component differs from the carrier by more than 15,000 c.p.s.—say 20,000 c.p.s.—then it will produce considerably more noise f.m. than a component differing by only 100 c.p.s. from the carrier but in the output of the receiver the former component will produce a 20,000 c.p.s. wave, **which is inaudible**. Hence noise components differing from the carrier by more than 15,000 c.p.s. or so actually cause no trouble even though they may produce considerable frequency modulation.

On the other hand, the transmitter can be readily designed to produce a large frequency swing when even a 50-cycle desired signal modulating wave is impressed. Suppose the frequency swing is ± 75 kc. (Remember that the carrier swings through this large range only 50 times per second). Suppose, on the other hand that the highest troublesome noise component (that 15 kc removed from the carrier) produces only a 5 kc frequency swing, although there are 15,000 such 5 kc swings per second.*

The signal-to-noise ratio will then be 75,000/5,000 = 15: 1 on a voltage basis, and this can be considerably higher than the signal-to-noise ratio obtained in amplitude modulation.

In short, by causing the desired signal to produce a large frequency shift a large signal-to-noise ratio can be obtained. A large frequency shift is not difficult to obtain; the amplitude of the wave remains constant, and all that is required are circuits of sufficient band width to accommodate the side bands produced by such a large swing. In amplitude modulation, on the other hand, there is a limit to how large the amplitude can be made compared to a given noise amplitude; a given carrier amplitude cannot be less than zero on inward modulation.



Since noise consists of all frequencies, consider that portion of the noise spectrum composed of frequencies extending from 15 kc below to 15 kc above the carrier frequency. As explained previously, those components close to the carrier in frequency produce the least amount of noise frequency modulation; those farthest from it (15 kc at most) produce the most noise frequency modulation. The total effect of all components, on any energy basis is, MAX SIGNAL/

$$\text{NOISE} = \frac{3\ (Fe)^2}{f_h}$$

where f_h is the highest audible frequency, say 15,000 c.p.s. and fe is the peak frequency excursion produced by the signal, say 75,000 c.p.s. The quantity 3 gives the averaging effect for all noise components from

(Continued On Page 46)

* Note that 5 kc is the deviation of the r.f. wave from its carrier frequency value, and 15 kc refers to the number of such deviations per second. The 5 kc corresponds to the amplitude of the modulating wave; the 15 kc corresponds to the modulating frequency.

For your note book

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

SERVICING CRYSTAL PICKUPS

As there are a number of troubles directly and indirectly traceable to crystal pickups, it is important that the serviceman be able to recognise them and know the proper remedies for them.

Crystal pickups are often the cause of *"rumbles"* or *"growls"* which are a source of annoyance to the listener. Although the crystal can be replaced, a simple cure that is usually effective in such cases is to wrap several thin rubber bands neatly around the pickup head. This dampens the mechanical resonance and consequently will be found effective when the direct tone from the pickup is objectionable.

Curing "Rumble"

Rumble caused by the pickup may often be cured by mounting the pickup base on a soft-rubber cushion. However, before making this change make sure the rumble effect is actually due to the pickup and not the record itself.

Another method of minimising rumble due to the pickup is to attenuate the low-frequency response by connecting a resistor across the pickup output. The correct value of this resistor must be determined by experiment. Start off by using a value of about 20% of the pickup load, and then increase or decrease the value until satisfactory operation is obtained.

A feature of the crystal type pickup is that it will provide a large output voltage but should this become excessive, the input stage may become overloaded resulting in poor quality and distortion. One method of remedying this condition is to shunt the pickup with a capacitor of approximately 0.001 mfd.

Heat Deleterious

It should be remembered that crystal pickup cartridges should never be subjected to excessive heat. They will be permanently damaged if subjected to temperatures above about 130 degrees F., even for a very short time. A source of heat seldom taken into account in home installations is the normal rays of the sun beating on an exposed crystal pickup, especially during hot summer weather.

This, in time, will damage the crystal in the same manner as will the application of heat to the exposed pickup from any other source. Consequently the lid of the record player should always be kept closed when the pickup is not in use.

Increasing Pilot Light Life

The life of 6.3 volt pilot lamps as used in a-c receivers and amplifiers can be increased by soldering the leads to the 5.0 volt rectifier instead of to the usual 6.3 volt heater winding. Reducing the voltage in this manner will approximately treble the life of the lamp.

One point to watch is that both contacts of the socket are thoroughly insulated since the light will now be at a high voltage with respect to the chassis. Unless this is done the lamp holder may cause a short circuiting of the high tension voltage or a severe shock.

For those who may not care to have the lamp at a high voltage with respect to the chassis, or if a 5.0 volt winding is not available on the receiver, the same effect can be obtained by simply wiring a 10 ohm resistor in series with the lamp.

Use For Old File

A handy constructional tool can be made from an old three-cornered file. By grinding down the sides to sharp edges, it will be found useful for scraping, stripping wire, as well as numerous other operations.

One end of the file can be ground to a chisel point, and the other to a round point, and it will be found handy for holding or prying up wires which are to be unsoldered, etc.

Handy Service Tool

The spring type of clothes peg now readily available from many stores can be easily fashioned into a handy service tool, by gluing fine emery cloth on the jaws and cheeks of the pin.

This simple gadget will be found useful for removing the enamel insulation from thin wire when it is pulled through the emery cloth. The emery cloth glued on the outside of the jaws can be used to clean connection joints or remove the insulation from larger size wires.

RADIO FREQUENCY MEASURING EQUIPMENT

By ALAN WALLACE

Following on from the previous article, which detailed the theoretical aspects of Panoramic Adapter design, we now present constructional details for building such a unit suitable for use with any conventional receiver.

The general operating principles of the panoramic adapter together with its possible uses were detailed in the previous article, and consequently now the constructional details for building up a typical unit will be given. In order to make the unit one which may be constructed with a minimum of expense and least difficulty, without sacrificing the high order of sensitivity and linearity essential in its operation, it will be seen that only standard components readily obtainable from most radio stores have been used in the design.

Simple Power Supply

The circuit arrangement follows broadly along the lines detailed last month, and it will be noticed that a particularly economical form of power supply arrangement is used, producing approximately 500 volts of HT for the CRT and about 250 volts for the amplifier and mixer stages. The input to the adapter is taken from the mixer plate of the associated receiver, through a 1.0 megohm resistor, to the grid of the 6K7 input stage.

The purpose of this resistor, which need only be of the ½ watt type, is to eliminate any detuning of the receiver IF through the connection of the adapter. Whilst a 6K7 tube has been used in this equipment, a 6SK7 or 6SJ7 could be used equally as well.

In fact, in applications where premixer gain is sufficiently low to eliminate the possibility of overloading, a sharp cut-off tube, such as type 6J7, may be used, with a slight increase in the available gain. In this latter case, it may be desirable to increase the value of the series screen resistor somewhat, in order to allow the gain to be effectively controlled by the variable bias method. Alternatively, it would be quite possible to control the gain of the unit by variation of the potential applied to the screen.

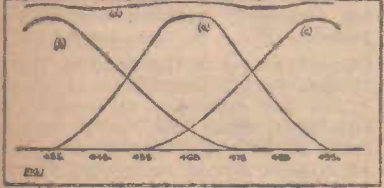


Fig. 1.—Detuning the coupling transformer as explained in the text, results in the general response curve shown in (d).

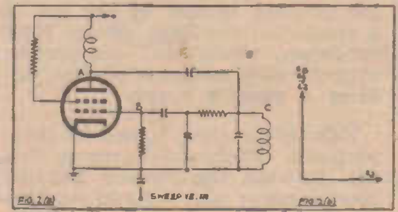


Fig. 2.—(a) The basic reactance tube circuit and in (b) the associate vector diagram.

It was mentioned briefly last month that it is necessary, in the input stages of the panoramic adapter, to apply some correction circuit, in order that the response of the unit will not vary unduly over the desired range of 100 Kcs., and in particular, will not exhibit a pronounced resonance peak in the vicinity of the receiver Intermediate Frequency. In this unit, a measure of correction is applied by the de-

Part 6

CONSTRUCTING A PANORAMIC ADAPTER

tuning of the coupling transformer, T1, in such a manner that a more or less uniform response is achieved.

For this particular purpose, a standard IF transformer was used, and the primary was adjusted so as to resonate at 435 Kcs., whilst the secondary was tuned to a frequency of 495 Kcs., producing the effect shown in Figure 1. Curve (a) is the response curve of the receiver IF transformer, (b) is the response curve of T1 primary and (c) is the response curve of T1 secondary.

This results in a general response curve over the system as at (d), which, although not perfect, is quite adequate for this application, considering the size of the screen. It is particularly important to ensure that this transformer is aligned in this manner before attempting to use the instrument, and the procedure for doing so is given in full at the end of the article.

6SA7 Mixer

It was decided to use a type 6SA7 as the mixer tube in this unit, thus ensuring that the oscillator coil, L1, will be readily available. Since the frequency of the local oscillations produced must have a mean value of 290 Kcs., it has been found possible to use a standard 455 Kcs. BFO coil in this connection. With certain coils, it may be found that it is not possible to tune them to the correct mean frequency, and in this event it may be necessary to add a small amount of inductance, as for instance, a small RF choke connected in parallel across the winding.

In order to produce the desired variation in the frequency of this oscillator, a reactance tube is employed in this unit, which whilst operating along the general lines detailed in last month's issue, has certain small differences which may require explanation. The basic circuit is shown in Figure 2a, with the associate vector diagram in Figure 2b. It will be seen that a 6AC7

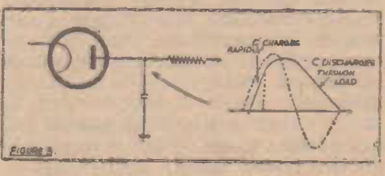


Fig. 3.—The waveform obtainable from the first filter condenser in the power supply.

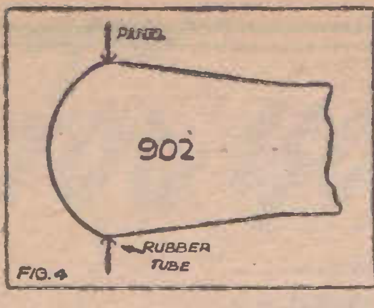


Fig. 4.—This diagram shows the method of mounting the front end of the cathode ray tube.

pentode is employed, connected in such a manner that, whilst its RF plate potential is virtually in phase with the applied signal as exists at the top of the coil, the grid voltage, and hence the instantaneous plate current, is caused to lead the applied voltage.

Variable Capacitance Effect.

Thus the device is equivalent to a variable capacitance connected across the coil terminals, the value of which varies in accordance with the voltage applied to the grid, in this case the time-base voltage, which is derived as explained later. The 25mH RF Choke specified in the anode lead may be any standard type, the ordinary honeycomb component being quite suitable, and its purpose is to place the plate of the tube at a high impedance to ground with respect to RF voltages.

The function of the 250K resistor in series with the applied saw-tooth voltage of course is to prevent the leaking away, through the sweep circuit and power supply filter condensers, of the RF voltage which is simultaneously applied to the grid of the 6AC7.

Considering the simplicity aimed at in this particular circuit, it was not considered desirable to use a separate saw-tooth time base, if it could be avoided, and the possibility was considered of using a sinusoidal sweep from an AC source. However, in view of the phase shifts which can occur in various parts of the circuit, it is quite possible, using a sinusoidal sweep, to get entirely incorrect and misleading results on the screen. Although phase correcting circuits are quite simple in operation, their adjustment without adequate comparison equipment could prove to be rather difficult. Hence it was decided to use a very convenient source of saw-tooth voltage which is available on the power supply itself—that is the ripple on the first filter condenser in the CRT supply.

Ripple Component

This ripple, which is really the AC component of the voltage upon the condenser is shown in Figure 3, and has a waveform of the desired shape. This is due to the fact that, while the rectifier is charging, the condenser is charging through a relatively low impedance, whereas during the non-conduction period of the rectifier the condenser is discharging at what is really an exponential rate, but, owing to the brief space of time involved, is for our purposes, sufficiently linear.

In order that this voltage will have sufficient amplitude to provide a satisfactory sweep, this first condenser is deliberately made small, any increase in the ripple content of the voltage fed to the CRT being guarded against by the use of a comparatively large second filter condenser, which in conjunction with the 10 K dropping resistor, ensures a smooth supply.

This voltage then, is used for three purposes. First, and foremost, it is fed, through the "Sweep Length" potentiometer and a .5mfd condenser, to the free X plate, thus providing the horizontal sweep for the CRT. Secondly, it is fed through the "Bandsweep" control and another .5mfd. condenser to the grid of the reactance tube. Since this "Bandsweep" potentiometer controls the amplitude of the voltage fed to the reactance tube, it will be seen that this will thus effectively vary the frequency of the local oscillator, and hence the portion of the spectrum surrounding the tuned signal which is represented by the trace on the screen.

Calibrating Scales

As this will vary with different instruments, it is very necessary, therefore, in the absence of any sweep padder arrangements, to calibrate both this control and any arbitrary scale which may be attached to the CRT screen, before putting the instrument into use. The third use to which this voltage is put is to supply, through a small condenser, a pulse, which, when applied to the cathode of the CRT will brighten the trace for the duration of the forward going sweep, and tend to extinguish the flyback, on the return trace.

We must now consider the circuits determining the instantaneous selectivity of the instrument, or its power to resolve between signals on adjacent frequencies. This factor is determined by the characteristics of the IF channel, and although overseas practice is to employ 100 Kcs IF transformers in an instrument of this type, again in the interests of availability of com-

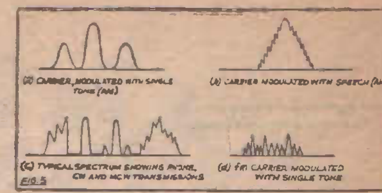


Fig. 5.—Typical traces of various types of transmissions.

ponents, we have selected an intermediate frequency of 175 Kcs, as transformers for this frequency are readily available at present. Subsequent to the completion of experimental work on this unit, a line of transformers has been released by the Aegis Manufacturing Company, with a frequency of 50 Kcs. It is considered that the inclusion of these transformers in the unit would be very desirable, and would necessitate no other changes than perhaps certain alterations in the constants associated with the reactance modulator, and local oscillator.

High Selectivity Necessary

Since it is desired that the utmost in selectivity be achieved from the IF stage it is necessary that the transformers must be selected accordingly, and also, in order to achieve this end, a type 6SJ7 is employed, running at a fixed gain setting. Although this is nominally a sharp-cut-off pentode, a small degree of protection against the possibility of overloading is afforded by use of a high value of screen resistor, the effect being to somewhat extend the grid-base of the tube.

However, it must be borne in mind that, although a maximum of selectivity is desirable, there is a limit, if full sensitivity is to be realised. This limit is determined both by the Q of the most selective coils in the system, in this case, the IF transformers, and by the rate at which the screen is being swept.

A useful expression which may be employed to check that the sweep rate in any particular instance is not too high for the width of band which is being swept, is that

$$T = \frac{4\,(F_{max} - F_{min})}{f^2}$$

seconds. In this equation, which is applicable to IF's having a Q of 100, T is the minimum sweep period in seconds, F_{max} is the highest frequency reached during the sweep. F_{min} is the lowest frequency, and f is the desired visual resolution, all frequencies being in cycles per second. Of course in this unit, since the sweep rate is fixed at 50 cycles per second, this expression cannot be applied except as a check, but it will certainly be of interest to any constructors designing their own sweep circuits.

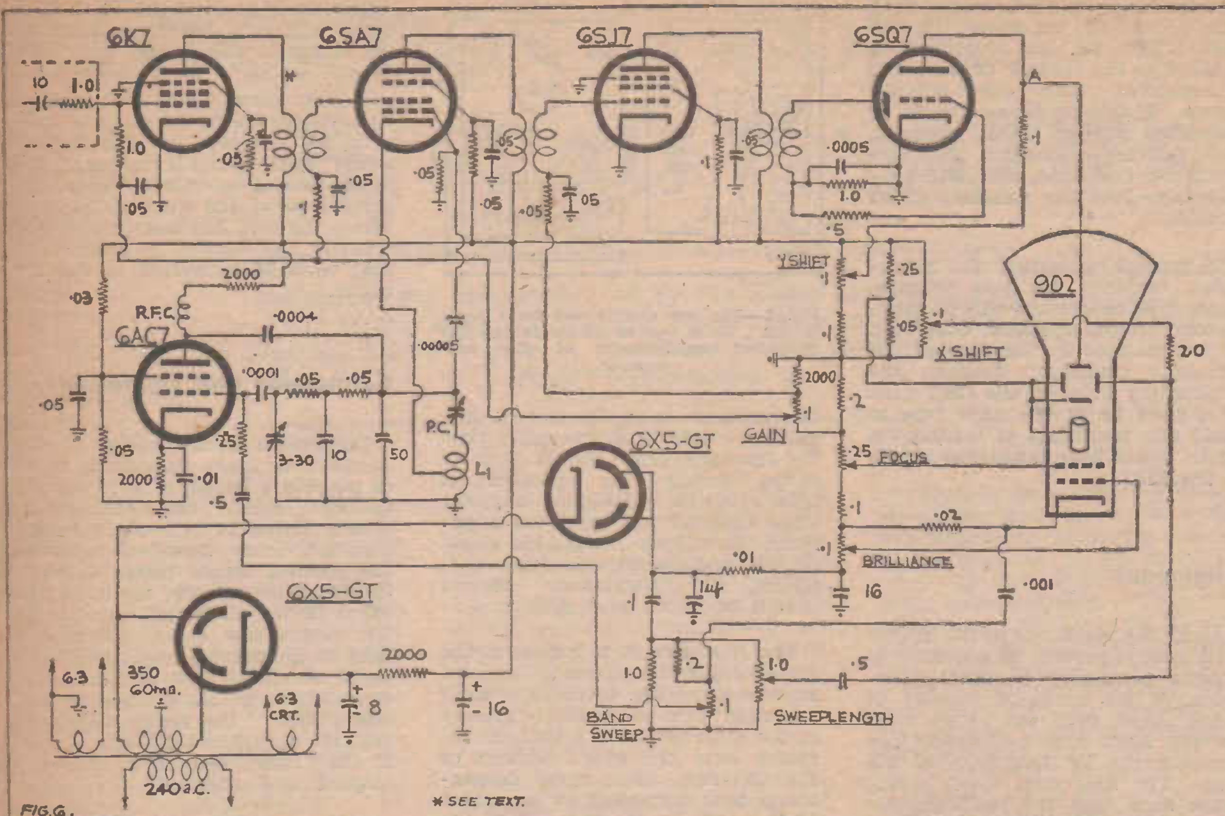


Fig. 6.—The complete panoramic adapter circuit. Note the use of a standard type power transformer for the CRT H.T. voltages. All components used are standard, thus enabling the unit to be readily duplicated.

From this stage the signal is fed to the detector circuits, where, although several variations were tried, it has been found that a standard diode detector, directly coupled to the grid of the amplifier tube, is the most satisfactory. It was found in practice, that the bias produced by the rectified current through the diode load resistor was quite adequate, using a 6SQ7, and no additional bias was necessary.

Avoiding Phase Shift

In order to avoid the introduction of any condensers into the circuit at all, thus obviating the possible occurrence of phase shift and loss of sensitivity, the output of the amplifier is fed directly to the free vertical deflection plate of the 902, the other plate of course being internally connected to the second anode.

The bottom end of the anode load resistor for this tube is returned to the moving arm of a 100k potentiometer, "Vertical Shift," which is connected into the divider network in such a way that it allows the potential at A, i.e., the mean potential of the Y plate, to be varied about the potential at point C. This corresponds to the potential of the second anode, to which the other Y plate is connected, thus providing an instantaneous control over the position of the trace on the screen. The "Horizontal Shift" operates in a similar manner, although in this case, since the sweep voltage is capacitively coupled, the shift voltage must be applied through a 2 megohm isolating resistor, the nett effect being the same.

Construction of the Unit

As will be seen from the diagrams, the unit is constructed along quite conventional lines, and should present no great difficulty to the average enthusiast. However, it must be stressed that particular care should be taken with all wiring, as any mistakes made will not make themselves obvious as is often the case with a normal receiver. It was decided to adopt the current American practice of earthing all cathodes, and one side of the heater circuit, directly at the valve socket to an earth bus system running around the chassis, as thereby many long leads are eliminated and the wiring is greatly simplified.

The top-chassis drawing illustrates the method of mounting the CRT above the chassis on a metal bracket, immediately in front of the power transformer. This places the transformer on the extension, as it were, of the axis of the CRT. and hence minimising hum pick-up on the actual beam of the tube, which is always likely to be a problem when a power supply is mounted on the same chassis as the tube.

It may be necessary, in some cases, if hum trouble is encountered, to try orientating the transformer for best results, and perhaps even totally enclosing the tube in a metal shield. However, this should not be normally necessary. It is essential to arrange the socket of the tube in such a manner that its position may be adjusted, so as to enable correct positioning of the tube; it would look rather ridiculous to have all the signals running up a 45 deg. incline!

The method of securing the front end of the tube is shown in Figure 4, and consists of the employment of a small circle of rubber tube, as for example, from some thin coaxial cable, as a "liner" around the inside of a hole cut in the panel. Against this the tube is held by the pressure of the socket mounting plate, making a support which is both neat in appearance, and mechanically rigid.

The only other construction point worthy of mention is that special care should be taken to ensure that the electrolytic condenser in the CRT supply, i.e., the supply which is taken to the cathode of the CRT, is connected with the polarity shown. If this condenser should be connected in the normal manner, with its can earthed, it will certainly be destroyed, and will probaby also ruin the associate 6X5G rectifier.

In general throughout the instrument, ordinary 400 volt working, paper type condensers will be satisfactory, unless specified otherwise, as for example in the case of the .001 ufd. condenser feeding the brightening pulse to the CRT grid. This must be of the mica type to avoid any possibility of breakdown, which would have disastrous results to the CRT.

Alignment

Again the alignment of the instrument should present no difficulty to anyone possessing a signal generator, or an oscillator capable of being tuned over the range from 290-470 Kcs., and preferably also covering the IF frequency of 175 Kcs. The first step, after having made sure that the oscillographic portion of the equipment is functioning correctly, is to align the IF transformers. This is most easily accomplished by connecting the output of the signal generator to the grid of the mixed tube, with the "Bandsweep" control at zero, in order that a varying local oscillator frequency will not cause any disturbing effects.

Following this, the IF transformers may be lined up in the usual fashion, indication of resonance being taken from the maximum displacement of the trace on the CRT screen. The deflection, of course, at this stage will only be a vertical displacement of the trace, and will have no peaked characteristic as yet.

Local Oscillator Adjustment

Having aligned the IF's, the mean frequency of the local oscillator must next be set. To do this, the signal generator, still connected to the mixer grid, is tuned to the intermediate frequency of the receiver being used with this unit in the author's case 465 Kcs. as the receiver was a CR100.

The slug on the oscillator coil (or parallel trimmer, if the coil has no slug) must now be adjusted until maximum deflection is again indicated, thus signifying that the lo-

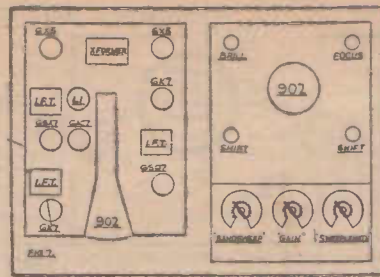


Fig. 7.—The top chassis and front panel layout. These can be varied to suit the individual requirements of the constructor.

cal oscillator is at the correct frequency. Note, it is necessary that the Reactance Tube should be in its socket during this operation, as otherwise, its additional capacity when inserted will upset the alignment. Of course, through the whole of this preliminary alignment procedure, the "Bandsweep" control should be in its zero position.

The next circuit to adjust is the mixer input transformer, and as mentioned earlier, this step is most essential, and contributes greatly to the achievement of a uniform response over the swept portion of the spectrum. The signal generator is now connected to the input of the unit, i.e., to the grid of the 6K7 input amplifier, and is first adjusted to a frequency 30 Kcs. below the IF of the receiver, in this case, 435 Kcs. Now the primary only of the input transformer is adjusted until resonance is indicated as before; with certain transformers it may be necessary to add a certain amount of additional capacity to allow the attainment of this frequency.

Adjusting Secondary

Having completed this step, the secondary of the transformer must now be adjusted to resonate at a frequency 30 Kcs. higher than the receiver IF frequency. This is accomplished in the same manner as with the primary, except that, in this case, it may be necessary to remove the small fixed trimming condenser across the secondary winding and replace it with a smaller value, before the desired frequency can be attained.

It should now be possible, by advancing the "Bandsweep" control, to obtain a peak in the curve on the screen, corresponding to the setting of the signal generator, although it will be noticed that the gain is far from uniform, as one tunes from one end of the range to the other. However, this is the correct characteristic allowing as it does compensation for the selectivity characteristics of the receiver, which is sharply resonant at the centre of this range.

At this stage opportunity should be taken to check the range of frequencies covered by the "Bandsweep" control, and if necessary, the series resistor modified to give this potentiometer the correct coverage. When the unit has been completely checked and aligned as detailed, it may then be connected to the receiver.

Connection and Operation

Connection to the receiver should normally be made through as short as possible a length of low-capacity co-axial cable, the components shown dotted in the main circuit diagram being mounted right at the receiver mixed plate. This is necessary in order to minimise the effect of the additional capacity of the connecting cable, which will tend to detune the receiver IF circuits. It should now be found that signals to an extent of about 50 Kcs. either side of the centre frequency will be reproduced on the screen, if the unit has been correctly aligned and adjusted.

If it is desired to observe the modulation envelope of the station being received, as for instance, to determine the depth of modulation, it is only necessary to turn the "Bandsweep" control down to zero. Then, since no frequency variation is taking place, only the desired station is presented on the screen.

According to the type of transmission being received, the pattern will vary, and several typical traces are shown in Figure 5, but after a little practice, the operator will get to recognise various types of transmissions, and will be able to make more or less accurate observations of depth of modulation, highest frequencies radiated, the presence of any spurious radiations, or any other such phenomenon.

DISTORTION — DOES IT REALLY MATTER?

Details of the discussion held by the Radio Section of the I.E.E. (Eng.), when the subject "To What Extent Does Distortion Really Matter in the Transmission of Speech and Music" was debated.

In asking the question whether this or that distortion in the reproduction of sound "mattered," it was necessary to define the conditions. The absence of a few octaves did not matter to the telephone user, nor was the listener disturbed by distortion if the programme was vitally interesting. On the other hand, the sensitive ear of a musician resented the combination tones and the missing frequencies which were too often the characteristics of the reproduction of orchestral performances.

There were technicians who argued that all types of distortion mattered and that, until the sound field to which the ear of the listener was subject was an exact replica of that in which the microphone was situated, their task would not be complete. Others, however, believed that the inevitable artificialities of practice denied the possibility of really faithful reproduction. Those adherents believed that just as a two-dimensional picture of a three-dimensional subject could be harmonious and beautiful, so an artificial reproduction of sound could give pleasure and evoke emotion. Assuming that argument to be true, then some forms of distortion did not matter.

Ear Final Judge

Thus, while we could not have binaural reproduction and had to contend with the super-imposition of the acoustics of the place in which we listened on those of the place where the sounds were received by the microphone, the result would inevitably lack absolute fidelity. As fidelity was finally judged by the ear of a human being with an emotional capacity, the technician would have to learn to what extent he might synthesise the original sound in order to evoke emotion and give pleasure to the human being.

Generally speaking, the public who listened to broadcasts, recordings and public-address systems were satisfied; they tolerated distortion for the sake of an ultimate pleasure or convenience. This toleration of the public, however, did not justify the technician's neglect of the outstanding problems of reproduction to obtain better synthesis, giving more pleasure and convenience for everyone.

Technical Aspects

Turning now from generalities to a more technical examination of the problem, the most obvious deficiency was the failure to reproduce the full audio spectrum because the upper-frequency region was subject to serious attenuation. Efforts had been made during recent years to increase the frequency response by one or two octaves, but the result, at least to some ears, had been singularly disappointing—the "glitter" of the modern "top" was more offensive than the previous mellow boom, so that listeners were often thankful for a tone control which eliminated the unpleasant harshness.

A recent consensus of American opinion had shown that the average person did not like high-fidelity reproduction. If high-fidelity reproduction meant the mere inclusion of a greater proportion of high-frequency waves and the disregard of any other factors, then American opinion was agreeable. One had to ask why a loudspeaker, which gave a reasonably constant output power over a wide frequency band, should, under steady-state conditions of measurement, nevertheless give a reproduction of speech and music which, by aural judgment, was unsatisfactory.

An uninformed opinion might have suggested that the wider the window was open the more dust was blown in, or, to put this analogy in technical phraseology, harmonics and combination tones might dominate the feeble components of the upper spectrum, and therefore it was better to remove everything than to be left with a host of spurious tones which masked the subtleties of the upper register. If the difficulties encountered in reproducing a clean "top response" consistent with low production costs were too formidable, then the question arose: What shape would the attenuation-frequency characteristic curve have to take in order to give the most pleasing synthesis?

Effect of Frequency

Some while ago opinions were expressed that a loudspeaker giving a maximum response in the middle register, i.e., 800-1200 c/s and an attenuation curve rising symmetrically on either side of this peak, produced a result more acceptable than that obtained with a curve which was a symmetrical about a middle-frequency band. Had that proposition been examined, and if so was it valid when tested scientifically?

In that connection, it had been stated that better results could be obtained when using a characteristic that showed falling attenuation for rising frequency; this artificiality was said to balance that arising from the superimposition of the acoustics of the room in which the listener was situated on those of the studio or auditorium whence the sound waves emanated.

Reports on the progress of research on the vibration of loudspeaker diaphragms and armatures would be interesting. A theory existed that a distortion in reproduction was caused when any moving mass in a transducer continued to vibrate after the stimulus causing it was cut off abruptly. Perhaps that had some bearing on the difficulty in obtaining satisfactory wide-band response.

Many modern amplifiers produced combination tones and harmonics. Even harmonics were said to produce less offensive distortion than odd harmonics, owing to their octaval relationship. Combination tones were probably more offensive than harmonics. Therefore, assuming a distortionless amplifier, it seemed probable that many loudspeakers themselves produced combination tones owing to their nonlinear response curve with changing amplitude.

If this discussion was to be comprehensive, it should not be confined wholly to considerations of broadcast and gramophone reproduction. An increased intelligibility of the public telephone service would be of real value. It appeared that a great deal of work was centred upon the receiver, whereas the carbon transmitter remained the weak link in the chain. What were the plans to improve matters on both a long and a short-term basis?

Measurement Problems

Another difficult problem was measurement. How, for instance, was it proposed to extend the frequency range at which accurate measurement of sound power could be made; was the probe microphone to remain limited in use to frequencies up to 3-4 kc/s a gamut in which it had proved so valuable?

Returning to broadcasting, it was disappointing to note that relatively little improvement had been made over many years. This was not to say, for instance, that, when a modern, expensive receiver was situated close to a powerful broadcasting station, it could not take advantage of the many valuable improvements which had been made in studio, microphone and recording techniques (and which were sometimes available to the public).

The point it was desired to make was that the average middle-priced domestic radio receiver used in a normal manner gave only an average result because usually the available frequency spectrum was limited by sideband interference. So long as radio programmes were distributed by the obsolescent system of radiating modulated long and medium carrier waves, so long would the incentive to make available to the public better reproducing instruments be lacking. The public had grown accustomed to accept a mediocre standard of clarity from their radio receivers; that tolerance of the public ear encouraged laziness.

Thus, while it would be of no value to set up high-fidelity transmitting systems if the average receiver could only handle the signals by reproducing additional harsh upper octaves, yet it would at least provide the basis to obtain that better synthesis which, while not necessarily reality, would be a greater source of pleasure.

General Discussion

The discussion which followed showed that, while there was reluctance to abandon the thesis that perfect reproduction could ultimately be achieved, most speakers thought that there were limits of technical elaboration and cost which at the present time prevented practical realisation of perfection by known methods. In any system of distribution—broadcasting wire relay or gramophone records—the originators of the programme had no control over the reproducing equipment, which included the listening room.

One speaker contended that perfect reproduction was impossible in the average living room, not only because there were characteristic modes (*Eigentone*) which might increase the sound level by as much as 25 db at some frequencies, but also because the repetition frequency of reverberation of sound pulses (e.g. single staccato notes) was much higher than in a large concert hall and had an irritating effect. The contrary view was expressed by another speaker, who contended that the ear was conditioned to accustomed surroundings and became alert only to unaccustomed conditions; e.g., a bathroom or the Albert Hall.

Under steady-state conditions the room acoustics were relatively unimportant, and subjective curves of the loudness/frequency response of the same loudspeaker than in "live" and "dead" rooms showed only minor differences. The rate of decay of vibration in a loudspeaker after the input had ceased might be passed unnoticed if they were similar to the reverberation characteristics of the listening room.

Loudspeaker Weakness

The loudspeaker was notoriously the weakest link in the chain and could be a prolific source of harmonics and combination tones. A three dimensional-model was shown of the amplitudes of harmonics developed by the loudspeaker for various fundamental input frequencies throughout its range. This indicated wide variations of amplitude characteristic with frequency. There was also much to be learned about the relationship of the electrical and mechanical impedances of a loudspeaker.

The difficulties of extending the high frequency range were discussed at some length. It was thought that the experiments of Chinn and Eisenberg in America did not prove that listeners preferred a restricted frequency range, but that they objected to subtle distortions introduced by the equipment. The quality of the high frequency response could be judged by listeners to top cut; in a bad reproduction the result would be described as "mellow," in good reproduction as "muffled." The experiments of Olsen with direct listening through acoustic-filter screens confirmed this opinion.

Treble vs. Bass Response

One speaker thought that too much attention had been given of late to high frequency response and it was of even greater importance to make sure of clean bass response, since harmonics of low frequencies could cause trouble over a wider frequency range.

The presence of combination tones was not always a sign of distortion in the equipment. The orchestra itself was a prolific source, particularly when there was faulty intonation in the playing. It was necessary for engineers to learn to distinction the origin of combination tones and to this end direct comparison between the original and the reproduced sound should be made on every possible occasion. It would be found that the tolerance of the ear for distortion depended to a marked degree on the nature of the programme material.

Controversy developed over the value of the trained musician as a judge of quality of reproduction. Some speakers held that excutant musicians such as organists, who were skilled in selecting and combining tone colors, could give valuable advice; others held that musicianship was a disadvantage, since it was an intellectual rather than a sensory talent. The form of composition and the technique of performance took precedence in the mind of the musician listener over the quality of the individual instrument. Perfect reproduction was not essential, and a synthesis giving a satisfactory resolution of the various instruments of the orchestra would carry all the information necessary to the enjoyment of the composer's ideas.

Long-Distance Television

All records for long-distance television reception were broken recently when a transmission from Alexandra Palace was resolved in Cape Town—nearly 6000 miles.

Having picked up on occasions the television sound channel, an amateur, H. Reider, secured from this country a standard Pye B16T receiver in the hope of receiving a picture. This set was used successfully without pre-amplification.

It had been predicted that long-distance working on very high frequencies would frequently be possible during the month.

Amateur NEWS *and* VIEWS

CONDUCTED BY KEN FINNEY

WIA Federal Executive

The WIA recently announced the members of the Federal Executive for 1949. The personnel are:

Federal President: W. Gronow VK3WG.
Vice - President: A. Glover, VK3AG.
Secretary: W. Mitchell VK3UM.
Treasurer: P. Evans, VK3OZ.
Q.S.L. Manager: R. Jones, VK3RT.
Publicity Officer: G. Manning VK3XJ.
Traffic Officer: J. Tutton, VK3ZC.
Contest Manager: E. Jenkins, VK3QK.

With the VK3 broadcasts on Sunday 1100/1130 Hours, official stations of the Wireless Institute in all States being as follows:

VK2WI, Monday, 2000/2030 hours.
VK3WI, Sunday, 1100/1130 hours.
VK4WI, Tuesday, 1930/2000 hours.
VK5WI, Friday, 1900/1930 hours.
VK6WI, Thursday, 2030/2100 hours.
VK7WI, Wednesday, 2130/2200 hous.

All times quoted being state local times and all transmissions are on the frequency of 3504 kc.'s.

Heard Island Stations

By the time this copy is read, the stations, VKIVU and VKIFE will be operating from Heard Island. This is officially recognised as a new country and will be included as Antarctica and so will be well worth trying for. A rather formidable antenna system is being erected at Heard Island, and the station should be heard on 14120 kc. around 2000 hrs. EAST.

CLUB NOTES AND NEWS

EXPERIMENTAL RADIO SOCIETY OF N.S.W.

Greenwood Hall, Liverpool Road, ENFIELD.

President: R.A. Blades (VK2VP)
Secretary: J. Carter (VK2OC)

This Club meets at Greenwood Hall each alternate Thursday night, the meetings for May being the 12th and 26th respectively.

It was with regret that the resignation was accepted of the Secretary, Mr. B. Taylor, whose services have been appreciated by all members. At the last meeting Mr. J. Carter, formerly the Publicity Officer, was appointed as Hon. Secretary.

The Club transmitter VK2LR has been on the air on the 7 Mc. band. Other equipment is nearing completion and the Club should be heard on several other bands in the near future. It is intended to hold a Field Day on Sunday, 29th May, and 144 Mc and 7 Mc equipment will be used.

All visitors and intending members will be welcomed and can be assured of a very interesting evening at the club rooms.

WAVERLEY RADIO CLUB

13 Macpherson Street,
WAVERLEY. . . . . .N.S.W.

Meetings of this Club are held at the above address every Tuesday night at 8 p.m. The present office-bearers are: **President, W. Johnston; Vice-President, H. Banks (VK-2MB); Secretary, J. Harrington; Treasurer, E. Johnson (VK2AFZ).**

The club's transmitter operates under the call sign VK-2BV, on the 20 metre band, but has not been on the air recently due to a complete overhaul of all equipment. The transmitter consists of a 6V6 tri-tet oscillator (using an 80 metre crystal), 6V6 doubler and an 807 final. The receiver is an 8 valve superhet.

It is anticipated that in the near future films will be shown at the club room each meeting night, thus making each meeting even more interesting. Visitors and intending members are always welcome at the club rooms, or further information can be obtained from the Secretary, Mr. J. Harrington, 92 Macpherson Street, Waverley.

GEELONG AMATEUR RADIO CLUB

65 Malop Street, Geelong

The recent DF field day held by the club proved such a success that it has been decided to hold another one in the near future.

Interesting lectures have been presented at the last two meetings. One of these was on "The Generation of Square Waves," presented by Mr. Jack Mitchell. This was well illustrated on the blackboard and by the use of a cathode ray oscillograph.

The following lecture, delivered by Mr. Cruickshank, dealt with the Cossor Double Beam Oscillograph. This lecture was well illustrated with several pieces of equipment, including a special camera used to photograph C.R. patterns.

Two new members were recently admitted to this club, and other interested radio enthusiasts should contact the secretary, Bob Wookey, VK31C, 158 Kilgour Street, South Geelong.

AMATEUR STATION — VK2AHZ — H. JACKSON

Harry, nicknamed "Bym" because of his "Believe You Me" saying is also referred to on the air as the "Mayor of Church Point." He is to be heard on 40 metres practically every evening, and should also be operating on 20 metres in the near future.

VK2AHZ consists of two separate stations, one being low power and one high power. The operating position is situated in between both station transmitters and receivers.

The main transmitter runs 98 watts input, the valve line up being 807 VFO-807 Buffer 807-813. The modulator is 811's driven by 6L6's, plate and screen modulated. Microphone is D104 crystal. The main receiver is all valve double conversion, superhet using army disposal dials and case.

The small transmitter is two stages—42 as crystal oscillator, 807 in the final, running 12-15 watts. The modulator for this is a 57 driving a 227 and 211E class A. The microphone in this case is a carbon. Receiver for this transmitter is a 4 tube TRF. His operating position has Press to talk switch with centre position OFF (Receive).

The antennae are end fed Zepp ½ wave on 40 metres, and matched impedance on 40 metres. As a final touch the antenna tuning unit is situated in a convenient position near the operating table so that the aerial current can be readily checked.

IN MEMORIAM

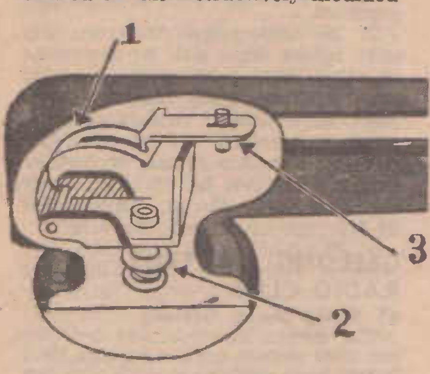
We regret to advise the passing of VK2GR, Alex. Robinson on February 19th, 1949. For the assistance he offered to new-comers in the Western Suburbs, thus enabling them to obtain their ticket, he will always be remembered. He was a member of the Gladesville District Amateur Radio Club, and was very active on the 14mc. amateur band.

Around The Industry

ACOS HIGH-FIDELITY CRYSTAL PICKUP

Designed to provide the utmost in high-fidelity reproduction, the new Acos GP12 crystal pickup should prove popular with all amplifier enthusiasts. Recent listening tests carried out with a sample unit indicated the excellent results possible when operated under the recommended conditions.

This new crystal pickup which has been specially designed for the connoisseur of recorded music, provides the user with the ultimate in high fidelity reproduction. Housed in an attractively-moulded bakelite arm, the unit incorporates the special crystal cartridge designed to prevent any damage to the crystal should the pickup arm be dropped onto a recording, etc. This cartridge is fitted with a permanent sapphire stylus, having a playing life of over 5000 recordings.



1. Weight compensating spring. 2. Spring-loaded swivel. 3. Weight adjustment.

Frequency Range

The useful frequency range of the pickup is from 25 to 12,000 cps, with the response being essentially flat over the entire range. The needle weight, which is adjustable to suit any particular operating conditions, is set at ½ ounce, and this in conjunction with the highly polished stylus, ensures minimum record wear. When correctly mounted the tracking error is less than 1.5 deg., and the needle scratch, noise and harmonic distortion are reduced to a negligible level.

To obtain maximum results when being used on commercial recording it is essential that a compensation network be used. The characteristics of the crystal unit are such that above approximately 250 cps, the response falls off at the rate of 6db per octave, and consequently a filter having the inverse characteristics of the unit response must be fitted. Typical circuit networks to achieve the desired results are included with each pickup.

Supplies of these pickups are now available from most radio distributors, whilst further technical particulars, including a special brochure can be obtained by writing or calling on the agents, Amplion (Aust.), Pty. Ltd., 36-40 Parramatta Road, Camperdown.

Attractive Radio Cabinets

From Slade's Radio Pty. Ltd., come details of a new range of radio cabinets which are now held in stock.

Both console and radiogram cabinets, in a variety of designs are available, with the prices ranging from 10 guineas for the console types. Attractively finished and constructed of first-class timbers, these cabinets should interest all requiring a high-grade cabinet either for a new set, or if modernising the present receiver.

Further details can be obtained either by writing or calling on Slade's Radio Pty. Ltd., Lang Street, Croydon.

New Eddystone Catalogue

A copy of the latest Eddystone catalogue has been received from R. H. Cunningham and Co., the Australian distributors for this equipment.

This booklet which is attractively printed, contains many items of interest to the amateur and short wave enthusiast. In addition to listing the already well-known short wave and transmitting equipment, several new lines have been included. Among these are a compact crystal calibrator, providing a high harmonic output up to 60 mc, a plug in signal strength meter, a 145 mc tuner unit and beam aerial assembly kit, and semi-automatic key.

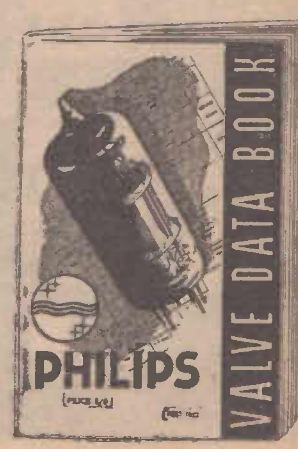
All readers interested in receiving a copy of this catalogue should write direct to the local agents, Messrs. R. H. Cunningham and Co., 420 William Street, Melbourne.

Philips Valve Data Handbook

Of interest to every radio technician, amateur and experimenter, is the recently-released edition of the Philips Valve Data Handbook.

Designed for quick and easy refence, this book comprises some 96 pages of valuable information dealing with over 700 different types of valves. Listed in an alphabetical and numerical order, these cover all the main American and European types, and in addition to giving the general operating characteristics, typical applications and valve base connections are detailed. A valve replacement guide and two pages of technical data on high vacuum Cathode Ray tubes are also included.

Copies of this booklet can be readily obtained from any Philips distributor, or by writing direct to Philips Electrical Industries Ltd., Clarence Street, Sydney. In either case, the price is the same, 1s 6d post free.



DX CENTURY CLUB
COVETED AMATEUR AWARD

In this article our Melbourne correspondent gives a few hints on how to work 100 countries and earn the DX Century Club Award—one of the most difficult of all amateur radio certificates.

There are many awards keenly sought by amateur radio enthusiasts all over the world. Of them all, the DX Century Club award must be the most coveted.

Sponsored by the American Radio Relay League, it is given to any radio amateur who can submit QSL card confirmation from 100 of the recognised countries of the world. Only stipulation is that every country claimed must be worked post-war and from the same location.

Few Holders of Award

Although tens of thousands are working day and night throughout the world for the award, less than 200 have received the coveted honor. It comes only after hours upon hours of listening and calling.

Just as the W.A.C. (Worked All Continents) certificate is the goal of every newcomer to amateur radio, so that DX Century Club is the aim of the veteran. Expansion of amateur radio and the setting up of stations in some of the remotest places on the globe have made the award easier than in pre-war years. To-day, the leading members of the club have more than 200 countries confirmed. In 1939 the No. 1 position holder was lucky if he had collected 110 countries.

Although the award is difficult, it is not impossible; bad locations can all produce some good contacts. In America some of the winners have even gained the award from apartment houses where the electrical interference and inability to erect a good clear antenna make the going really difficult.

One wonders why there are so few Australians on the list. Just because this country is isolated on the map should be no excuse for the VK call sign not appearing more frequently.

Operating Hints

Perhaps a few suggestions on how to work 100 countries would not be out of place. Those who think directional antennae and high power are necessary can forget this myth. One VK3 with 100 countries to his credit has done it with 70 watts and a folded dipole antenna.

The eagerly - sought DX Century Club award.

Although DX can be consistently worked on the 7, 14 and 28 m.c. bands, the 14 m.c. band is by far the most suited for the rarer contacts. It is, therefore, best to specialise for operation on this band which is normally open 20 hours of the day for international communication. During some nights it is possible to work all contacts between 8 p.m. and midnight.

Two most important necessities needed for working DX are a good clear well-insulated antenna and a V.F.O. (variable frequency oscillator).

By
ROTH JONES
(VK3BG)

Antenna Systems

First let us discuss the antenna. Many simple single wires lend themselves ideally for DX communication, and are quite easy to erect. One of the best for all round coverage is a full-wave length wire fed one quarter wave in from the end either by the new 72 ohm twin lead (which incidentally is now available in ample quantities) or by the unbalanced coaxial cable. Both will give highly satisfactory coverage. If placed east-west or north-south, the antenna's four main lobes will fall in areas where most of the stations are located. For all intents and purposes this antenna can be recognised as a general coverage type.

Another equally as efficient antenna used by thousands to-day is the dipole or folded dipole. Of the two, the latter is becoming far more popular. Made with 300 ohm cable for the radiator and feed line the whole affair is extremely light and places no undue strain on poles or fixtures.

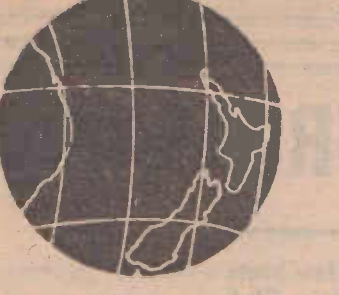
The dipole's main disadvantage is its lack of radiation at the ends, frequently necessitating the erection of a similar antenna at right angles. This, of course, is offset by the antenna's excellent characteristics broadside.

Handled intelligently, these antennae will work 100 countries in time.

They should be at least 35 feet high, cut accurately to the frequency used and insulated well at ends and feed points.

A good frequency to cut for 14 m.c. operation is 14,050 k.c.

(Continued on Page 47)



TRANS-TASMAN DIARY

By J. F. FOX

(Special N.Z. Correspondent)

3XC IS FIRST OF NEW STATIONS

The recently opened station, 3XC, Timaru, is the first of the five new stations planned by the New Zealand Broadcasting Services. Featuring both commercial and non-sponsored programmes, this new station will serve the large farming area South Canterbury.

In the latter part of last year Timaru became New Zealand's latest city. Situated on the East Coast of the South Island, Timaru is one of the Dominion's favorite holiday resorts. Each year around the Christmas and New Year holiday season thousands of visitors come to swell Timaru's 20,000 population.

With the growing up of Timaru, it is fitting that the Government should open a broadcasting station to serve the city and large farming area of South Canterbury.

The opening of 3XC is part of the long-range expansion plans being carried out by the New Zealand Broadcasting Service, and Timaru is fortunate in being the first of the five new stations to come on the air. When the station began transmission it saw the inauguration of a new type of programme broadcasting in this country, non-advertising and advertising periods being incorporated in the daily programme. By this method both the business community and the cultural sections of South Canterbury can have an equal share of the air.

Station 3XC broadcasts for seven hours each day, from 7.00 to 10 a.m., on Mondays to Saturdays, and 8.00 to 11 a.m. on Sundays, while each evening the station is heard from 6.30 to 10.30 p.m. The advertising periods are from 7.00 to 10 a.m., and 6.30 to 7.30 p.m.

Remote Control Transmitter

The transmitter, which is normally unattended, is situated at Washdyke, one and a half miles north of the City of Timaru, on a flat marshy site just above sea-level and 500 yards from the South Pacific Ocean. The carrier power is two kilowatts, and the frequency is 1160 kilocycles.

At present the station is operating with a temporary antenna of the folded-top type, rigged on two 70ft. wooden masts. A 175ft. steel mast will replace the present system later in the year. The aerial feed is by buried, co-axial cable. The unattended transmitter is a standard A.W.A. type J50551, 2 kw. unit, housed in a small building with suitable louvres for ventilation.

The transmitter is controlled by dialling on a selector system designed by the New Zealand Broadcasting Service, using the digits one to 10 to secure the following operations:—

(1) Power on.
(2) Filaments on.
(3) High-tension on.
(4) Transmitter off.
(5) Programme on Line 1; control on Line 2.
(6) Programme on Line 2; control on Line 1.
(7) Control circuit off; telephone on.
(8) Control line available for any other purpose.
(9) Operation normal.
(10) Line connected direct to transmitter; transmitter speech equipment off.

On completion of each sequence, an indicator lamp at the studio lights up, showing that the operation is completed.

The studio equipment is connected with the transmitter by two land lines, one line is normally used for controlling the transmitter, and the other for the programme. The power radiated from the transmitter is checked with a receiver using a calibrated signal strength meter.

Opening Ceremony

In declaring the station open on Tuesday evening, January 18, the Minister in Charge of Broadcasting, the Hon. F. Jones, said that as far back as April, 1944, the New Zea-

(Continued on page 47.)

RADIO COVERAGE FOR ALL-BLACK TOUR

The forthcoming tour by the New Zealand Rugby team to South Africa has caused a headache for those arranging radio broadcasts. Rugby followers in New Zealand will be anticipating an early morning rise to hear the Test matches—providing the broadcasts can be relayed successfully.

Receptions in New Zealand of stations from South Africa are regarded as the most difficult in the world. Although the South African Broadcasting Corporation has six shortwave transmitters (the highest power being 5 kilowatts) for relaying the medium wave stations, the Government of that country does not permit international broadcasting.

Two alternatives are available to the New Zealand Broadcasting Service: one is for them to arrange with an overseas shortwave station that can receive the African stations, then relay the programme. The other is for the programme to be relayed through a post office radio telephone circuit. If the former is used, the N.Z.B.S. may be able to have "Radio Ceylon" to act as a relay station, or the Australian Broadcasting Commission's Perth station. Reception of African stations is good in Western Australia.

In connection with the latter, up to the time of writing these notes tests were being carried out by the Post Office authorities in South Africa with one of their transmitters. Up to the present the reception tests of this transmitter have given poor results, according to advice received from the N.Z.B.S.

The Broadcasting Service have, however, made arrangements for Mr. Winston McCarthy, the well-known sports commentator, to accompany the team to South Africa and broadcast descriptions of the games. Mr. McCarthy will take a tape-recorder and record all the games. The recordings will be air-mailed to N.Z. and heard approximately two weeks later.

Mozambique To Assist

"Arrangements are being made by the New Zealand Radio DX League to monitor broadcasts from Mozambique in order to supply the New Zealand public with the Rugby scores as soon as possible," said Mr. A. T. Cushen, short-wave Editor of the "New Zealand DX Times."

"The League is certain from the recent tests between Lourenco Marques and Invercargill, that results of the games can be heard in New Zealand as soon as the matches conclude," he said; "the news could be released to the morning newspapers of the Dominion."

The president of the Radio Club of Mozambique stated he will be pleased to co-operate in every way, and expressed the hope that results would be announced within minutes of the completion of the games.

ON THE BROADCAST BAND

"ALL INDIA RADIO" TRANSMITTERS

With the approach of winter months reception of Asiatic broadcasting stations will gradually improve. Among the most widely received stations in this country are those operated by All India Radio and which are detailed in this article.

In trying to provide entertainment of interest to as many listeners as possible, the difficulties experienced by radio personnel concerned with the organisation of such programmes must indeed be great. However, in this country, they at least have not the worries of running programmes to entertain listeners speaking more than one language. When looking through the schedule of programmes broadcast over the stations operated by All India Radio one is able to gain some slight idea of just what a problem this situation presents.

In its attempt to provide entertainment and information to the people of India, the All India Radio network at present comprises some 16 medium wave and several short wave stations. It is reported from reliable sources that the network is doing an excellent job under difficult conditions.

Heard in Australia

Many of the stations operated by All India Radio may be logged in this country during our winter months when reception from the Asiatic continent is at its best. Interesting listening is possible at present and during coming weeks, particularly between the hours of about 11.30 p.m. when many of the local stations have closed down, till stations in India leave the air, from 1.45 to 3.30 a.m.

Numerous broadcasts are made in the English language, and European type music is frequently played, which helps considerably when making out reception reports. A news bulletin in English goes on the air from all stations at 1.30 a.m. from the studios in Delhi, while some stations take a relay of news from the B.B.C., London, at 2 a.m. The news from Delhi at 10.30 p.m. would not be heard in many locations due to interference from local stations.

Latest Station List

In some cases in the following stations list we have listed times when regular English language sessions are broadcast from particular stations. Items such as local weather and announcements are worth listening for, as it provides one with a splendid chance to identify stations which are often in relay with Delhi and other stations. Call signs are not usually announced over All India Radio units, and announcement something like: **"This is All India Radio calling from Delhi,"** being most frequently heard.

758 kc., Tiruchi or Trichinopoly, VUT, 5kw. In addition to the 1.30 news in English from Delhi, takes the B.B.C. relay at 2 a.m., followed by local announcements and weather details for 5 minutes at 2.10. Usually presents European type music for half an hour before closing at 3 a.m. One of the best signals from India at our listening post. Reports from India show the location as Tiruchi.

770 k.c., Allahabad, VUA, 100w. Concludes transmission at 2 a.m. following news in Hindustani.

780 kc., Gauhati. Appears to operate in relay with Shillong, signing off at 1.45 a.m. following news in English from Delhi.

810 kc., Calcutta, VUC, 2kw. Appears to run several English language programmes around 4 a.m. Local announcements and weather in English and Bengali is scheduled for 12.50 a.m., the station leaving the air at 3 a.m.

840 kc., Vijayawada. Listen for this one till closing at 2.30 a.m.

886 kc., Delhi, VUD, 20kw. Numerous English language programmes from this one, the station remaining on the air until 3.30 a.m.

1022 kc., Lucknow, VUW, 5kw. On air till 3 a.m.

1131 kc., Patna, VUZ, 5kw. Closes 3 a.m.

1200 kc., Baroda. Concludes transmission at 2.30 a.m.

1231 kc., Bombay, VUB, 1500w. Local news and weather, 11.40 p.m. Often English language or European music round 2.15-2.30 a.m., signing off 3.30 a.m.

1290 kc., Nagpur, VUN3, 1kw. Local announcements and weather, 12.20, signing off at 3 a.m.

1305 kc., Amritsar, VUA2, 50w. Usually carries programmes relayed from Jullundur, signing off at 2 a.m.

1333 kc., Jullunder, VUJ2, 250w. Another low power unit, usually relaying from Delhi at 1 a.m., closing down one hour later. Programmes relayed from Amritsar.

1355 kc., Cuttack, VUK2, 1kw. On air till 2 a.m.

1420 kc., Madras, VUM, 250w. On air till 3 a.m.

1460 kc., Shillong. Leaves the air 1.45 a.m., usually carrying same programmes at Gauhati.

730 kc., Hyderabad, VUW. State-controlled station—mainly native type programme.

We extend our thanks to Mr. T. Pande, Information Officer, at the Office of the High Commissioner for India, Canberra, for his valued assistance concerning the above information.

Notes were also used from the "Indian Listener" and new call signs taken from "DX Times" (N.Z.).

by
ROY HALLET

New Philippine Station

An interesting new Philippine Island station that some may not have logged as yet is DZAB, "The Station of the Stars," operating on a frequency of 860 kc. We are looking forward to passing some interesting information concerning this station on to you via this page in the near future.

Signals from this area should prove quite interesting, as we mentioned last month, during the coming weeks. Midnight to about 2 a.m. is perhaps the best time to listen.

We remind readers again of the call-signs changes which have taken place in this island group, the prefix K having been replaced by the letter D. Manila stations appear to all use the letters DZ as the first two letters in their call sign, while those operating from Cebu, DY.

With the Listeners

Mr. Ray Rooke, Manly, has added several verifications to his list of Australian stations during recent weeks. However, he mentioned in his letter, that even after mailing a second report in each case, he has received no reply from stations: 2KA, Wentworth Falls; 4BK, Brisbane, and the latter's relay unit, 4AK, at Oakey in the Darling Downs.

(2KA has been known to verify reports although several other enthusiasts have reported lack of success in their attempt to obtain a QSL from this station. Stations 4BK and 4AK advised "Tune In" (N.Z.) some months ago that as a result of certain changes in station policy listeners' reception of the station would not be verified by mail for at least the time being.)

* * *

Mr. Norman Harper, Tooborac, Victoria, reports hearing the powerful transmitter operating from Tijuana, Mexico, XEBG, 1500 kc., at good volume around 9 o'clock. He finds KOMA, Oklahama City, Okla, U.S.A., good also between 8.30 and 9.30 a.m. on 1520 kc. At 9 p.m., A.E.S.T., the studio clock at this station shows 5 a.m., the station being in the Central Time Zone of U.S.A., which is 16 hours behind A.E.S.T. Stations further west operate under either Mountain (17 hours behind) or Pacific Standard Time (18 hours behind A.E.S.T.), while, of course, American Eastern Time (15 hours behind A.E.S.T.) is employed nearer the East Coast of U.S.A.

Mr. Harper has also been successful in logging the new low-powered Australian station, 5AL, Alice Springs, on 1530 kc.

* * *

Mr. John R. Adams, Wangoom, Victoria, has also experienced some interesting DX recently. He has logged KOMA, and also another station operating from Mexico, namely, XERF, widely heard in this country several months ago. Operating from Piedras Negras, this station broadcasts usually from studios in Del Rio, Texas, running numerous English language announcements consisting mainly of advertisements. This reader asked for several station addresses, and these have been forwarded.

Listen for These

Among the stronger signals to be heard during coming weeks include the powerful 2YA, 570 kc., Wellington, N.Z., heard very well at night till closing around 9.25 a.m., and again around 5 a.m. At this time numerous other stations in the Dominion should provide interesting listening.

JOAK, presenting the Japanese home service from Tokyo on 590 kc., is also good at present around 11.45 p.m., and in some locations this one is also audible around 5 a.m. **WVTR**, also in Tokyo, on 870 kc., running AFRS programmes in English, is also good for an hour or so from when 2GB leaves the air—around 11.10 p.m.

Listen also for Hawaii around 2 a.m., **KGMB** (in Japanese language); also on 590 kc., **KMVI**; 550 kc., **KPDA**; 630 kc.; **KULA**, 690 kc., both in Honolulu, are among those to be heard, the latter four in English language.

Whilst most of the old reliables appear certain to provide interesting listening on the 1500 and 1600 kc. section of the band during the coming weeks, it is likely that several interesting new loggings may be made, as the number of stations operating from America on this band is now considerable—something like 70 to 80. These range in power from 250 watts to 50 kw., and consequently at favorable locations there will be some verifications coming along towards the end of the year. From sunset to around 11 p.m. is usually the best time to listen for DX on this band. Around 6 p.m. Americans are occasionally heard concluding their night programmes, or a few later commencing their morning transmissions.

SHORT WAVE LISTENER

NEW SCHEDULE FOR RADIO HONG KONG

The following details and schedules of Radio Hong Kong recently came to hand and these should be of interest to all Short Wave listeners.

The network consists of two medium transmitters of 2 kw. power and a short wave transmitter of 2.5 kw. power. The call signs and frequencies are:

CALL SIGNS AND FREQUENCIES:

ZBW 845 kcs. XMTG English Programmes from 1230-1400 and 1800-2315 daily.

ZEK 640 kcs. XMTG Chinese programmes from 1230-1400 and 1800-2315 daily.

ZBW3 9.52 MCS carrying the Eng. and Chinese. PGMNS on ZWB and ZEK, from 1230-1400 and 1800 to 2315.

On Sundays the English programme starts two hours earlier, viz.: 1030, and the Chinese programme half hour earlier Ghurkali Programme), viz., 1200.

BASIC SCHEDULES AS FOLLOWS:
ENGLISH—

- 1030 English Programme and Church Service (Sundays only).
- 1230 Daily Programme Summary and Recorded Music.
- 1315 News in English,
- 1330 Recorded Music.
- 1400 Close down.
- 1800 Children's Programme and Recorded and News Analysis. Music.
- 1900 B.B.C.-G.O.S. Relay. World News
- 1915 English Programme.
- 2000 B.B.C.-G.O.S. Relay from the Editorials.
- 2110 Weather Reports and Forecast followed by Recorded Music.
- 2200 B.B.C.-G.O.S. Relay Radio Newsreel followed by Music.
- 2315 Close down.

CHINESE—

- 1200 Ghurka Programme (Sundays only).
- 1230 Weather Reports and Recorded Music.
- 1330 New in Mandarin.
- 1340 News in Cantonese.
- 1350 News in Swatow.
- 1400 Close down.
- 1800 News in Mandarin.
- 1815 News in Swatow.
- 1830 Recorded Music.
- 1900 Children's Programme, etc.
- 1930 B.B.C.-F.E.S. Relay News in Cantonese.
- 1940 Recorded Programme.
- 2000 Studio Concert, Recitals, Theatre Relays, Radio Plays, Orchestral Music, Recorded Music, etc.
- 2258 Weather Reports.
- 2300 Close down.

Readers' Reports

Until further notice would all S.W. listeners forward their list of station loggings direct to the Short Wave Editor, Box 5047, G.P.O., Sydney. Copy for inclusion in June notes should reach us not later than the 1st May, 1949.

Radio Sario, Manado

In a recent letter of verification from the Dutch Forces Radio Station, RADIO SARIO, some interesting facts regarding the station were given. The first broadcast of this station took place on the 23rd September, 1946, after several months of experimenting just for fun with very poor Japanese material by a Sergeant-Major of this radio station.

The wavelength is given as 9745 kc. or 30.80 metres, but the transmission has been measured by Ken Boord and is 9720 kc. Power used is 800 watts.

PROGRAMME TIMES

In Indonesian—1730-1800 hrs., Local Time, and on Saturdays and Sundays from 1800-1900 hrs.

In Dutch Language—Daily, from 1800-2000 hrs., and at the weekend from 1730 till 1800 hrs. and 1900-2210 hrs., Local Time.

The broadcast is specially for the Dutch and Indonesian Forces, as there is no civil broadcasting company in Manado.

Austrian Station

In a recent issue of the Swedish DX Bulletin is a report that the Blue Danube Network is testing a new transmitter on the earlier frequency of 7220 kc., between 2345 until 0040 the next morning. Reports were asked for and the address given as Radio Station KZCA, APO 451, U.S. Army.

Chinese Stations

From the DX Bulletin of the Swedish Broadcasting Corporation the following interesting information concerning Chinese transmitters has been gleaned. Call sign prefixes have altered in keeping with the recent post-war call sign allocations, so that XGOA which operates on a frequency of 11880 kc. now uses the call sign of BEF7. The frequency of 9730 kc. gives the call sign of BEA—operating at 11-1415 over 9730 and 5985 kc. according to its own message. However, the quality of transmissions is not good and the calls are very indistinct, making identification somewhat difficult.

In a recent verification card, XORA Shanghai have advised that the call sign will now be BEB5. This is heard on a frequency of 11868 kc. from 1030 to 1230, with the signal strength improving as the transmission progresses.

Another station heard from 1000 G.M.T. is BCAF, located at Tawian. This station broadcasts on a frequency of 11682 kc., and this has been checked by Graham Hutchens of Radio Australia.

The programme consists of Chinese news and Western music with an English lesson, heard sometimes on Tuesday from 1115 till 1150 G.M.T., and other weeks on Wednesday evenings at the same time.

From Ray Aldridge, of Amersham, England, comes news that XBW3 has extended its programmes till 1516 G.M.T. He heard a B.B.C. relay unit until 1514, after which a local weather report was given.

RECENT LOGGINGS

Details of stations now being heard in most locations in this country.

FAR EAST STATIONS.

XLRA, 11500 kc.: Now being heard with Chinese News and Western music at 11 p.m. This is a good signal.

Chinese, 6230 kc.: Western Music and Chinese news at 1115.

BED5 11860 kc.: This is only a fair signal, at 1130, Chinese news and Western music.

PCAF, 8990 kc.: At 1115, Chinese news followed by western music programme. Some interference on this frequency.

XGOY, 15170 kc.: English news, weather reports and musical items from 1200.

XRRA, 10260 kc.: Fair signal, typical Chinese programme, with some western music at 1145.

XGYA, 7990 kc.: This gives a relay of XNCR in Chinese news and music. Heard at 1045.

PCAF, 11680 kc.: Heard giving English lessons and music at 1215.

Pakistan, 15270 kc.: English news and music, at 1230.

VUD7, 15160 k.c.: At 0900 Despatches from Delhi by Douglas Stewart.

Siam, 9790 kc.: Siamese and English News and Music at 1000. This is a good signal.

SEAC 17760 kc.: At 1100 BBC relay of news and news anlysis. Music.

SEAC 15120 kc.: Request programme of music and news from 1145.

YDE 11770 kc.: This is only a fair signal, Music and Dutch News at 1000.

Radio Sario, 9720 kc.: Dutch news and music at 1130. Verification gives frequency as 9745 kc., with a power of 800 watts. The transmitter is constructed of poor quality Japanese material.

PLB7, 11000 kc.: This is a good signal at 1000, with English news and music.

EUROPE.

HER8, 21520 kc.: French and German News followed by Yodelling session at 1115.

Rome 15120 k.c.: At 2300 English and Italian News,, closes at 2305.

Rome 11810 kc.: News in Italian and Music at 2200.

CS9B 4845 kc.: This is an excellent signal —at 2015 Portuguese news and music.

OZR2 15160 kc.: Danish news, chimes and musical programme. Listen for this at 1000.

LLW 17820 kc.: News to Whaling Fleet and music at 0800.

LLR 21730 kc.: At 2100 Norwegian news and music. Closes at 2200.

CBLX 15090 kc.: At 1215 News, music, weather reports and greetings.

CHOL 11720 kc.: Stories of To-day and Yesterday; music at 0930.

CKLO 9630 kc.: At 2230 Sunday Concert Hall and News.

HOB, 6200 kc.: This station announces as Radio Panamericano. News and Music at 1145.

COCW 6330: Usual good programme of music and Spanish news.

PRL8 11720: Radio Nacional Fair Signal in Portuguese news at 0945.

ZYK8 15140 kc.: Portuguese news and music at 1030. This one suffers from interference from YDG.

U.S.A.

KCBR 6180 kc.: At 1115 English news and music. Also a Russian session.

KCBA, 15150 kc.: Musical session followed by news at 0345.

WOOW 11870 kc.: At 2130 Service to Europe, English news for 15 minutes.

Panama Schedule

Another item from Ray Aldridge gives details of Radio Atlantico, Hola, Colon, Panama. This station broadcasts a programme in English from 2200-2300 G.M.T.

DIELECTRIC HEAT-WOOD FABRICATION TOOL

(Continued from Page 7)

heat is even. This is in contrast to the excessive temperatures on the other layers of plywood produced in heated-platen presses. Handling is somewhat reduced over the multiple platen press, but for thin plywood, where the heat does not penetrate far, the economics favor heated-platen press. Twenty-eight plywood panels 23 by 36 by ⅜ inches, weighting 9.5 lbs. per panel, can be cured in 16 minutes using a 10-kw r-f generator. This is a rate of 1.66 lbs. per kw per minute.

Stray-Field Heating

The construction of plywood panelled doors illustrates the use of stray-field heating. A three-inch-thick skeleton framework of slats is glued on both sides and placed between two quarter-inch plywood panels in the press. Both platens of the press have a series of alternately spaced, high-voltage and grounded electrodes, each one-half inch wide and 1½ inches apart.

The dielectric field passes from one electrode down through the plywood, along the glue line, and up through the same plywood panel to the next electrode. This system permits the gluing of both sides of the door without having to heat all the way through the door which in one case was 3½ inches thick. Using a 10-kw generator, a 3- by 7-foot door can be panelled with a heating time of two minutes.

Because dielectric heating can develop heat throughout the cross-section of a material, the seasoning of wood appears as a logical application. As a general rule, however, such is not the case. Fast heating causes checking, hollow horning (collapse of inner cell structures) and fracture of the wood by the rapid release of steam pressure from its centre. If the heating rate is reduced enough to eliminate these faults, the economics favor the standard drying ovens.

The use of radio-frequency heating to evaporate water is fairly expensive. To offset this high cost, other factors must be important, such as extremely long kiln-drying times for specialty woods where a breakdown would cause serious production loss, or where space for drying is limited. An example of the exceptions is the drying of stock from which bowls for smoking pipes or heads for golf clubs are made.

Shielding of Installations

Radio-frequency generators resemble a high-powered radio transmitter except that the energy from the generator is expended into some material between the electrodes instead of into an antenna and thence to space. However, transmission of the r-f voltages to the work permits some portions of the installation to act like small antennas. Since the frequencies used in r-f gluing are the same as those used for short-wave radio, a small amount of radiated energy could cause considerable interference with established communication channels.

The F.C.C. requires that all radio-frequency heating installations be shielded so as to limit the radiated energy to a low value of ten microvolts per meter at one mile. Shielding is accomplished in either of two ways. The whole radio-frequency installation is enclosed in a shielded room made of a double-walled copper screen; or, since the generators are specifically designed to meet the regulations, the work-handling equipment and electrodes only are enclosed in a shield that eliminates radiation of radio-frequency energy. Presses are completely enclosed except for specially designed apertures. The shielding affords ideal protection to operating personnel, and, where parts of these shields are removable for easy access, they are interlocked with the generator so that no high voltages are present if an operator approaches the electrodes.

DIRECT-COUPLED FIVE

(Continued From Page 19)

a 30 henry rating capable of standing the total set drain of about 100 ma. The rectifier is a 5V4G—an indirectly heated type, and this is necessary to afford some measure of protection to the electrolytic condensers when the set is first switched on.

Receiver Assembly

The assembly of the receiver is not difficult, but the following points should be noted. When mounting the valve sockets, make sure the grid and plate pins are nearest to the points to which they will be connected. This is important, as with a poor layout and consequently long leads instability is sure to develop.

Next, mount the gang on rubber grommets and put solder lugs under the four mounting bolts. Connect these lugs together with the earth leads from the gang to one point on the chassis.

The dial used is the recently released Efco USL/50. When mounting this dial take out the screw which holds the dial drum on the plate and push the dial drum on to the gang shaft. This insulates the dial drum and gang from the dial plate and does not affect the cushioning of the gang. In addition, if the gang is not mounted quite straight on the chassis no strain will be placed on the cord or drum, and hence the cord will not slip around the spindle.

The remaining condensers and resistors, after the major components have been bolted in position, should be mounted close to their associate circuit. These are so few in number that the actual wiring up should not take very long.

After the wiring has been checked over, insert the valves and switch on. If all is in order, the next step is to align the various tuned circuits for maximum results. The actual procedure will vary with the individual coil unit used, but in general the procedure is somewhat similar to that previously given.

Alignment Procedure

In brief, this is as follows: Tune in a station at the high frequency end of the band and adjust the aerial trimmer for maximum output. Then tune in a station at the low frequency end of the band and adjust the aerial slug for maximum output. Loosen off the dial drum and adjust the pointer to register correctly on the known station. Retune the receiver to a known station at the high frequency end of the band, and position it correctly by means of the oscillator trimmer. Check the aerial trimmers and repeat low frequency adjustment.

The alignment of the SW bands is carried out in a similar manner. If no low frequency adjustment is provided, simply tune in a station at the high frequency end of the dial and adjust the aerial trimmer for best results. Correct tracking and positioning of the stations should be carried out by altering the oscillator trimmer.

Then if gang, coils and dial match correctly the various stations should be received in their correct position as indicated on the dial glass. If necessary the -i-f-t slugs can be peaked for maximum output, using a weak station on the high frequency end of the band as a guide. However, care should be taken with this adjustment so as not to get these coils out of alignment.

BASIC ELECTRICITY AND MAGNETISM

(Continued from Page 23)

Since q represents the number of charges per sq. cm., i.e. $q = Q/A$, then $Q = qA$, and substituting this value for Q in 6.6 we finally get,

$$C = \frac{K\ qA}{4\pi qt}$$

$$= \frac{K\ A}{4\pi t} \text{ e.s.u. of capacitance} \quad 6.7.$$

This result is very important because it shows that the capacitance of a parallel plate capacitor varies directly as the area of the plates and the dielectric constant of the substance between the plates. It also shows that the capacitance varies inversely as the distance between the plates.

Equation 6.7. is also important in that it shows you the basic method used in calculating the capacitance of any system of bodies; it should also aid you in understanding how quickly these mathematical manipulations can become very complex, and why final equations yielding the capacitance of a particular system appear complicated and repelling. It is most important of course that you have been able to follow the reasoning and deductions associated with the derivation of the above formula.

The Practical Formula for Parallel Plate Capacitors

It was pointed out in the last article that the e.s.u. of potential was too large, and the e.s.u. of quantity was too small for practical use, so that "practical" units are used instead of electro-static units. You should realise of course that the practical unit of potential difference, or the volt, and the practical unit of quantity, or the coulomb, are identical in character to the e.s.u. and differ only in magnitude, or, in other words, numerical value. Hence, by multiplying and dividing equation 6.7. by the necessary conversion factors, we obtain an expression which yields the capacitance directly in micro-farads, which is the unit of capacitance more frequently used.

Since 4π is also a numerical factor, or approximately 12.56 we can include this value in the final factor we get in our practical expression. The practical expression is,

$$C = \frac{0.568\ K\ A}{10^6\ t} \text{ microfarads} \ldots\ldots 6.8$$

where A and t are in sq. cms. and cms., respectively.

When A is expressed in sq. inches, and t is expressed in inches, equation 6.8. becomes,

$$C = \frac{0.2235\ K\ A}{10^6\ t} \text{ microfarads} \ldots 6.9$$

wherein A and t are in sq. inches and inches, respectively.

If the capacitor consists of more than two plates, that is, if it has N total plates, equation 6.9 is modified to

$$C = \frac{0.2235\ K\ A\ (N-1)}{10^6\ t} \ldots\ldots 6.10$$

HIGH QUALITY AMPLIFIER

(Continued from Page 28)

at the one spot. These points can then be connected up by means of an earth lead. This arrangement will tend to prevent any instability due to stray chassis currents, as may occur should the components be earthed in a haphazard manner.

Output Transformer

In the case of the output transformer, it will be noted that the feedback winding consists of a black and yellow lead. For correct operation the black lead is the one to be earthed. The two red and two black leads are twisted together to form the voice coil leads, and once again the black wires are connected to earth. These voice coil leads are connected to a four-pin speaker plug mounted on the right-hand side of the chassis.

When the wiring has been completed, check it over, making sure there are no errors, and then plug in all valves except the rectifier, connect up the speaker, and the pickup. Switch on and within a few moments, the heaters should light up. If all appears to be in order, plug in the rectifier, watching for any signs of overheating, or flashing, which could indicate a fault in the high tension supply.

Check P. U. and Microphone

The usual humming sound should be heard as the pickup gain control is advanced. Check the operation of the unit then by playing a record. The microphone can be tested in the same manner, but care should be taken to keep the gain control down if this is done in the same room as the speaker, otherwise acoustic feedback may occur.

If this checks satisfactorily, then your amplifier is ready for operation, and if used with a well-baffled speaker will provide you with a reproduction, far superior to that usually obtained with a single tetrode output stage.

F. M. vs. A. M.

(Continued from Page 31)

-15 to + 15 kc from the carrier. Thus, the maximum signal to noise ratio is $3\ (75/15)^2 = 75:1$.

If, however, the noise amplitudes are comparable to the carrier amplitude, then the ratio is less than the above. Frequency modulation is superior to amplitude modulation in this respect only when the noise amplitude is one-half or less of the signal amplitude. The amplitude of the noise at the limiter is a determining factor. If a very large frequency excursion is employed, then the i.f. band width must be correspondingly large. But this in turn means higher (and narrower) noise peaks, and thus the signal-to-noise ratio will begin to decrease as the frequency swing is increased. For this reason an excursion of about 75 kc is optimum compared with a 15 kc audio band.

Actually, the effect of noise in the presence of a signal is to produce a disturbance during part of the signal cycle only, namely, during the time the carrier is swinging through ± 15 kc of its ± 75 kc signal excursion. The effect of course averages out in the ear; but the signal-to-noise ratio is still greater for F.M. and A.M.

Fig. 4 shows that a disturbing frequency produces amplitude as well as frequency modulation. The two effects are additive in the receiver output if the disturbing frequency is higher than the carrier frequency, and subtractive if it is lower. This is on the basis of the single-ended detector used originally, such as the side of the resonance curve of an L-C circuit. To eliminate additive effects, a limiter is employed. This is a tube that clips off the variations in amplitude of the wave, thus leaving solely the frequency modulation. It therefore improves the signal-to-noise ratio very appreciably.

Modern F.M. detectors or discriminators, as they are called, are of the push-pull type, and are insensitive to amplitude variations of the carrier. It would therefore appear that a limiter is not required. However, there is an interaction that takes place even in a balanced discriminator between the two effects, and produces a decrease in the signal-to-noise ratio. For this reason a limiter is favored even in the case of a balanced discriminator circuit.

There are, of course, other advantages of frequency modulation, such as increased dynamic range, fidelity, and the like, but these all tie in and depend upon the increased signal-to-noise ratio of F.M., so that it was felt that a discussion of this feature would prepare the reader for any subsequent articles on this subject.

DX Century Club — Coveted Amateur Award

(Continued from page 41.)

If properly erected they will work for years without any attention. Although beams give a much louder signal, they are rather bulky on the 14 m.c. band.

V.F.O. Essential

The second — and incidentally equally as important piece of equipment—is the V.F.O. The days of crystal control on the DX bands are a thing of the past. In these days of spot frequency operation, the V.F.O. is a MUST to hop around the band and zero-beat the elusive DX stations. The reason should be obvious. The rare DX station operator does not tune his receiver much past his own frequency. The further away you are calling, the less the chance of raising him as others closer to the frequency will get in first.

Recently the Clapp series-tuned oscillator came into prominence. Without a doubt it is the most simple and stable of all R.F. oscillators used for controlling transmitter frequency. It is stable and efficient. The need for stabilising stages such as used with the once popular electron coupled circuit is quite unnecessary. The oscillator can be directly coupled to a beam-powered R.F. amplifier. Instead of wasting money buying several crystals, the DX club aspirant would be far better off investing the money in a Clapp oscillator. One could be made in a Saturday afternoon.

Break-in Procedure

Another almost equally important necessity, is break-in operation allowing the operator to listen during key-up conditions. Easiest method is to key the negative lead of the transmitter and block the receiver input by a suitable relay during key-down conditions.

Among break-ins many advantages are:

(a) Prevents unnecessary calling as it allows the operator to hear the "called" station should it answer another station.

(b) Reduces time between send and receive to a minimum.

(c) Makes signing after each "over" unnecessary.

(d) Makes QSO's more personal.

If you have a good antenna, V.F.O. and break-in you still need plenty of commonsense and patience.

Should the rare DX station called answer another station do not think he cannot hear you. Sit on him answering only when his contact is completed. Calling too early and jamming him will only get his back up and he'll probably (and quite rightly) ignore you.

Soon after a new country is worked, send a QSL card either direct or through the bureau being run by the Wireless Institute of Australia. It is a wise move to put a note on the card stating that the card is needed for the DX Century Club. Don't foster the American bribing habit of sending presents hoping "Mr. Elusive DX" will send a QSL to say "thank you."

If these simple rules are adopted you SHOULD qualify for the DX Century Club—in time. Never give in. If you miss one night you'll make up for it the next. Carefully index each new country worked using the official country list as your guide.

When you at last qualify and the long-sought 12in. by 9in. certificate is hanging on the wall you'll be a proud man. You will be entitled to be proud. You will be the minority in the majority. You will be an international figure in amateur radio. You will have achieved something and made friends in some of the most isolated and primitive countries of the world. But you will not rest on your laurels. DX hunting will be in your blood. You will still chase the rare and elusive one and the more they get the more elusive they appear to be.

Good DX ol' timer.

3XC is First of New Stations

(Continued from page 42.)

land Government was planning for the extension of broadcasting for the post-war period. Cabinet approved the establishment of a chain of low-powered stations in the provincial towns to serve the immediate surrounding districts. Station 3XC was the first of the low power, remote controlled stations to be installed and brought into operation. It was hoped that at a later date a permanent studio site would be built for the Timaru station. Mr. Jones added that 10 years ago there were 300,000 licences compared with the 434,000 of this year.

The Rev. Clyde Carr, M.P. for Timaru, said that it was a great day for Timaru, and he was thrilled with having a station in the city. He outlined the efforts of obtaining a broadcast station for Timaru many years ago, when considerable opposition was met from a local radio club.

Mr. D. C. Kidd, M.P. for Waimate, congratulated the Government on opening a station in South Canterbury. He felt that through 3XC warning could now be given during floods in the district. Mr. A. E. S. Hanan, Mayor of Timaru, spoke on behalf of the Mayors of Temuka, Waimate and Geraldine.

Professor James Shelley, Director of the N.Z.B.S., in handing over the station to Mr. G. C. Wansey, the manager of 3XC, thanked the officers of the Public Works Department, and all who had helped in the construction of the studios and transmitter building.

Atomic Energy

(Continued from page 12.)

the first demonstration could be made. However, with a basic plan that envisions tapping the much larger supply of trained engineers and scientists available in industry and applying them to work on appropriate problems, it seems certain that the advent of nuclear energy in the electric power field is much nearer than otherwise.

As it stands today, comparatively little of man's store of knowledge is applicable toward hastening the day of controlled atomic energy. Handbooks and manuals chart and tabulate physical and chemical properties of the many available materials, metallic and non-metallic, under a variety of conditions of temperature, humidity, pressure, solvents and so forth—but not under those expected in an atomic reactor. The immense task of measuring, recording, and tabulating these properties, with the additional variables of atomic conditions, may have to be done all over again; for some materials and some properties, it certainly shall.

There is indeed a big job to be done, so big, in fact, that one could not be blamed for being pessimistic about the possibility of a successful outcome. Perhaps the most optimistic note to be found lies in the fact that atomic energy is still a young science, not yet half a century old, and that knowledge of it is still meagre.

So, then, man is not really in a good position to judge the future of atomic energy, its possibilities, its nearness or the true value of apparent problems. Perhaps, instead of being pessimistic, an "*ignorance is bliss*" attitude would be better. Nevertheless, the realisation of the magnitude of the job and the steps being taken to put adequate manpower to work on it give assurance that the necessary research and development will be made and done in as short a time as can reasonably be expected.

The Mail Bag

S.D. (Western Camp. P.O., Victoria) is interested in DX-ing and asks for additional information on the method of obtaining verifications from the various stations.

A. Your letter has been forwarded to our Broadcast Notes correspondent, Mr. R. Hallett, 35 Baker St., Enfield, and no doubt he will write direct to you re this matter in the near future.

R.A.P. (Mosman, N.S.W.) intends building up the "All Wave Battery Two," and writes in for the June, 1948, issue containing details of the S.W. coils.

A. Many thanks for the letter, R.A.P., and we appreciate your remarks about the magazine. The issue requested containing details of the SW section of this receiver has been forwarded, and is no doubt in your hands by this time.

H.L. (London, England), forwards a subscription to RADIO SCIENCE.

A. Thanks for the letter and remarks about the magazine, H.L. The subscription has been attended to, and the earlier issues requested have been forwarded. We trust these will reach you in good order.

G.F.E. (Wellington, N.Z.) recently constructed the Low Cost Amplifier and Two Valve Tuner and writes: "Since building up the tuner and low cost amplifier in Vol. I, Nos. 1 and 2 of RADIO SCIENCE, I have been intending to write and let you know how pleased I am with the results. In fact, I would like to say how pleased I am with RADIO SCIENCE. I am by no means an expert in the radio sphere, it is just my hobby—but RADIO SCIENCE takes care of most of my technical requirements, and at the same time provides interesting reading . . . The amplifier is giving all that could be expected of it. I'm using a good pickup and find plenty of gain to play with and a bit for the neighbours too! . . ."

A. Your interesting letter was appreciated, G.F.E., and we are pleased to hear of your results with these two circuits. Using the 6K8 would probably lower the gain slightly, although the results should still be satisfactory. Make sure you are using the correct oscillator plate and screen dropping resistors, otherwise your operating voltages will be incorrect. The November and December issues were combined, as a change in distributors took place about that time. Copies of this issue are still available. Price 1/-, plus postage.

R.C. (Lockleys, S.A.) is interested in the "Scratch Filter Unit" described in the March issue of RADIO SCIENCE, and asks some questions regarding this circuit.

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."

A. The 6AQ6 is a duo-diode high mu triode, and can be replaced by either a 6Q7 or 6SQ7. These types are practically identical as regards electrical characteristics, and it should not be necessary to make any circuit alterations. The 6BA6 is a variable mu-r-f pentode, which is being produced locally, and consequently should be retained in the circuit. It should be readily obtainable now from most radio stores. The two condenser values are non-standard, and it will be necessary to obtain these values with standard units. However, you will probably find that a close approximation will be suitable. R12 should be a .47 meg. Apparently the point mark was obliterated during the block-making process. We should be pleased to hear of your results with this unit when you build it up. Many thanks for the encouraging remarks, and we are pleased to think RADIO SCIENCE is "tops."

S.J.H. (Reid, Canberra), forwards a subscription to RADIO SCIENCE and asks some questions concerning a tuner and amplifier combination he intends building up. ... ..

A. Thanks for the letter and subscription, S.J.H. This has been attended to by the Subscription Department, and the issues required have been forwarded. The World Wide Six circuit could be amended as you suggest to use an 807 in place of the 6V6GT. Possibly better results in your case would be obtained by also replacing the 6SQ7 with a pentode driver. If you intend keeping the same general layout this could be a 6B8G as it also has the two diodes for detection and A.V.C. An alternative would be to replace the second 6SK7GT with a duo diode type, such as an EBF35, and use a 6SJ7GT for the audio stage. The dropping resistor for the tuner section to reduce the higher B plus voltage would be O.K. Possibly the small amplifier described this month may interest you as in this case an 807 could be used if desired. Also, it has the preamplifier stage for a microphone. However, as soon as you decide the actual circuit we would be pleased to offer you any advice or assistance regarding it if you care to drop us a line.

ADDRESS WANTED

Would Mr. J. C. Liddy, who recently forwarded a manuscript dealing with electronic devices, please forward his address. This was omitted from your letter.

W.E.L. (Bendigo, Victoria), is a regular reader of RADIO SCIENCE, and asks the meaning of the terms "power output" and "power sensitivity."

A. Thanks for the letter W.E.L., and here are the answers to your questions. The power output is a rating of the output capability of a unit at a stated percentage of distortion. It measures the amount of work that can be done by the output circuit, when the input is loaded to its allowable limit. On the other hand, power sensitivity is the ratio of the output power to the input power necessary to establish that rated output. Therefore, the valves that require little input to accomplish large output have a much higher power sensitivity rating although the actual output power may be the same. We note your request for a small AC-operated amplifier, and no doubt the one described in this issue should be of interest to you. This has provision for microphone and gramophone and gramophone pick-up, and although using only a single 6V6GT in the output is an excellent performer when only a low power output is required.

R.D.S. (Woodville, S.A.), forwards his change of address.

A. Your new address has been noted by the Subscription Department, and this will take effect from the current issue.

AN APOLOGY

Messrs. Amplion (A/Asia) Pty. Ltd., local agents for the Acos GP 12 pickup advertised in this issue, advise that the initial shipment which was due to arrive early this month has now been delayed. They regret any inconvenience to customers and dealers this delay has occasioned, and according to the latest advice received these pickups will become available early in June.

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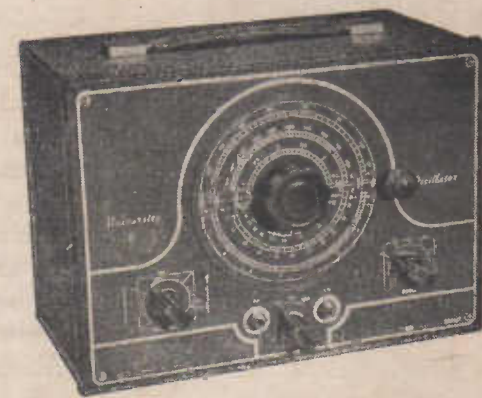

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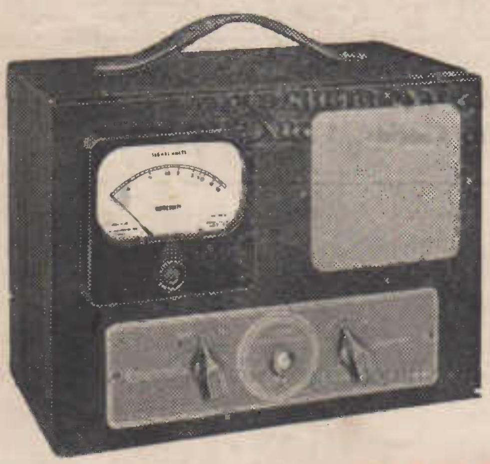

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