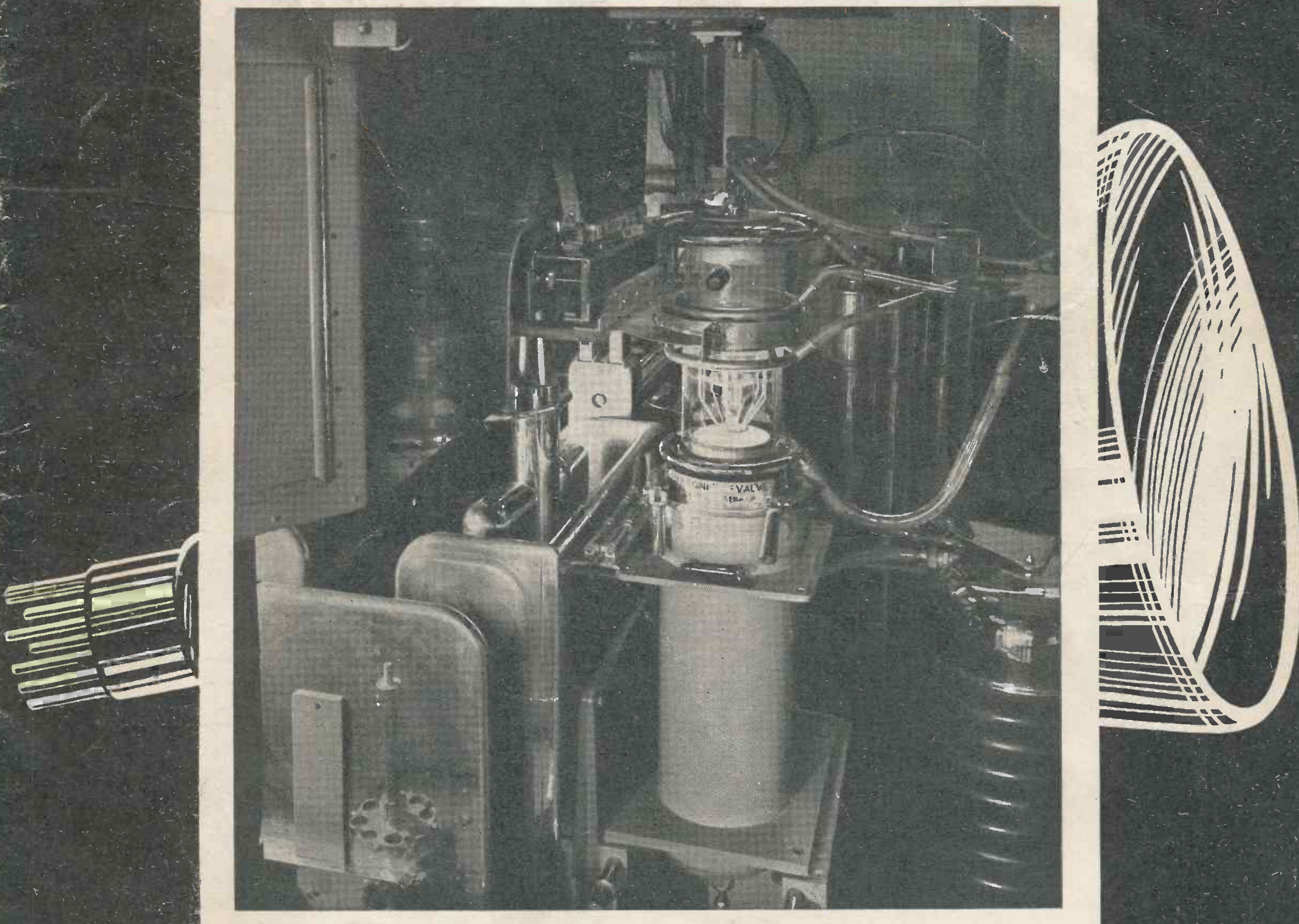
ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD

OCTOBER, 1939

1/6



SOUND AMPLIFIER SYSTEMS FOR RAID WARNINGS

(SEE PAGE 583)

THE FIRST TELEVISION JOURNAL IN THE WORLD

BERNARD JONES PUBLICATIONS LIMITED LONDON

www.americanradiohistory.com

No. 140. Vol. XII. OCTOBER, 1939

Electronics and Television and Short-Wave World

EDITORIAL, ADVERTISING AND PUBLISHING OFFICES
CHANSITOR HOUSE, 37/38, CHANCERY LANE, W.C.1.

Editor-in-Chief : BERNARD E. JONES.
Editor : H. CORBISHLEY, F.T.S.

Telephone : HOLBORN 6158, 6159 & 2857
Telegrams : BeeJaPee, Holb., London

Subscription Rates : Post Paid to any part of the world—3 months, 5/- ; 6 months, 10/- ; 12 months, 20/-. Published monthly, 1/6 net, first day of the month. Proprietors : BERNARD JONES PUBLICATIONS LIMITED.

Our New Scope: Our New Price

FOR some long time we have been considering the question of enlarging the scope of this journal, it having become abundantly evident that television is only the most ocular development of a remarkable new industry—that of Electron Engineering, which is increasing in importance every day. It is quite impossible to forecast the ultimate development of this industry, but from the outline of its scope given in the article overleaf, readers will gain some idea of the remarkable possibilities. The desirability, and almost the necessity, of enlarging our scope has been pressing upon us, but if we hesitated to make a decisive change in the policy of this journal, it was because we had pioneered television from its earliest days when, in spite of the resolution and enthusiasm of John Logie Baird and a few others, it was regarded as a mere dream; and we take a very natural pride in having played our part—a greater part than is generally known—in its development.

However, with the coming of war, special considerations have compelled the closing down of the only British television transmitter and have brought to a close "for the duration" any popular development, although it would be quite wrong to assume that there is not considerable activity behind the scenes; this activity, however, is not likely to be given an opportunity of interesting the public yet awhile. On the other hand, there is at the moment, and will continue to be, intensive research into a dozen or more other branches of the electronic science. Such research may well bring about, and will almost certainly do so, an immense number of practical applications the importance of which can hardly be exaggerated.

Everybody knows that during the last war there was a remarkable development in wireless; remember, for example, the electronic valve, known practically at the time only to a relative few who were able, once hostilities had ceased, to take advantage of their knowledge and in a brief time give the world the then astonishing radio broadcast.

There will be similar, and possibly as important, although not necessarily such spectacular, developments in the near future in the immensely wide and evergrowing field of applied electronics in modern engineering, and it does not need any special argument on our part to demonstrate that there is sound sense in our change of title and enlargement of scope. We shall continue to chronicle as before all important development in television and in short-wave reception, although we should not be serving the public interest in drawing marked attention to war-time development in short-wave transmission.

We are not blind to some imperfections in the present issue but readers will realise that we have had our share of the troubles with which all businesses are afflicted at the present time. From our editorial and business staffs we have lost key-men, and there are all the minor difficulties associated with the sudden coming of war. Thus, while our first number of "Electronics and Television" is consequently not quite typical, we hope to make it more so as the months go by, and, in the meantime, judged by war-time standards, we hope readers will agree that there is not much to grumble at.

Finally, our price! With deep regret we are compelled by circumstances to raise our price or—frankly—to join the host of publications that have been suspended or put out of existence during the past few week. We beg readers to accept our word that in raising our price to 1s. 6d. we have not sought in the very least to take advantage of them, the position being simply that the war-time difficulties relating both to cost and revenue have left us no alternative. We shall hope to carry the great majority of our readers with us, and they may be sure that we shall strive month by month to give them excellent value in up-to-date news and information on all the subjects within our new scope.

THE FIELD OF ELECTRON ENGINEERING —AN EXPLANATION

ELECTRON engineering is the term implying the application of electron theory to the practice of modern engineering. The term may be considered as distinct from Electrical Engineering which deals with the application of electricity in the widest possible sense.

In electron engineering we are dealing with the free electron and its behaviour under various external conditions and forces. The field is wider than that of radio engineering, which is mainly concerned with one of the applications of the electron theory to power engineering—in fact, electron engineering is the mean between the radio branch and the power engineering.

The Free Electron

The basis of electron engineering is the free electron. Why " free " electron? Are not all electrons free? The answer is that in the ordinary electrical circuit their freedom is only relative. We are all acquainted with the theory of electron flow in conductors—the familiar Ohm's Law can be calculated in terms of electrons per second instead of the unit of current. The electron moves in the substance of the conductor according to well-known laws; the speed of movement and the quantity passing per second can both be controlled and the flow can be diverted or reduced by altering the conducting paths.

At no time, however, is there any tendency for the electrons to leave the conductor under normal conditions. They are at liberty to move among the atoms of which the conductor is composed, but the surrounding insulator (usually the air) presents a barrier which they cannot penetrate. If a layer of air is interposed in the conducting path the movement of electrons stops and the circuit is broken. The movement of the electron in the ordinary electrical circuit is not therefore unrestricted and it may be considered as tied to the conducting paths laid down for it.

Wider Field of Action

As soon as the electron movement is unhampered it becomes free in the true sense and individual electrons can leave the surface of the metal and pass into the surrounding space. To produce such a widening of their field of action, conditions must be different, and it is usually necessary to remove the surrounding air, partly or wholly, and to provide an attractive force near the conductor to persuade the electrons to leave. The electron can further be stimulated to leave the conductor by heating it, as in hot cathode tubes.

Once liberated, the free electron can be utilised in numerous ways. It can be controlled by external fields and amplify minute potentials as in the case of the thermionic valve. It can be used to produce other electrons as in secondary emission tubes.

In a beam of free electrons we have the basis of the most versatile of indicating instruments—the cathode-ray tube.

All these properties and uses of the free electron are well known to radio engineers and there are many uses to which the engineering industry can put the valve, photo-cell and cathode-ray tube.

When the space into which the electron moves is not a vacuum but contains other gas atoms, a new phenomenon is produced due to collisions between the electrons and the gas atoms. Ionisation, as it is called, is responsible for another class of thermionic devices: the gas-discharge rectifier, the thyratron, or grid controlled rectifier, and innumerable varieties of glow tubes for decorative or lighting purposes.

Electron Production

In most cases the emission of electrons from a conductor is assisted by heat—the source of electrons is a wire glowing red hot and coated with special emissive substances. The emission of electrons from cold metal is sometimes used to produce ionisation, and this is referred to as "cold-cathode " emission. The glow tubes of Geissler, with their ornamental shapes, are perhaps the oldest examples of cold cathode ion tubes, and these tubes were the forerunners of modern neon lighting. In the category of cold-cathode tubes must be included the photo-cell in which the emission is brought about by the action of light on specially sensitive surfaces.

The science of electron engineering therefore covers all the applications of the free electron to industry—whether in the thermionic valve, in light relays, cathode-ray tubes, neon lights or more complicated research apparatus such as the cyclotron.

The heavy engineering industry is now realising the immense possibilities of electronic devices as an aid to production and measurement. The cathode-ray tube, in the past few years has emerged from the research laboratory and is now found in the workshop as a convenient check on all types of measurement. An American paper has listed no less than 95 different applications of the tube, each being particularly suited to some problem in industry.

Photo-cells are found in factories where counting and checking form part of routine processes. They perform the work untiringly and without the " human element " which so often allows a flaw to pass.

Thyratrons are used to control heavy currents with the greatest accuracy. Mercury vapour rectifiers are among the most efficient power transformers and require no supervision as does rotating machinery.

Many Applications

Fresh applications are being found for gas glow tubes. Their eclipse in the war period is only temporary and development in their application to domestic lighting is still proceeding.

All these electronic devices are, however, not infallible. They have their " off periods " when obscure faults develop, and they require occasional servicing like a radio receiver. The radio engineer comes into the field of electronics with one advantage—his experience in radio valve circuits and applications.

By applying this experience to the wider field and increasing his knowledge of the other applications of the free electron he may treble his usefulness to the industry and be ready to undertake work in a wider field which at the present time is unfolding itself.

OUR COVER ILLUSTRATION : This picture shows part of the main output amplifier, including the Marconi 14 Sw valve, of the Empire short-wave station.

NEW ELECTRONIC APPARATUS FOR DIAGNOSIS OF MENTAL DISEASES

ELECTRICAL ACTIVITY IN THE HUMAN BRAIN

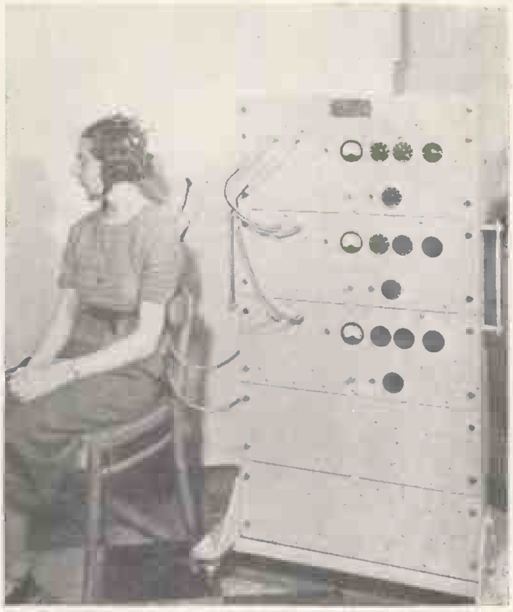


Fig. 1. The amplifier connected to the scalp by small pad electrodes. There is no discomfort to the patient.

This article describes an important application of the high-gain amplifier to electro-physiological research, and is reprinted from the "A.E.I. News," the Journal of Associated Electrical Industries, Ltd., by permission.

THE intimate relationship between electricity and the functions of the human body has been known for a long time—in fact since the time that Galvani demonstrated his classical experiment on a frog's leg. From this demonstration has arisen the whole investigation into the forces which control our "living and being," and as new discoveries are made the similarity between the human organism and modern electrical communication systems becomes more and more apparent.

Every movement is undertaken in response to a signal received or transmitted from the brain, the nature and characteristics of the signal being as distinct as those of a telegraph code. These code messages, transmitted by means of the nerves, serve to actuate the various muscles and co-ordinate our movements to the finest degree of precision. Damage to the nervous network inevitably results in loss of efficiency, although it may not be immediately apparent, but damage to the main transmitting centre, the brain, has such disastrous results that an increasing amount of time and money is being spent on the endeavour to find out the cause and cure of such defects.

The latest aid to the diagnosis of brain disease is an instrument which goes by the name of the "electro-encephalograph"—roughly speaking an electrical brain-writer. Its development followed on a discovery by the German physiologist Berger, in 1929, that the cells composing the brain were capable of developing an electrical potential in a similar manner to the potential developed in muscular and nervous tissue.

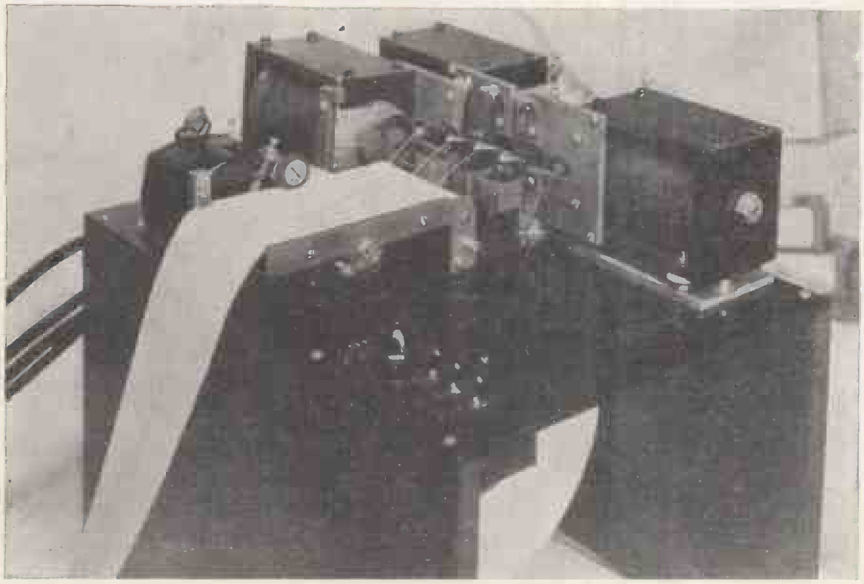


Fig. 2. Recording pens on a paper chart give a continuous indication of cell activity in the brain.

Brain Waves

Berger's "brain-waves" were looked on in the nature of a curiosity for some time, mainly owing to the lack of suitable precision apparatus with which to record results; and it was not until the work of Adrian, Matthews, and other physiological experts showed that muscle and nerve potential could be recorded accurately that attention was turned to Berger's work.

W. Grey Walter, a Cambridge physiologist, has devoted several years to the development of a suitable apparatus for recording the electrical activity of the brain, and the results of his work are now embodied in the Ediswan electro-encephalograph made under his direction.

To understand the results obtainable, it is necessary to remember that the brain in a normal condition is the seat of various minute electrical impulses, almost in the nature of random discharges between cells. These potentials are only of the order of 10-50 microvolts, but can be detected by means of electrodes placed on the surface of the scalp.

In order to render these small

Brain Wave Activity

changes in potential easily visible on a record, enormous amplification is required, and amplifiers having a gain of 5-10 million have been constructed. The output from the amplifier is recorded by means of a cathode-ray tube and photographic paper, or by ink writing mechanism using a continuous roll of paper.

The apparatus has three identical high gain amplifiers connected to three cathode-ray tubes. The reason for the triple combination will be seen later in the explanation of the principle of the diagnosis. A common time sweep circuit deflects the beams of the tubes simultaneously across the screen at a speed of 1-2 traverses per second, and the long afterglow of the screen enables the movement of the beam to be easily followed. The amplifiers are connected to the patient by special silver electrodes which are pressed on to the scalp and held in place by rubber bands. A valuable point about the apparatus is that it is perfectly safe in use and there is no danger nor discomfort to the patient.

Interference Precautions

With such high amplification, careful precautions have to be taken against electrical interference, and it is sometimes necessary to use a shielded room. Even the electric light mains are a source of considerable trouble, and in old buildings complete re-wiring has had to be carried out in some cases.

To minimise hum picked up from the apparatus, high-tension batteries are used for the amplifier supply, and these also enable stable operation to be obtained even at the maximum gain.

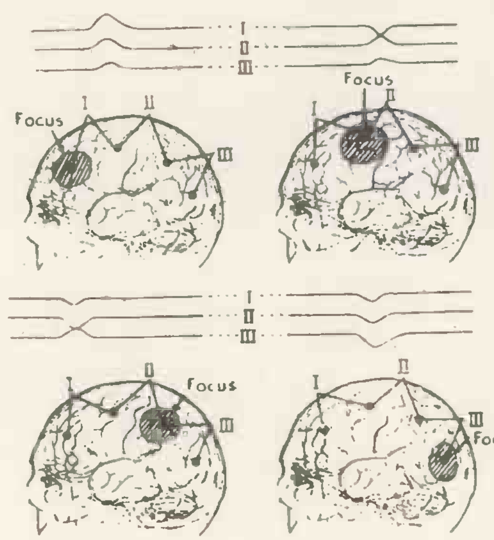
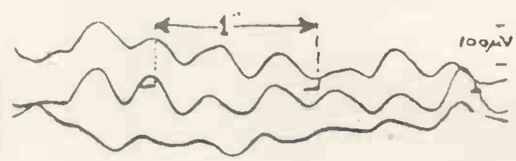


Fig. 3 (left). How the focus of abnormality is located by the apparatus.



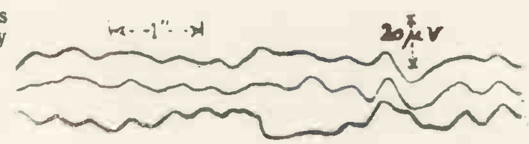


Fig. 4 (top) and Fig. 5 (bottom). Records taken from an anaesthetised patient and from an unconscious patient with brain trouble.

Nature of Records

The electrical phenomena first discovered by Berger, to which the name "Berger rhythm" is sometimes applied, consist of slow rhythmic changes in potential between two points on the scalp, the changes occurring at the rate of approximately ten per second. This phenomenon is only noticed when the patient has the eyes closed, as mental activity associated with seeing objects upset the rhythm altogether.

A second type of wave activity is associated with depressed or nervous subjects and is slightly quicker in rhythm (18-25 per sec.), and occasionally even quicker waves have been observed.

These rhythms are all obtained in normal subjects, but it is in abnormal cases or in those under the influence of drugs that the most remarkable differences are observed. Under ether anæsthesia, the electrical effects take the form of slow waves of much greater amplitude which appear to spread over the whole area of the brain, and these are easily distinguished from the normal variations referred to above.

The slow abnormal waves are also present in cases of brain disturbance, whether due to incipient tumours or well-established growths, and it is this fact which makes the instrument so valuable for the diagnosis of disease. Another important point is that the seat of disturbance is usually clearly defined, almost as though there were a definite source of electromotive force in the brain. This source is referred to in clinical work as the "focus" of the disturbance.

Exploring

The object of the surgeon is to explore the surface of the scalp and narrow down the field of search until he locates the focus with accuracy. In the great majority of cases this enables him to operate on the seat of the trouble immediately, without the necessity of exploring further.

To locate the focus accurately three pairs of electrodes are necessary, and their action is shown in the diagrams of Fig. 3.

In the diagram in the left upper corner, the focus is assumed to be under one of the electrodes marked "I." The other electrode of the pair is connected to one of the "II" pair, and so on to form a series "chain" of exploring points.

If we assume that the focus gives rise to an impulse of negative polarity, this will appear on the recording screen as a peak in the upward direction, shown above the diagram.

As each of the other electrode pairs is in series with No. 1 pair, this peak will be repeated on each of the records in the same direction.

Now, in the diagram on the right, assume that the focus is moved to the point shown under the junction of Nos. 1 and 2 electrodes. The direction of potential impulse will then be in the opposite direction in No. 1 pair, and in the original direction in Nos. 2 and 3. The peak on No. 1 record will thus be reversed, while those on the other two will be unchanged.

A similar change will be seen in the lower left-hand diagram, while in the lower right-hand diagram the focus is at the other end of the chain and the polarity of all the potential peaks is reversed.

The position of the focus in relation to the electrodes is thus seen by observing the phase relationship between the three records while the electrodes are moved to different positions on the scalp.

Fig. 4 shows a typical record obtained from the apparatus. In this case the patient was under ether anæsthetic, and it will be seen from the time marked on the chart that the frequency is about 2-3 per second. Fig. 5 was taken from an unconscious patient suffering from brain trouble and the similarity in the record will be apparent.

Both the records are quite easily distinguished from the higher frequency and smaller amplitude of trace obtained on a normal subject.

Although the equipment is primarily intended for use in the diagnosis of brain disorders, the fact that it consists of a high gain amplifier and cathode-ray tube allows it to be used for any physiological research in which minute potentials have to be studied or recorded. For example, one tube may be used to record an electrocardiogram (heart action potential) while the second and third record the brain potentials. Heart sound potentials may be picked up by a microphone and amplified, the record being compared with the electrocardiogram.

The apparatus was shown at the Ediswan stand at Radiolympia, where diagrams and explanatory labels showed the lay visitor how this important apparatus is helping to add to medical knowledge and assist workers in the field of mental science.

QRT

By R. W. H. Bloxam, XGM6LS

IN August, 1914, a red van drawn by a dapple grey horse called at my house and collected my large loose-coupled aerial tuning inductance, several other loading inductances (all with their brass rods and sliders), three crystal detectors, headphones, and the antenna, complete with spreaders. This antenna was the only one in the town of 50,000 inhabitants, and had always been to 49,999 of them a local object of wonder and great speculation, as its huge shell insulators gave it a very imposing appearance—nothing like it graced the landscape for many miles.

Once again the clouds of war have broken, and so the last "test" call has gone out, and as far as British ham stations are concerned our cherished bands are silent.

Let us hope that it will not be long before we have the right to use them again.

Somehow that last QSO had a great kick in it. Rumours of an imminent QRT were current, on the 7 mc. band anyway, for a considerable time before the gong sounded, indeed it was amusing to hear some of the comments and conjectures which passed between stations. One optimist was heard to remark that he understood the QRT was not going to be general, but merely that the G.P.O. was not going to issue any *new* licences!

Of course, there are many good reasons why a general cessation of private experimental transmissions is necessary in time of war. Apart from the possibility of QRM on such bands as are useful to the Services, there are other important reasons, some of them not being obvious at first sight.

At the time of writing, information is to hand that the G.P.O. are collecting transmitting apparatus once again, but obviously the task is somewhat more formidable this time, amounting as it must to over 2,000 stations.

Apart from the cost, the amount of storage space required may be imagined by multiplying one's own junk pile by the approximate number of stations, plus a wide margin for fellows like Jones who built a new transmitter each month!

It all seems rather purposeless anyway, because that mythical spy fellow wanting to tell the enemy why they are not winning the war is hardly likely to be found among the ranks of the *licensed* transmitting fraternity, whose credentials have all been inquired into before licences were granted to them.

No, that fellow's QRA will not be found in any Call Book.

Many of the younger members of our fraternity will now be "brass-pounding" in one or other of the Services, and those of us who by reason of age or engagement on other duties are compelled to relinquish our keys, wish them vy 73, Good Luck, and a speedy return to ham radio.

We shall look forward to hearing the old familiar call signs over the air once more.

It seems a pity that no form of emergency network or other communications system has been evolved from the very good material and skilled operators that would have given willing service to help at home.

However, help can be given in other directions, and in spare moments as are left one may dream and plan that new modulator, on paper at any rate, and maybe, who knows, the XYL may even get that cupboard door fixed that has waited a couple of years.

Influence of Cathode Rays on Luminescent Screens

Experiments have recently been made on the effect of continuous luminescence produced by a cathode ray on an insulated screen in a high vacuum cathode-ray tube. These experiments show that:—

1. The charge imported by the ray to the screen leaks off at the same rate.

2. The screen potential is always positive with regard to that of the cathode.

The areas of the screen impinged by the cathode ray shows a decrease of brightness as a function of the time of impingement according to a logarithmic law. This effect can be attributed to two reasons:—

1. The primary electrons liberate metal atoms out of the screens substance, producing a blackening of the fluorescent layer, and therefore a weakening of the produced light.

2. Some of the liberated metal atoms move in front of or into the luminescent centres of the substance and prevent the transfer of the energy required for the production of light. It can be shown that at the same time a regeneration process is present. This regeneration is due to the partial retransfer of the metal atoms into their original positions in the crystal grid whereby the affected luminescent centres regain their luminosity.

Experiments with intermittent electron impingement show that regeneration can be increased thereby.

A FLEXIBLE VOLTAGE AMPLIFIER

The drawback of the high vacuum cathode-ray tube is its insensitivity to low values of deflecting potentials. In this article G. Parr describes a simple voltage amplifier which can be adapted to a variety of uses

SOME time ago the writer had occasion to observe an A.F. potential of a few volts on a cathode-ray tube which was not fitted with the usual internal amplifier. Accordingly a "hook-up" circuit was necessary, and in order to make it as flexible as possible the circuit below was made up.

The valves used were power pentodes of the 6F6 type, which happened to be available, although 6C6's would be more suitable. The power pentodes are wasteful of anode current but have the advantage of accepting a reasonable grid swing, such as may be encountered in transients, without overloading. The circuit can, however, be adapted to any type of H.F. or L.F. pentode provided that they are reasonably matched.

It is well known that the deflection circuits of the cathode-ray tube should be symmetrical with respect to the anode if defocusing is to be avoided. To obtain a symmetrical output the circuit was therefore arranged as shown. The first pentode is capacity coupled to the second with the lead taken to terminal 1 of the output. The output from the second pentode is then connected to terminal 2 and the deflector plates are connected between 1 and 2, the earth terminal being connected to the anode of the tube. If the input to the second pentode is adjusted to equal that of the first a symmetrical trace will be obtained.

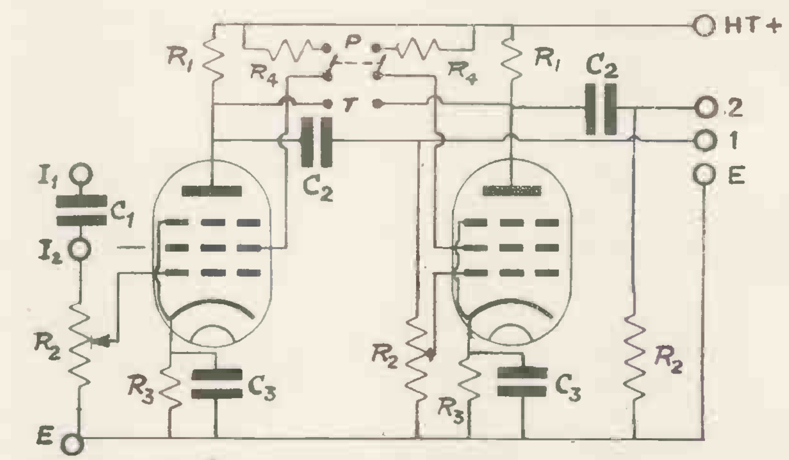
With this circuit, two alternatives are possible. By using terminal 2 and earth, a two stage amplifier is available for deflection, which will not be symmetrical but which is useful if the input is too low for the single "paraphase" amplifier. Or the output from the first stage may be tapped from terminal 1 and the earth return. Finally, by providing a two-way double pole switch, the pentodes can be converted into triodes if required.

The connections to this switch are shown at the top of the diagram. The screens are connected to the centre points and the upper contacts are taken to H.T. + through dropping resistances of 100,000 ohms. On moving the switch to the down position (T) the screens are connected direct to the anodes.

The valves are mounted on a sheet of aluminium or tinplate measuring 7 in. by 7 in. Two of the sides are bent down to form flaps 1½ in. deep, leaving a top platform 4 in. by 7 in. which is ample to accommodate all the components on the underside.

The following values of components were used:

R1 Anode load 20,000 ohms 1 watt.
R2 Grid resistance 0.5 meg.
R3 Bias resistance 3,000 ohms 1 watt.
R4 Screen resistance 15,000 ohms 1 watt.
C1 Input condenser 0.1 mfd. 500 volts working tubuluar.
C2 Coupling condenser 0.1 mfd. working.
C3 Cathode by-pass condenser 25-50 mfd. 12 volts working.



The circuit of the amplifier. It can be used as a one- or two-stage amplifier by selecting the output terminals.

With 300 volts H.T. from a standard rectifier unit the total current taken is approximately 20 mA., but this can be reduced considerably by reducing the screen voltage.

The screen voltage is a convenient method of altering the overall gain of the amplifier and can be reduced with advantage if a high input swing is not anticipated. The valves are working at the lowest point of their characteristic, but the anode voltage swing is ample for ordinary deflection.

It should be pointed out again that the use of 6C6 valves will result in a much higher overall gain, and the constructional work is the same, with the addition of a screened lead for the top grid connection.

With 6C6's the circuit constants are modified as follows:

R1 100,000 ohms 1 watt.
R2 As before.
R3 300 ohms.
R4 0.4 meg.
Condensers as before.

The gain is then approximately 60 per stage as against 10-20, but the output voltage is low.

When checking the amplifier, apply a known signal of, say, 2 volts A.C. to the input terminals. Then connecting the deflector plates between terminal 1 and earth, measure the height of the wave on the screen. Transfer the deflector plate to terminal 2 and alter the second gain control until the same amplitude of wave is obtained. The amplifier is now balanced for symmetrical deflection, and if the plates are finally connected between 1 and 2 an amplitude of twice the previous value should be seen.

This point on the gain control should be marked so that the amplifier can be set for paraphase operation without the trouble of calibrating each time. For two-stage working it is probable that maximum gain will be required on the second stage and the gain control can be turned up accordingly.

Please ask your bookstall or newsagent to reserve a copy of ELECTRONICS AND TELEVISION & Short-Wave World each month and avoid disappointment.

Lenses and prisms for use with ultra-violet and infra-red light are now being made from single large crystals of rock salt, potassium bromide, lithium fluoride and other salts. Crystals made by a new process have been "grown" to weights as much as 25 pounds and sizes of 8 in. in diameter and 10 in. long. Lenses of this type are used because ordinary optical glass is almost opaque to ultra-violet light.

TAKE COVER!

THE DESIGN OF SOUND AMPLIFIER SYSTEMS FOR WARNINGS IN FACTORIES

This article is a survey of the methods by which factories and offices employing large staffs can ensure that adequate warning of air raids is given in time of emergency and that the necessary evacuation of premises to air raid shelters can be controlled efficiently and quickly by "key" men, in strategic positions.

We have long been familiar with the applications of sound amplifying equipment in assisting the human voice, as exemplified by the use of P.A. equipment by orators and at open-air gatherings under such conditions speakers would be inaudible except to a few.

A new and now vitally important application is that of relaying air raid warnings and the control of large numbers of people in a manner similar to that often employed by the mobile police.

For factory or office premises, where the wail of the sirens may pass unnoticed amid the noise of machinery, or the clacking of typewriters, an externally situated microphone with an amplifier relaying the warning to all parts of the building by means of loudspeakers would be quite satisfactory. The idea is essentially practical and may be enlarged upon.

While the simple method of relaying all noises picked up by an outside microphone to all parts of the premises during working hours has much in its favour, it may prove to be a source of distraction to workers and possibly cause confusion by the immediate and unorganised response to a warning.

It is preferable that a single loudspeaker in the office of an executive or key man should be the first indicator of a warning. The alarm may then be switched through to each department in turn, or all simultaneously, and a second microphone used to convey directions for the orderly movement to shelter.

The requirements of a "key man" announcer are an intimate knowledge of the premises and numbers of people employed in the departments, the positions and capacities of the shelters, the names of the foremen or other officials in the department, together with other items which will present themselves in individual cases —and, of course, a cool head and clear voice.

Code calls in the form of tones generated in a local oscillator and fed into the main amplifier could be devised. The signalling from shelters to control positions by this method is one application. For example, the familiar G.P.O. "burr burr" might mean "Shelter full," and the engaged tone might be interpreted as "Assistance needed." A tone generator can be a very simple device and several code practice generators which have been described in past issues of Television and Short-wave World, would prove suitable.

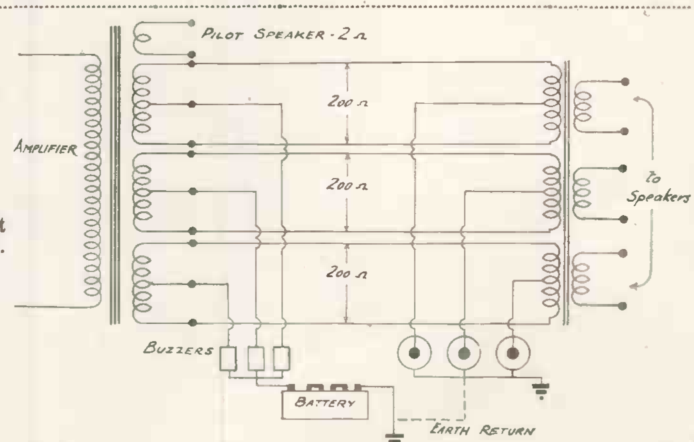
Whilst existing call systems may be utilised and even theatre sound systems pressed into service with little difficulty, it is assumed in the following suggestions that no equipment of any kind is available. It will readily be seen from the later points in this article how the above-mentioned equipment may be arranged to best advantage.

First the amplifier. For relaying warning by external microphone, the amplifier should have for preference a frequency response extending only over the range covered by the sirens. This point assumes importance when traffic and other extraneous noises which would give rise to undesirable "interference" are considered. A simple filter circuit should achieve this object.

The question of power output is of importance, since watts are relatively cheap and become cheaper when purchased in quantity; it is safer to err on the side of excess power than otherwise.

Three or five watts on a single speaker will easily suffice for an office employing about twenty people under normal conditions, but in a busy machine shop, thirty watts may prove barely adequate. The following table may be of assistance. The use of ordinary loudspeakers has been assumed, but it must be borne in mind that considerable improvement will result if more efficient and/or directional types are employed. Area has been taken into consideration as not exceeding 100 sq. ft. per person.

People.	Office. Watts.	Quiet Factory. Watts.	Noisy Factory. Watts.
10	3	7	15
30	7	15	30
100	15	30	60
300	30	60	60



Theoretical circuit for buzzer system.

In case it might be thought that the figure for 300 people in a noisy factory is erroneous it is suggested that sufficient warning could be given so that machinery could at once be shut down thus providing "quiet factory" conditions. Further, it is assumed that on powers of 15 watts and over, the sound is distributed over speakers carrying 5 to 8 watts each, according to their size, and sensitivity. The use of speakers of the 15-watt class is desirable for large premises.

Speakers should be placed so that an effective volume of sound is available in corridors and rooms outside of, but adjacent to, the main office or workshop. If necessary, extra power and speakers may be apportioned.

Since a 30-watt amplifier costs little more than a 15-watt type (about 20 to 45 per cent., according to the number of speakers, record playing, and other equipment) it is suggested that a 30-watt amplifier be counted on at the outset. The most advantageous ratio of watts per £ is reached at this figure, and it is cheaper to add sufficient 30-watt channels to produce the wattage required, than to purchase a single high-power amplifier. Duplication of equipment is a resultant advantage to be considered.

At this point, the author would respectfully draw the reader's attention to the Premier 30 to 60 watt amplifier which is a most economical proposition, and eminently suitable for the purpose. It would be well to consider the arrangement of the wiring so that a complete key point—that is, amplifier, microphone, etc.—may be moved if necessary to another position in the event of the first becoming dangerous.

Simplicity of wiring is important. The line from the warning microphone should be of low impedance (about 200 ohms) and speakers or groups of speakers at any considerable distance from the amplifier should be "taken out" at 200 ohms or 500 ohms, and re-distributed via a matching transformer to avoid power losses and use of heavy cables. It is important that a strategic group of speakers could not be put out of action through a failure of a single line. 15-ohm speakers may be put in series or series-parallel groups though in the series connection, speakers in a chain may be put out of action by the failure of a single speaker or connection.

Discretion must dictate the arrangement for individual cases. With plenty of reserve power line losses may be heavy without reducing the overall effectiveness of the system and bell wire may be used.

The possibility of plugging in a record player must not be overlooked where the speaker system extends to shelters adjacent to, or in a part of, the factory. Now for a few points on the provision of the remainder of the equipment.

Microphones.—The crystal microphone, besides being rather expensive, has a low output at high impedance and, while a screened lead has no effect on the frequency response, the output is decreased by the additional capacity; generally speaking, therefore, it is unsuitable. The carbon microphone requires energising, tends to pack during continued use, and is noisy; the output, however, is high and a line transformer may be used. The moving coil microphone appears to be the most suitable since it has the advantages of the carbon type without the troubles of packing and energising.

Care in protection of the external microphone from weather is important, and a suitable housing should be contrived, damp in particular being excluded. The microphone may be turned to face the nearest siren and may even have a directional flare or megaphone attached, to secure the greatest signal-to-noise ratio.

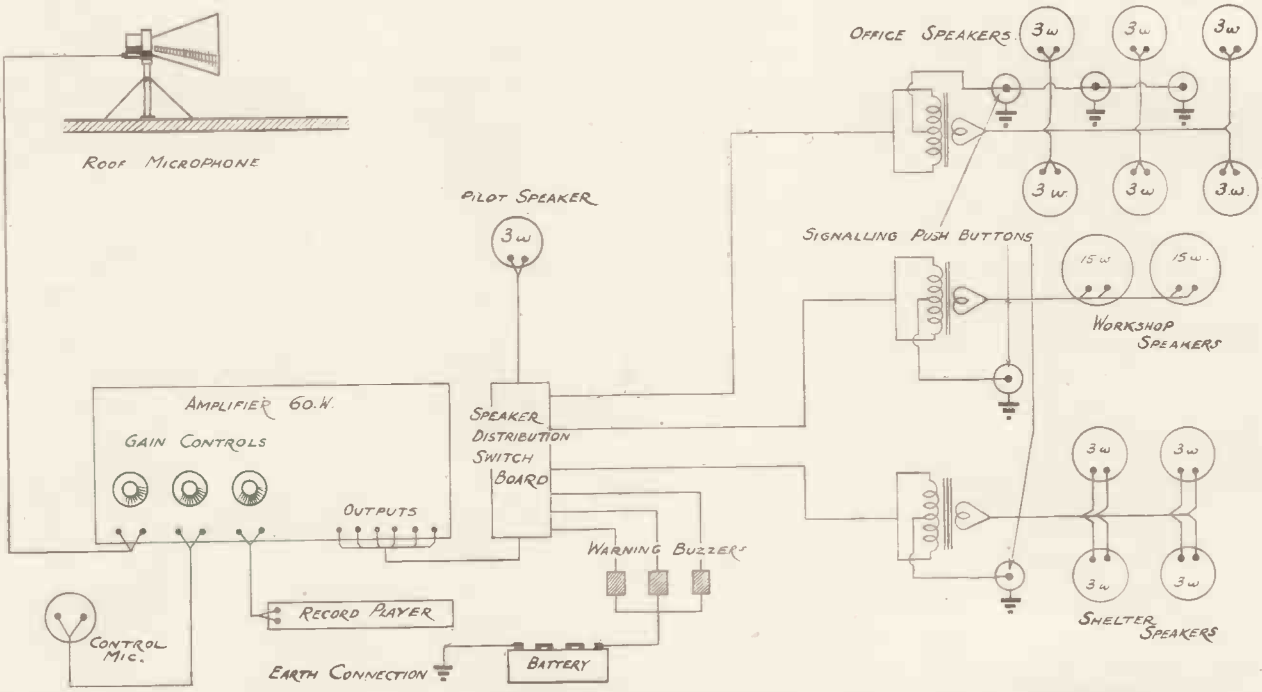


Diagram of suggested layout of warning system for factory and offices employing about 300 persons. The figures of wattage marked on the loudspeakers is the suggested distribution of power and can be achieved by proper matching of impedances. Good earth connections are necessary for proper working of the buzzers.

Loudspeakers.—Speakers may, for economy, be of the 8 in. or 10 in. P.M. type, commonly available in flat or box baffles for office or similar premises, and in short "flare" dust-proof baffles for factory premises. Horn type projection speakers may be recommended for their high efficiency and directivity.

The average good 10 in. P.M. speaker will handle about 6 watts in a flat baffle and 8 or 9 watts in a fair-sized flare extending from 12 in. to

(*Continued at foot of page 587*)

FOR THE SERVICE ENGINEER

SIGNAL TRACING IN SUPERHET OSCILLATORS

By John F. Rider
Author of "Successful Servicing"

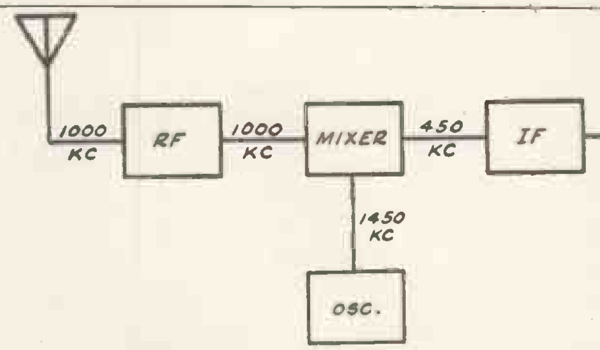


Fig. 1. This block diagram shows where the frequency of the signal is changed before going through the I.F. amplifier.

SIGNAL tracing in oscillator circuits differs from that in other parts of the receiver in that the signal to be checked is generated by the set oscillator and not supplied by an external signal generator. In some sets, the heterodyning oscillator signal is developed by a separate valve and circuit which is coupled to the mixer circuit; in other sets, the functions of the mixer and oscillator are combined within a single valve. No matter which system is used, the purpose of the oscillator is to provide a signal of the proper frequency to combine with the incoming R.F. signal and produce, in the mixer, the intermediate frequency at which the I.F. amplifier is designed to operate. This is illustrated in the block diagram, Fig. 1. In this diagram, the R.F. signal in the aerial circuit has a frequency of 1,000 kc. The intermediate-frequency amplifier is designed for a 450 kc. signal. We can produce an I.F. signal of such frequency by tuning the oscillator to 1,450 kc. Then, when both the 1,000 kc. R.F. signal and the 1,450 kc. oscillator output are fed to the mixer, a signal representing the difference between 1,450 and 1,000 or 450 kc. is developed in the mixer. Other combinations occur also, and the 450 kc. signal likewise would result if the oscillator were tuned to a frequency of 550 kc., which is 450 kc. lower than the R.F. signal, since the difference between 1,000 and 550 would also be 450. In actual practice most receiver oscillator circuits are designed to operate at a frequency which is higher than that of the incoming R.F. signal.

The writer of this article, John F. Rider, is well known to radio amateurs and servicemen both in America and this country for his books and articles on radio servicing.

Any amplifier valve may be used as a superheterodyne oscillator and we find in commercial practice that triodes, tetrodes, and pentodes are employed. When the oscillator is combined with the mixer, a pentagrid converter tube is generally used though this same action can likewise be performed, but less efficiently, by any of the simpler amplifier valves.

A wide variety of oscillator circuits is to be found in broadcast receivers, but actually these are simply minor variations of a few fundamental circuits which are shown in Fig. 2. Of these circuits, most sets use either the Hartley (Fig. 2A) or the tickler feedback (Fig. 2D). In the Hartley circuit, the signal voltage developed between cathode and earth (which is equivalent to the signal voltage between anode and cathode since the plate is bypassed to earth) is coupled back into the grid circuit to produce oscillation. The number of turns above earth at the point to which the cathode is connected determines the amount of feedback in the circuit and consequently governs the oscillator voltage developed. This tap likewise is chosen to produce relatively uniform oscillation over the tuning range of the oscillator. It is important to remember the influence of the tap position with regard to oscillator performance. Sometimes the wire becomes loose on the coil form so that the amount of feedback is less than it should be. Then the oscillator performance will be affected, causing "dead spots," wide variation in oscillator voltage over the tuning range, poor tracking and misalignment. These faults may occur in all the circuits shown and are readily revealed in the signal-tracing process.

The circuit of Fig. 2B is the same Hartley circuit but the anode voltage is fed through an R.F. choke to the tuned circuit. The characteristics of

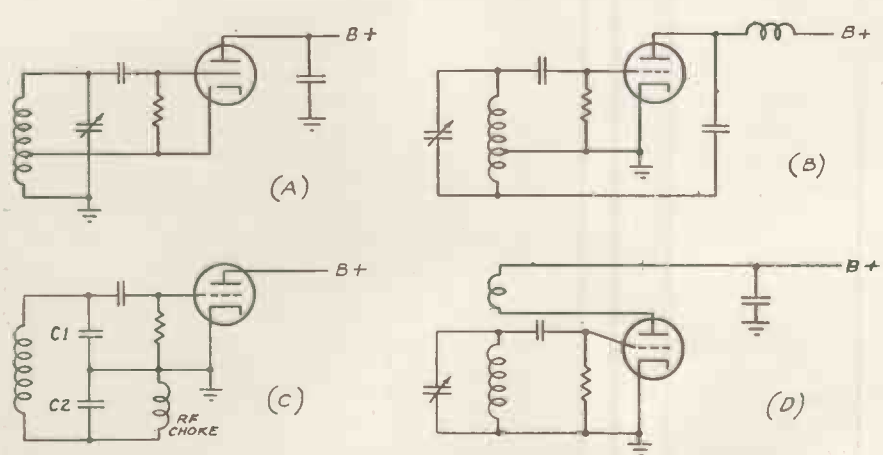


Fig. 2. Fundamental oscillator circuits used in superheterodynes. They are : A, the Hartley Oscillator ; B, Hartley with plate voltage fed through R.F. choke ; C, the Colpitts oscillator ; and D, the tickler-feedback circuit.

Checking Frequency Stability

the two circuits are similar. The Colpitts circuit of Fig. 2C is seldom used in receivers though frequently in transmitters. Feedback is obtained through the condenser C2 and is determined by the ratio of the capacities of C1 and C2 and the amount of feedback. The R.F. choke is provided merely to act as a return path to earth.

One of the most widely used circuits is that of Fig. 2D. This is the familiar tickler-feedback circuit, in which a coil in the anode circuit is coupled inductively to the grid coil in proper phase relationship to produce oscillation.

voltage which is caused by rectification of the oscillator signal voltage in the grid circuit of the oscillator valve. We should expect this voltage to be of the order of −10 to −30 volts. It is unlikely in any event that the voltage will become too high, since the oscillator circuit is ordinarily so designed that the maximum signal voltage can be developed only when all components of the circuit, including the valve, are new and functioning properly. Any effects which cause trouble in this circuit normally tend to lower the signal voltage, rather than raise it.

The oscillator voltage is coupled

the reaction of the probe cable upon the circuit under test. It is also possible to make such measurements by opening the oscillator grid leak connection to the oscillator cathode and inserting a microammeter (approximately 1,000 micro-amps. full scale) in series with the oscillator grid leak. If the grid leak resistance is 50,000 ohms, the current through the resistance should not be less than 120 nor more than 500 micro-amps. The uniformity of oscillation over the operating range is tested by simply rotating the receiver gang condenser over its range and, with the test instrument connected, noting the variation in the D.C. voltage as the oscillator is tuned. If, at any point, the valve stops oscillating, the voltage will drop to zero or become positive with respect to the cathode. Some oscillator circuits employ a cathode resistor and in such cases, the oscillator grid voltage may read negative with respect to earth, though not to cathode, even when the valve is not oscillating.

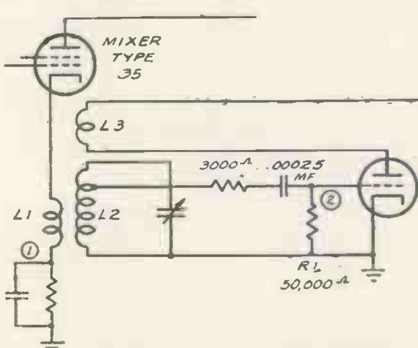


Fig. 3. A portion of the mixer-oscillator circuit of the Colonial Model 47, 48.

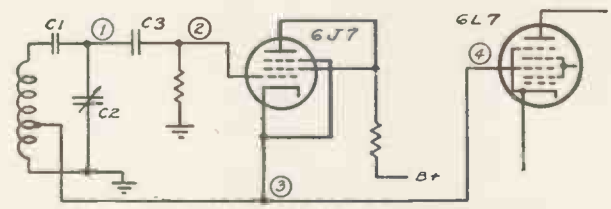


Fig. 4. In this mixer-oscillator circuit of the RCA Model C9-4, the 6J7 is the oscillator and 6L7, the mixer.

The proper oscillator signal voltage required depends on the type of mixer used and the method of coupling to the mixer circuit. If a pentode mixer is employed, the peak oscillator signal voltage applied to the pentode grid should not be greater than 9 volts when the d.c. bias of the pentode mixer is −10 volts. For any other bias, the peak oscillator signal voltage should be one volt less than the pentode grid bias. In pentagrid mixers, such as the 6L7, the peak oscillator signal voltage should not be less than 12 to 18 volts, depending upon the operating voltages of the 6L7. Any normally obtained value in excess of this minimum voltage is satisfactory.

It is seldom necessary to measure the oscillator peak voltage directly since D.C. voltage measurements will give us all the information we need. Consider the oscillator and mixer circuit of the Colonial 47, 48, shown in Fig. 3. As a result of oscillation, grid current flows through the resistor R1 causing a negative voltage at point 2 with respect to the cathode. This is a pulsating D.C.

into the cathode circuit of the type 35 mixer in this receiver by means of the inductive coupling between coils L1 and L2. L1 is in series with the cathode bias resistor for the mixer valve. If the oscillator voltage fed into the cathode circuit should become excessive, grid current would flow in the mixer circuit, causing an increase in the cathode bias voltage. This condition can be checked by measuring the mixer cathode bias voltage and noting if the bias voltage changes when operation of the oscillator is stopped. If the circuit is performing properly, there should be no change. If the cathode voltage becomes lower when the oscillator is not working, then the oscillator signal voltage across L1 is too high. One condition which might cause this trouble would be a change in position of L1 which would increase its coupling to L2.

Measurements of the D.C. voltage across the oscillator grid leak preferably should be made with a very high resistance voltmeter and the test leads should be very short unless a probe is used with some means for isolating

Frequency Stability

Frequency stability is checked by means of a resonated valve voltmeter, calibrated in frequency over the operating range of the oscillator to be tested. The test is made by connecting the test probe to some portion of the oscillator circuit where the signal voltage is indicated. The resonated valve voltmeter is then tuned until its indicating device gives a maximum reading. If the oscillator frequency should change, the voltmeter will no longer show a maximum indication, but may be retuned to a maximum by adjusting it to the frequency to which the oscillator has drifted. The amount of frequency change which takes place may be determined by comparing the initial frequency setting with that to which the voltmeter must be tuned to restore the original indication. Thus, if the oscillator signal frequency were originally 1,500 kc. and the frequency to which it had drifted were 1,700 kc., the amount of oscillator drift is 1,700-1,500 or 200 kc.

Proper tracking may be checked by signal tracing, not only at the aligning and padding frequencies, but also at any other frequency over the tuning range. By measuring the operating frequency of the oscillator at any setting of the tuning condenser, one can find out if it is precisely tuned to produce the required intermediate frequency for the incoming R.F. signal to which the receiver is tuned.

The resonating valve voltmeter (or any highly sensitive frequency meter) is used in making these tests. This instrument is similar to that employed in making tests by signal tracing in other portions of a superheterodyne receiver ahead of second detector. Its probe is placed sufficiently close to the oscillating circuit to provide enough oscillator signal pickup to give an indication on the test instrument and the signal frequency is determined by noting the frequency calibration point on the indicating instrument at which a maximum indication is secured.

Let us take a simple oscillator circuit and test and trace its signal by this method. The circuit of Fig. 4 is used in the R.C.A. model C9-4 receiver and will serve as an example for practical application of this test system. We shall assume that the receiver is inoperative, yet signal tracing of the R.F. signal has shown that the R.F. signal is present in the mixer circuit. The first test is to discover if the oscillator is functioning. This is done by connecting the voltmeter from point 2 (the oscillator control grid) to earth and noting if a negative voltage is present. If so, the tube is oscillating and further tests will be required. If the voltage at point 2 is zero or positive, then the trouble is immediately localised in the oscillator circuit and tests of individual components will determine the exact cause.

If we find that the oscillator circuit is functioning, then we should check the frequency with the resonating valve voltmeter. This is done by placing the test probe on the stator of the oscillator condenser or the control grid of the oscillator valve. The signal voltage will cause the test instrument to give maximum indication when it is tuned to resonance with the frequency at which the oscillator is operating. If the incoming signal is 600 kc. and the intermediate frequency 465 kc., the oscillator should be operating at 1,065 kc. If the measured frequency differs greatly from this the trouble is then localised to some component which affects the tuning of this circuit.

The actual frequency measured may give a clue to the trouble. If the padding condenser C_1 is shorted the frequency of the oscillator will be lower than 1,065 under the above conditions, and in fact will be only slightly higher than 600 kc. A short in the tuning coil or loose turns raises the oscillator frequency to a value higher than 1,065 kc. An open circuit in C_2 also increases the frequency since the only tuning capacity is then the residual of the circuit.

Having checked the oscillator frequency the next step is to see if the oscillator signal reaches the mixer circuit. In Fig. 4 it will be noted that the mixer injector grid is directly connected to the oscillator cathode. Check first at point 3, noting the signal level at this point. It will be lower in voltage than at points 1 and 2 since it is only a portion of the voltage across the oscillator coil. Now move the test prod to point 4—the voltage should be the same as at 3. A short circuit to earth at 3 or 4 would short out the feedback winding of the oscillator and stop oscillation. This, however, would be found on the initial test for oscillator operations.

"Sound Amplifying Systems for Raid Warnings"

(*Continued from page* 584)

30 in. square section. For large premises the author can particularly recommend the pendant type flare speaker where a high ceiling makes it possible to take fullest advantage of the excellent sound distribution characteristics of this type.

Other types to be particularly recommended are the Rola G12 models, these being suitable for fairly large powers.

Where the possibility of electricity supply failure exists, it may be wise to consider the provision of a standby power source consisting of batteries and vibrator or motor generator units. The Premier Radio Co., Ltd., list such a unit in their new catalogue and have also a " mobile " edition of the 30-60 watt amplifier available as a 25-watt self-contained unit operating on car type accumulators or mains at will.

It is to be hoped that these few notes will assist harassed executives and engineers to find a satisfactory solution to some problems which, since the actual conditions of operation have not yet arisen, and, let us hope, will not arise, are a subject of much speculation.

A Useful Booklet for the Service Engineer

The *Wireless and Electrical Trader* have recently published a booklet on the " Cathode-ray Oscilloscope and Its Uses in Radio Servicing." Written by Mr. W. E. Miller, the Technical Editor of the paper, it embodies the subject matter of a series of articles by him which have appeared from time to time.

Commencing with the theory of the tube and the power supply, the various applications are then described with excellent photographic illustrations.

A particularly useful section is " Tracing Hum," which shows oscillograms of ripple output in conventional rectifier circuits. The effect of defective reservoir or smoothing condensers is clearly shown. A further series of photographs illustrate the tracing of distortion in A.F. stages.

Receiver alignment is dealt with fully with more explanatory diagrams, and the booklet concludes with notes on miscellaneous tests, including those on vibrators in car radio receivers.

This is a thoroughly practical and well-illustrated book at a moderate price (2s.). Every radio dealer who runs his own service section should possess a copy, and it might well be adopted as a handbook for students who are learning the practical side of radio servicing at the technical institutes.

Please ask your bookstall or newsagent to reserve a copy of ELECTRONICS AND TELEVISION & Short-Wave World each month and avoid disappointment. Mention of " Electronics and Television & Short-wave World " when corresponding with advertisers will ensure prompt attention.

ASPECTS OF TELEVISION DISCUSSED AT THE TELEVISION CONVENTION — OLYMPIA, 1939

As announced last month a Television Convention which was open to the public was held at Olympia during the last week of the exhibition. The chairman was Mr. H. J. Barton-Chapple.

The first speaker was Mr. R. G. Clark, of Mullards, who spoke of the value of intelligent observation by the public, and said that it must be realised that those engaged in television were creating a new system.

Mr. Clark emphasised that the design of transmitter and receiver were closely interlinked, and that the most important matter was the question of definition. The standard was determined largely by the carrier frequency and the range of frequencies was limited. The use of a lower frequency would lead to trouble from interference and multiple images, and the definition would be lower. A higher frequency would still present the multiple image problem and would give less range, while the generation of the necessary power would be very difficult, if not impossible. The present standard, he said, represented the middle course between prudence and rashness.

Mr. Clark said that many transmitters would be needed even for a limited national coverage, and that the provision of separate studios was not favoured on account of their cost. This left the possibility of linking the transmitters to a single studio either by H.F. cable or by U.H.F. radio links. The former was not simple, and its cost was high, while the latter were liable to interference.

The past year had shown real engineering development. The production of special types of valves had simplified receivers and gave them greater reliability. The C.R. tube, too, had been improved in every way—it was more compact, had a smaller and more uniform spot, had greater sensitivity, and a better screen of improved colour and higher luminosity. Controls on receivers had been reduced to a minimum.

Mr. T. C. Macnamara, of the B.B.C., dealt with transmitting problems. Considerable improvement had been made in details in the last year, and the most important was the introduction of a second studio. The provision of a central control room was also important.

Cameras had been improved; the Marconi-E.M.I. tubes gave better definition and contrast than a year ago, and their colour response was more consistent. Studio lighting was better; much knowledge had been gained from the practice of film studios, but television had its own problems. The reason for bad lighting, which he admitted did occur at times, was inadequate time for full-dress rehearsals. It was generally agreed that outside broadcasts were the most important, for there was no other visual medium with a completely topical flavour.

Much work has been done in the installation of O.B. gear, and several methods of linking it up with Alexandra Palace were available—U.S.W. radio, balanced cable and balanced cable plus telephone line. It was possible to use 1 to 4 miles of ordinary telephone line with a repeater every mile.

Referring to the range of Alexandra Palace, Mr. Macnamara said that it had been expected to be about 25 miles, but it had turned out to have a safe range of nearer 35 miles. Good reception had been obtained up to 70 miles. The range was limited by car-ignition interference. If all cars were fitted with suppressors the range would be very greatly increased.

Ultra-high Frequencies

The next speaker was Mr. Owen Harries, who dealt with the possibility of using wavelengths below two metres. He stressed the need for new research on such wavelengths, both on their production and on their propagation. He was of the opinion that there would be no abrupt change of field strength at the horizon, and he did not think that with high power the range would prove unduly limited. The difficulty was to generate high power, and up to the present only a few watts had been produced.

In America a method had been developed in which a beam of electrons in an applied field had a natural frequency and a negative resistance. The difficulty was that the wavelength depended on the voltage and current, and no one had yet shown a way of amplifying or modulating with such systems.

It was practicable to transmit very short waves down a metal tube with conductive walls, and by placing a horn at the end, reflections could be avoided. The system was reminiscent of a speaking tube and was highly directional.

Mr. Harries also referred to the possibilities of micro-waves in medical practice. They had been tried in Germany for anæsthesia, and were said to have no after-effects. A U.H.F. field applied to the head resulted in unconsciousness which lasted as long as the field was applied.

During the discussion which followed Mr. Davis expressed his conviction that the British television system was sound. The adoption of 405 lines was originally a bold decision which had been justified by events, and he did not think a change would be necessary for years to come. In the case of cinema television a greater number of lines would be desirable because of the direct comparison with films.

Mr. Lance expressed the view that more elaborate aerials and new circuits for ignition interference suppression would be the next developments. Dipoles had been used for years, but he hoped that something better might be found.

Mr. Barton-Chapple asked if it were possible to screen micro-waves adequately so that they would not prove dangerous to the engineers, and he also referred to the possibility of using vertically and horizontally polarised waves of the same frequency without mutual interferance.

In reply Messrs. Clark, Macnamara and Harries agreed that the screening of micro-waves was difficult. They did not feel that it would be possible to avoid interference between stations on the same wavelength by using vertical polarisation for one and horizontal for the other on account of the tilting of the wavefront. Tilts of 20 degrees had been measured on the Alexandra Palace signals.

HOW TELEVISION RECEIVERS HAVE IMPROVED

U.H.F. DESIGN TRENDS IN TELEVISION RECEIVERS

Fig. 1. An early vision receiver employing many stages of amplification.

LOOKING back at the last few years of ultra-high frequency television broadcast, it is interesting to note the change from bulky receivers bristling with controls, to the compact models having only two or three controls, and looking more like articles of furniture.

In the early days of radio the same change occurred. Multi-gang condensers and high efficiency screened coils were unknown, and the natural result was a great elaboration and size of apparatus. A change due to the coming of high efficiency valves and other apparatus was inevitable. The parallel change in television, however, has been on a different scale, having begun with many advantages due to past developments of radio, and the account given here illustrates the rapid development of high-frequency vision receivers during the last three years.

A good example of an early vision receiver is shown by Fig. 1. It is clear from this illustration that many stages of amplification were necessary to give the desired performance. Six high slope television pentodes were used, together with a triode, and one double diode. These were connected in the sequence—H.F. pentode mixer using a separate triode oscillator, four stages of intermediate frequency amplification, push-pull rectification, and one stage of video amplification. This receiver had a sensitivity of the order of 250 microvolts, and a bandwidth of approximately 2 megacycles. There were three controls—tuning, sensitivity, and picture contrast, this latter operating on the video stage only.

For the layout of this receiver, a simple scheme was adopted in which the tuned high frequency coils and trimming condensers were enclosed inside a series of aluminium screening cans, which were mounted in line on the upper side of a long steel chassis. Underneath this chassis lay the H.T. dropping resistances, by-pass condensers and other components with their associated wiring.

This article by
C. E. Maitland, B.Sc. (Eng.) of Baird Television Ltd., details the improvements made in receiver design in the last two years.

This arrangement gave sufficient screening to ensure stability, the spacing of the valves in one line on a long chassis aiding in this by maintaining the maximum distance between points of highest gain.

The next receiver is illustrated in Fig. 2, from which will be seen the striking change in layout. In this receiver three secondary emitter valves and one diode were used, arranged to give two stages of straight high frequency amplification, rectification, and one stage of video amplification. The great improvement in valve characteristics will be seen from the following comparison between the valves of the two receivers given in the next column.

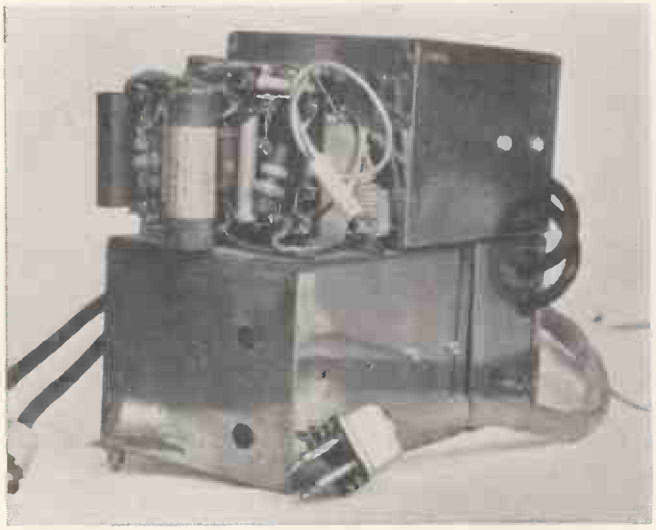
	Television pentode Mullard TSP4	Secondary emitter Mullard TSE4
Mutual conductance	4.7 mA per volt	14.5 mA per volt
Input capacity	9.6 mmfd	10 mmfd
Output capacity	7.5 mmfd	9.3 mmfd
Grid damping	5,000 ohms min. at 45 Mc.	2,400 ohms at 45 Mc.

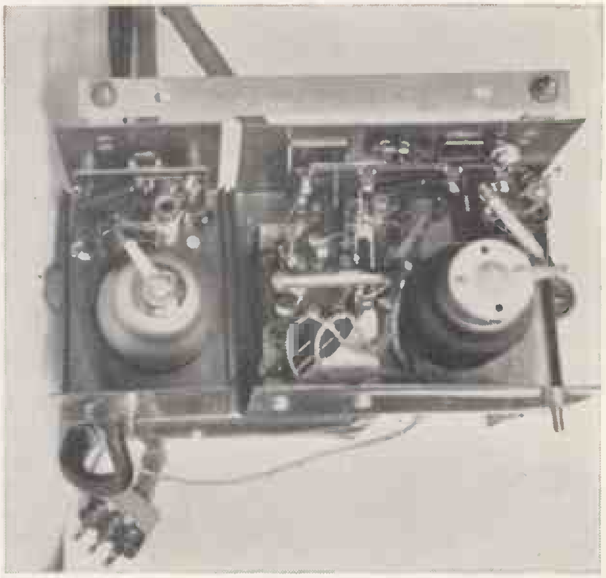
The later receiver has a considerably better performance than the previous one, giving greater sensitivity, better picture detail, and greater freedom from mush. Controls are reduced to one, since the tuning is pre-set, and the gain control alone is needed.

The layout in this case has departed from the idea of a chassis fitted with separate screening cans. Instead, chassis and screens were combined. The construction was such that a framework of copper sheet, bent into a certain shape, and fitted with three separate covers, formed a compact assembly, consisting of three adjacent screened compartments. For each compartment, the sides were made by the turn-ups from the main framework, and the top and two ends were accounted for by the cover. Small flanges in appropriate positions ensured the fixing of the covers, and also served to improve the metallic contact between the various parts.

It is to be expected that a 45 megacycle straight H.F. receiver of high sensitivity would require many precautions against instability, H.F. losses, and other troubles, and this was certainly the case. The copper screening just described overcame

Super-het V "Straight"





Figs. 2 and 3. Two views of a receiver which owing to improvement in valve characteristics allowed of considerable modification of design.

many such difficulties by enabling by-pass and earth return circuits to be made most effectively. The arrangement of the components inside the different compartments was also considered with the same end in view. An inside view of the receiver (Fig. 3) shows how components were laid out to make all H.F. wiring as short as possible, and to reduce stray capacity to a minimum. From this photograph it can be seen that the valves were mounted in a position to allow the top cap grid connection, and the anode and other base connections, to appear on opposite sides of the main framework. Since the second valve was inverted in relation to the other two, each compartment contained the components for one stage of amplification, that is, all the circuit between the anode of one valve and the grid of the next.

Very satisfactory performance was obtained with this receiver, which appeared to justify the attention given to the details of its construction.

One question which arose during the design of this receiver was—would a superhet give any better performance? A three valve superhet receiver using TSE4 valves was actually constructed during the development of the other model to answer this question.

The result was to confirm the opinion that a high sensitivity superhet receiver needs an H.F. stage preceding the mixer valve to prevent too much mush from that valve. This being the case, it was obvious that the receiver would need to have four valves, in order to retain the advantage of I.F. amplification.

Straight Receivers

The same consideration was taken into account in designing the next receiver, again a three valve straight H.F. model. This model, just developed, presents another striking reduction in size, as well as many other interesting features. There is, for example, a much simpler construction, and a great reduction in the total number of parts. This time a steel chassis was used, and all the H.F. components were mounted on one side, as can be seen from the photograph Fig. 4. Less elaborate screening was required, and three sheet-iron covers (not shown) were fitted so that the two edges of adjacent covers came across the middle of each valveholder, leaving a small clearance at this point.

Increased Simplification

All the valve connections being on the one base, such screening effectively isolated the anode and grid of each valve, together with the H.F. circuits. It was found that the reduced dimensions of this valve, and the introduction of the single ended base connection in place of the more usual base and top cap connection

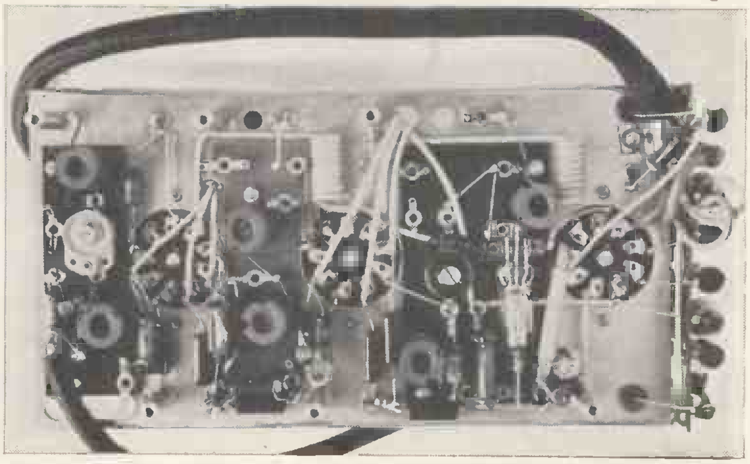


Fig. 4. Further simplification of design is apparent in this straight H.F. model.

contributed much to the improved performance of the receiver. Characteristics of the valve are given below.

Mullard EE50 secondary emitter valve
Mutual conductance 14 mA per volt
Input capacity 7.7 mmfd.
Output capacity 7.7 mmfd.
Grid damping 9,000 ohms at 45 Mc.

This receiver illustrated the fact, often met in high frequency work, that the most effective design from the point of view of performance is that which leads to the simplest and most compact construction.

This trend in the receivers generally is illustrated in the drawing, Fig. 5, which shows the move towards compactness of design, while the graphs of performance show how the receivers at the same time have improved both as regards picture quality and signal sensitivity.

In conclusion, the writer would like to thank Messrs. Baird Television, Ltd., for permission to publish this article.

Mention of "Electronics and Television & Short-wave World" when corresponding with advertisers will ensure prompt attention.

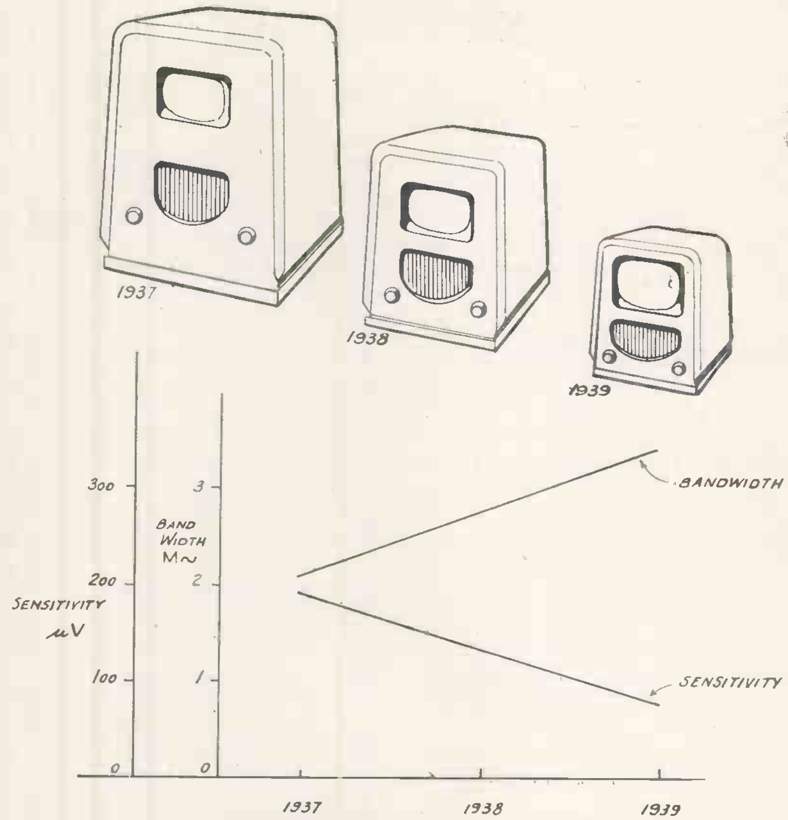


Fig. 5. Relative receiver sizes and relative performances in the last three years.

Television in Italian War Planes

Squadron Already Equipped

MAJOR C. C. TURNER, writing in the *Daily Telegraph and Morning Post,* says that according to a New York newspaper Italy has an air squadron equipped with radio television sets.

It is claimed that difficulties due to the weight of the ordinary television installation, and to the need for very strong light, have been overcome. The installation, it is stated, has been reduced to "flying" weight, and daylight, even without direct sunlight, is sufficiently strong.

At first the application of this discovery was limited to transmission of pictures of cloud formations to a ground station, or similar pictures from the ground to the 'plane, but it is now claimed that from a 'plane at a height of 6,000 ft. a motor car on a road can be seen clearly enough to recognise its make. A television range of 100 miles is said to be attained.

The application of this discovery to "spotting" for the artillery is foreshadowed, and may even now be practicable.

Experiments have been in progress in several countries for some time.

The televising of actual scenes from the air should not be confused with the employment of the infra-red ray for "seeing" objects, such as 'planes or ships, hidden in fog. As long ago as August 23, 1935, *The Daily Telegraph* reported on an invention which revealed to the observer a 'plane four miles away in cloud and a ship 12 miles distant.

Air Ministry Research

Four years ago the Air Ministry financed television research undertaken by the National Physical Laboratory. This had in view the installation in a 'plane of a screen on which the pilot could see a spot, representing his 'plane, moving over a map of the aerodrome, and enabling him to approach and land in fog.

This was a very different method from that of the Lorenz, or other "blind" landing system, which guide a pilot during his approach, and inform him automatically of his height from the ground as he comes in.

In August, 1935, a decree by Hitler directed that television in Germany should be placed under the Air Ministry. All television apparatus came under regulations relating to military equipment. The fact that television can be used in war was at that time new to the general public.

Luminescent Afterglow

The afterglow of luminescent substances excited by cathode rays can be represented by two exponential curves giving a satisfactory approximation of the initial part and the end of the curve showing afterglow as a function of time. The curve shape of the afterglow depends on the excitation intensity.

If interrupted excitation is used the measurements show a strong decrease of the degree of modulation for high frequencies, for instance, of a few per cent. for 105 cycles per second. Different luminescent substances give different steepness of curves, showing degree of modulation as a function of frequency. The degree of modulation is calculated on the basis that the afterglow curve consists of one and of two e-functions.

THE MURPHY NOISE-LIMITING CIRCUIT

Although the television transmissions have been suspended for the present particular interest attaches to the fact that steps have of late been taken to obviate the interference caused to ultra-short wave transmissions by interference from motor car ignition systems. This article describes the means adopted in the latest Murphy receivers.

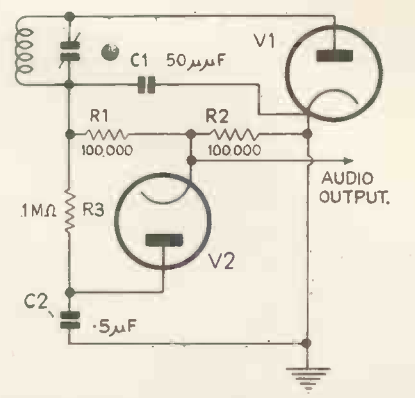


Fig. 1. The "Dickert" noise limiting Circuit. The basis of the means adopted in the latest Murphy receivers.

INTERFERENCE with television reception caused by motor car ignition systems in mild cases causes a few small but intensely bright spots to dance about the picture, often accompanied by a crackling noise from the loudspeaker. In more severe interference horizontal bands of these bright spots rapidly pass up or down the picture, accompanied by a roar from the loudspeaker, which may sound almost like a machine gun.

There is no doubt that ignition interference is by far the most serious type experienced, though most people agree that while its effect on the picture is serious, it is not so distressing as the noise it causes the speaker to emit.

Cause and Nature

The first step in overcoming the interference is to find out its exact cause and nature, and here we have not far to seek. The earliest method of generating wireless waves consisted of causing electric sparks to pass between two brass balls, to which were attached lengths of wire and metal plates. Each spark which passed was followed by a short train of oscillatory current in the wires attached to the balls, and by a corresponding train of wireless waves. Exactly the same thing occurs in the ignition system of a motor car, and it is not surprising therefore that every car should be an unintentional transmitting station.

Obviously, the radiating efficiency of the ignition system wiring cannot compare with that of a transmitting aerial, but, unfortunately, what the car lacks in transmitting efficiency in this way, it makes up to some extent by its very high instantaneous power. Instantaneous currents of 100 amperes have been measured in sparking plug leads, and to maintain a current of this value flowing in a transmitting dipole would require 400 k.w. In the motor car, of course, such currents are not maintained, and the train of radiation set up by each spark dies away in a fraction of a microsecond.

The wavelength of the radiation is determined by the electrical characteristics of the ignition wiring of the car, and is usually between five and ten metres (hence the absence of this kind of interference on medium waves).

But it must not be imagined that this radiation is limited to one wavelength, like that from a modern broadcasting station, and can therefore be tuned out. The signal from a motor car must rather be compared with that from an early type spark transmitter, which, as many people know to their cost, "comes in all round the dial."

Since the radiation from the car is of the same nature as the wanted signal, it is obviously difficult to do much about it at the receiver. Interference can, of course, be reduced by choosing the best location for the aerial or by making the latter directional. Yet even where interference might be described as "not really bad," the peak values of the interference at the aerial may easily be twenty times as strong as the wanted signal.

It will, therefore, be readily understood that even a three-fold improvement in signal-to-noise ratio at the aerial may not do much towards improving reception. It will also be clear why suppression at the source is so very desirable. No doubt this will be made compulsory in time, but in the long meanwhile, we must do what we can at the receiver. As a matter of fact, the receiver does help us without any special arrangements.

Under normal receiving conditions the final valves in the set will be giving nearly their full output. Peaks of interference, many times as strong as the desired signal at the aerial, can therefore only be reproduced at a level somewhat greater than the signal. The receiver has a "limiting action," in other words. Since the range of brightness that must be produced on the cathode-ray tube is much more definite than the range of sound that must be produced by

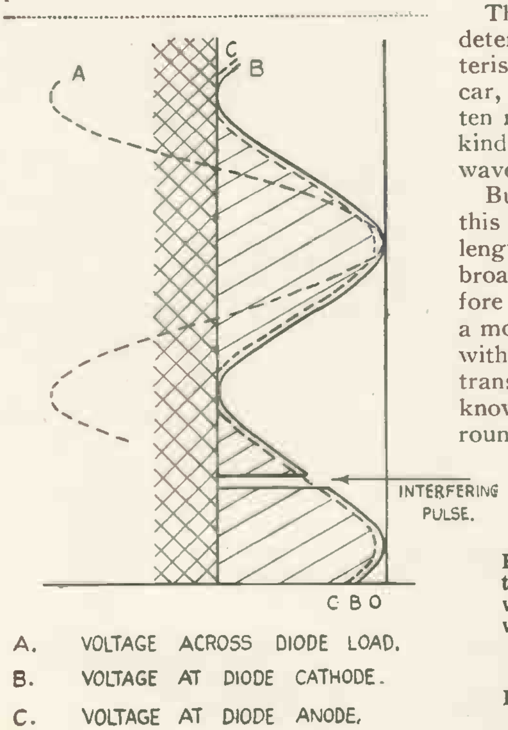
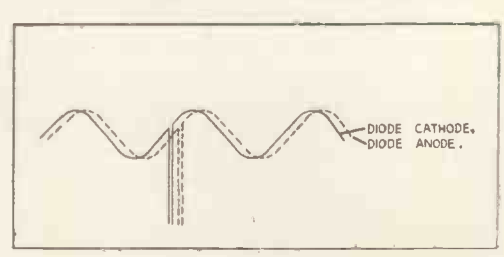


Fig. 2 (left). Curve showing how the voltage at the cathode V2 varies between zero and a negative value equal to the steady voltage across the diode load.

Fig. 3 (right). Diagram showing action of delaying network.



How Limiting Circuits are Used

the loudspeaker, the output stages of the vision receiver can be designed to be working much nearer to their limit than the sound output stages.

In this respect, therefore, the vision receiver is better off than the sound receiver, and it is for this reason (in addition to the psychological one that the interference is more distressing to the ear than to the eye), that special steps have been taken to reduce the effect of interference on the sound receiver. It is worth pointing out here that the problem of removing noise in a television receiver is a little more hopeful than the general one of removing noise in a broadcast receiver, for technical reasons bound up with the relative widths of the I.F. circuits in each.

Limiting Circuits

The most practical known circuits for reducing the effects of car interference are "limiting circuits," designed to carry out more efficiently the natural limiting action of the receiver.

Their operation may be illustrated by reference to the circuit Fig. 1, which is known as the Dickert noise limiter. Here the diode V_1 is shown connected in a normal second detector circuit. Resistors R_1 and R_2 in series form the diode load, and C_1 the by-pass condenser. The valve V2 is the noise limiting diode. When a signal is received a steady negative voltage is developed across the diode load by the signal carrier, and an audio voltage is superposed on this, due to the signal modulation.

If the modulation is 100 per cent. the total voltage across the diode load will fall to zero on one peak and rise to double the steady mean voltage on the other peak of modulation. (Curve A, Fig. 2.)

The voltage at the cathode of V_2 therefore varies between zero and a negative value equal to the steady voltage across the diode load. (Curve B, Fig. 2). But the anode of V_2 assumes this steady voltage, so that in the absence of noise, V_2 just never conducts on 100 per cent. modulation. A strong peak of interference will try to make the cathode of diode V_2 go more negative than this, but will not succeed, because conduction of the diode V_2 will prevent it.

In effect, the diode V_2 "short-circuits" any excursions of its cathode voltage beyond those caused by 100 per cent. modulation of the received signal. The cross-hatched area in the diagram Fig. 2 is thus "forbidden" to the diode cathode.

Though such limitation is worth having, unfortunately it still permits interference to cause painfully loud noises in the speaker. Obviously, it is desirable that the shaded area in the diagram should be added to the "forbidden" cross-hatched area, or, in other words, that the diode anode should be maintained not at a steady voltage, but at a voltage which follows the cathode voltage except during the interference.

The circuit included in the Murphy television receivers this year does not quite do this, but achieves very nearly the same result. The voltage applied to the diode anode is the same as that applied to its cathode except that as it passes through a delaying network, it arrives a few microseconds later.

The action can now be followed from Fig. 3. When the interference arrives at V_2 diode cathode, it tries to drive it negative. No interference, however, has yet arrived at the anode of the diode on account of the delay network, so that the cathode is almost immediately trying to go negative with respect to its anode which, of course, it cannot do without the diode conducting. The pulse of interference is thus truncated to little greater amplitude than the difference between the two curves in Fig. 3. This much reduced pulse will eventually arrive at the diode anode, but it can do no harm here provided that the original pulse has ceased by then and that no other pulse has arrived. The second possibility is remote. It is evident that the noise can only be cut out provided it is of short duration, a condition which is almost always fulfilled by motor car interference.

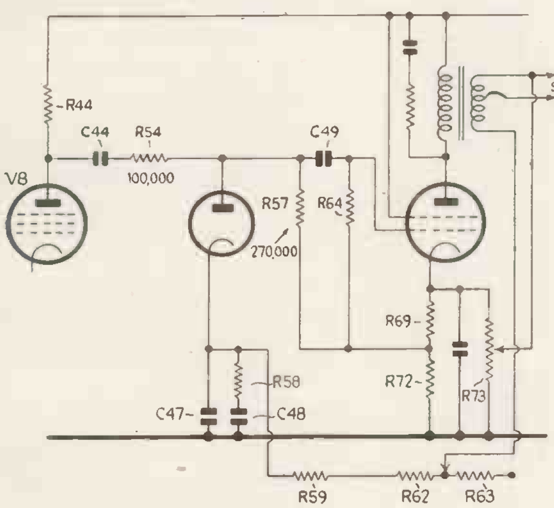


Fig. 4. Essential features of the limiting arrangements employed in the latest Murphy receivers.

The "Limiter" in Practice

It now only remains to explain how the scheme is put into practice in the new Murphy receivers. The essentials of the circuit are shown in Fig. 4. The noise suppression diode is actually in the same envelope as the second detector diode, but is drawn separately here for the sake of clarity. Functionally, the two diodes are quite separate. The noise suppressor is not even connected to the detector diode load, as in the above explanation, but follows the L.F. valve V_2.

Since suppression works purely on the audio signal, this is obviously permissible, though special care must be taken with the amplifier, and the phase inversion of the signal and interference, which it causes, requires the suppression diode to be reversed from the explanation above; i.e., anode takes the place of cathode. C44 with R54 and R57 form a condenser and tapped grid leak; the diode anode is connected to the tap.

The insertion of R54 is necessary in order to make the impedance of the circuit feeding the diode high compared with the impedance of the diode itself, for it is clear that a diode can only short-circuit a source of impedance that is high compared with itself.

(*Concluded on page 624*)

A COMPLETE GUIDE TO VALVE VOLTMETERS

VALVE VOLTMETERS IN THEORY AND PRACTICAL USE

Sometime ago we published an article on the theory and use of the valve voltmeter. This aroused great interest among readers who were desirous of understanding the theory and construction of these instruments and numerous requests have been received for additional details. We are, therefore, reprinting the notes in an expanded form together with details for the practical construction of the several types described. The survey is probably the most comprehensive yet published.

THE general characteristic feature of the most usual type of valve voltmeter is its great sensitivity, defined as the reciprocal of the power required for full-scale deflection of the indicating instrument. A reasonably high-grade moving-coil meter, such as would be used for valve voltmeter purposes by the research worker, would give full deflection with an input of about 40 microwatts. Used as the indicating instrument for a valve voltmeter of the high-input-resistance type, full scale deflection would be obtained with an input of the order of 0.1 microwatt.

Another characteristic feature (perhaps its most valuable one) is the extremely wide range of frequency over which it may be used, from the lowest A.C. frequencies (about 10 c.p.s.) up to 30 megacycles per sec. The most general type of construction (as described herein) is suitable for use between the limits 50 c.p.s. and 10 mc.p.s., without serious change of calibration. By special design, valve voltmeters have been constructed to work at frequencies up to 150 mc.p.s. A special technique is also needed for voltmeters working below 10 c.p.s. and for D.C. (" electrometer " use).

Lastly, the " law " of the scale indication can be arranged to choice within certain limits.

In the instruments described here the values of the circuit elements are given in the appendix.

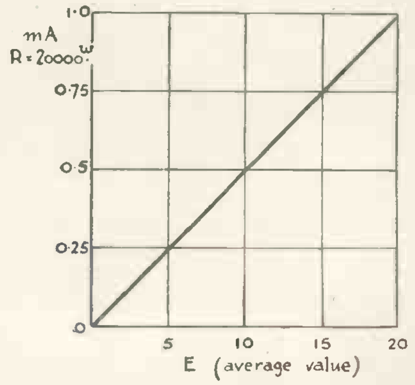


Fig. 1a. Law of scale of direct-reading diode violtmeter.

The Diode Voltmeter

Structurally this is the simplest type of valve voltmeter, and in practice it takes three forms:—

(a) Direct-reading.
(b) Direct-reading peak.
(c) " Slide-back " peak.

Type (*a*) is depicted in Fig. 1. It consists essentially of a D.C. voltmeter shunted by a condenser, in series with a diode. Owing to the curvature at the lower end of the anode volts—anode current characteristic of the diode, and the effect of the so-called " contact potentials," it is necessary, if the instrument is to be used for full-scale readings of less than about 20 volts, to use a potentiometer (P_1) to apply a small positive bias to improve the linearity at the lower end of the scale.

The characteristics of the instrument are as follows:—

The " law " of the scale is a close approximation to linear, as depicted in Fig. 1a. The reading is proportional to the average value of the applied voltage wave, consequently the error is large for distorted waveforms, if, as is the standard practice, the scale is calibrated in terms of r.m.s. values.

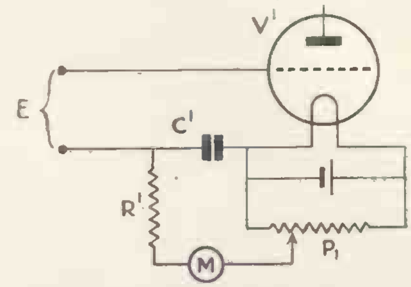


Fig. 1. Direct-reading diode voltmeter.

The input resistance is, to a fair approximation, $\frac{1}{2}R_1$, whatever value R_1 may be.

This type of instrument is very useful in cases where a small load upon the source to be measured can be tolerated, as in the case of measurements on power amplifiers.

If, in the case of the instrument shown in Fig. 1, the meter M is omitted, the resistance R_1 made very high (of the order of a megohm or so) and an electrostatic voltmeter placed across it in parallel with the condenser, a very useful and interesting type of instrument results, namely, the *Direct-reading Peak Voltmeter* (*b*). This latter instrument is generally arranged as in Fig. 2 (a) or (b).

A suitable electrostatic instrument for experimental use is the Ferranti 0-300 volt 2½ in. scale (for general use) or the 0-600 for testing output stages of small power amplifiers, as described later. The valve is preferably chosen to stand up to the voltage to be measured. A small bright emitter transmitting valve (T15 or similar) or one of the new small high-voltage diodes, such as the Marconi or Osram U16 or U17 is suitable, if the higher range meter is desired.

This variety of valve voltmeter does not require calibration, the peak voltage being read directly on the e.s. voltmeter. The input impedance is approximately $\frac{1}{2}R_1$, as in the case of the previously described instrument. For use at low frequencies C_1 may be of the order of .1 mfd., but for high-frequency measurements solely, C_1 need not be greater than 0.001 mfd.

Two interesting applications of this instrument are worthy of description:

(1) For measuring the percentage modulation of transmitters.

For this the instrument is coupled, either directly, or by means of an

Slide-back Voltmeters

aperiodic coupling coil, to the transmitter to be investigated.

The coupling is adjusted until the reading on the meter is about half full scale or a little less. Modulation is then applied to the transmitter, and the reading will be seen to increase. Let us call these two readings A and B respectively. The percentage modulation is then

$$\frac{100.(B-A)}{A}\%.$$

The meter may be made direct-reading for this purpose by dividing the upper half of the scale into ten main divisions each representing 10 per cent. modulation (with subdivisions if desired). When using this device, the coupling to the transmitter is always adjusted so that with unmodulated carrier the instrument reads exactly half full-scale voltage (corresponding with zero on the modulation scale). When modulation is then applied, the instrument reads the percentage directly on the upper half of the scale. Since most e.s. voltmeters have an approximately "square-law" scale, the modulation readings will occupy the upper 75 per cent. of the actual scale length, which is very convenient. Such a scale (based on the 0-300 voltmeter) would appear as shown in Fig. 3.

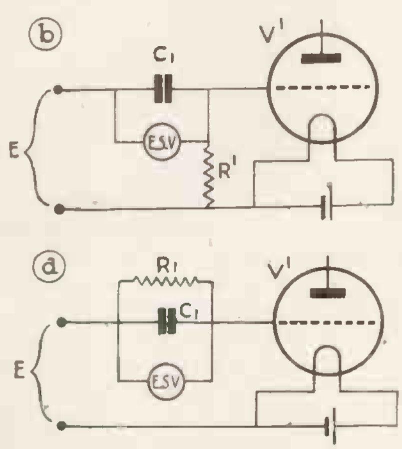
(2) For checking the correct loading of L.F. amplifier output stages.

Consider the output valve anode voltage—anode current curve, with superimposed "load-line," shown in Fig. 4. It will be seen that with correct operating conditions the peak anode voltage would be 570 volts, as indicated by the lower extremity of the load-line.

The peak voltmeter (arrangement as Fig. 2b) is connected between the anode terminal of the valve and cathode to earth, and the peak (including of course the D.C.) anode voltage read, whilst an A.C. signal voltage of the correct amplitude (54 volts in the case shown) is applied to the grid of the valve, working under the desired operating conditions. A lower reading of the peak voltage than that shown (for instance) in the curve indicates that the load impedance is too low, a higher reading that the load impedance is too high, in the proportion that the reading is lower or higher than the correct reading indicated on the curve according to the expression

$$\frac{V_p^1 - V_a^1}{V_p^1 - V^1}$$

where V_p is the peak reading indicated on the curve. V_p^1 the peak reading according to the voltmeter and V_a^1 the applied anode D.C. voltage, allowing for the D.C. drop across the output transformer windings.



Figs. 2a and 2b. Circuits of two types of direct-reading peak voltmeter.

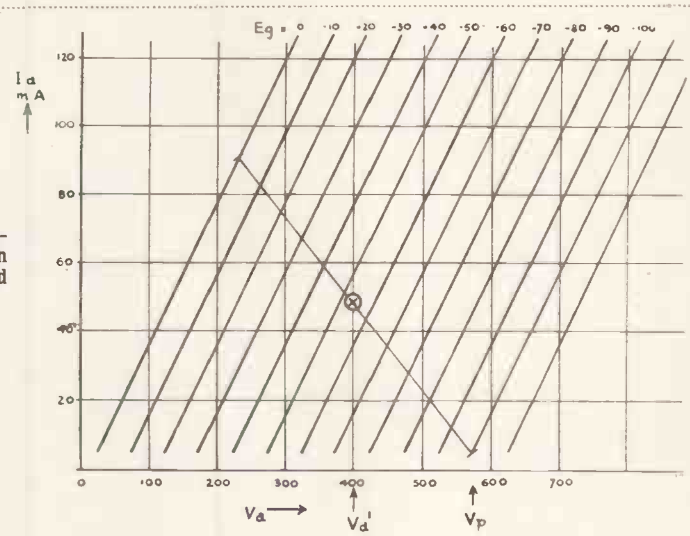


Fig. 4. (right) Anode-current curve with superimposed load line.

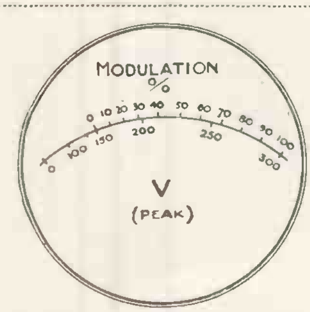


Fig. 3. Arrangement of scale of peak voltmeter.

Type (*c*), the Slide-back Voltmeter, is shown in Fig. 5a. For the sake of economy, in the instrument shown therein, the circuit is arranged so that by means of the switch S, the same meter may be used for indicating both the rectified current and the value of the slide-back bias voltage. Calibration is not required.

With the meter switch in position 1, and the bias at maximum value, the voltage to be measured is applied, and the bias reduced until the first signs of a reading appear on M. The bias is carefully adjusted by means of P_1 until, so far as can be judged, the rectified current indicated on M is just reduced to zero. The switch S is then thrown to position 2, and the value of the bias voltage read. This latter is then the value, to a more or less close approximation, of the peak voltage applied.

The disadvantage of this instrument is that it is not easy to determine exactly the point at which the rectified current ceases. The instrument becomes more accurate as the indicating instrument (M) is made more sensitive, and/or the anode impedance of the diode (V_1) reduced.

The Triode Slide-back Voltmeter (*Fig. 5b*). One method which was used in order to render the slide-back

Grid Rectifying Triode Voltmeters

method more sensitive was to use a triode instead of a diode. So far as this intention is concerned, it is doubtful if there is any advantage, since in order to obtain any increase in sensitivity over the diode, it is necessary that the " slope " (G) of the triode, expressed in mA/V, should be greater than 1/R where R is the anode resistance of the alternative diode, expressed in thousands of ohms. Few if any triodes can fulfil this condition in competition with modern diodes, since the slope at the cut-off point is seldom greater than 1 mA/V, whilst almost any modern small diode can show an anode resistance much less than 1,000 ohms.

The advantage of the triode slide-back voltmeter lies in the fact that the rectified current indicated on the meter is not derived from the load circuit, and since the grid of the triode does not attain a positive voltage in order that rectified current may show, the instrument offers a very high input resistance, which is often desirable for some purposes. Its method of operation is exactly as described for the diode slide-back, except that the initial value of bias necessary in order to bring the valve to the anode current cut-off point must be subtracted from the total slide-back bias. With this instrument some increase in accuracy over the diode instrument is perhaps attainable by working to a " false zero," i.e., a small but definite reading of rectified anode current (say, 0.05 mA).*

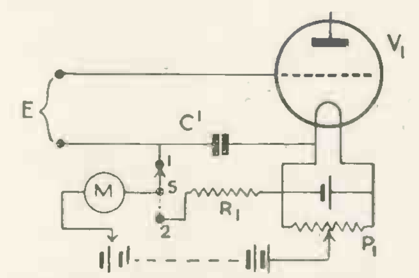


Fig. 5a. The slide-back valve voltmeter.

Slide-back voltmeters may be used for almost any purposes for which the direct-reading peak voltmeter described above) may be used, with the advantage, particularly in the case of the triode instrument, that the input resistance is much higher. The latter instrument may also be used with a grid condenser and leak, as described later, which again offers a further advantage.

The fact that the " slide-back " bias must be at least a little greater than the highest peak voltage which it may be desired to measure renders this type of instrument inconvenient for voltages much in excess of 100.

The Grid Rectifying Triode Voltmeter

The main disadvantage of the direct-reading diode voltmeter is that the power for the operation of the indicating instrument has to be drawn from the source to be measured. Since the power required for the operation of the indicating instrument itself, apart from that dissipated in the series resistance, is of the order of 40 microwatts, this type of voltmeter is not suitable for use in delicate measurements.

To avoid the comparatively large dissipation of power mentioned, one might use a very high load resistance (of the order of several megohms) and use the voltage developed across this to bias the grid of a triode negatively, since the power required to bias the triode would in itself be negligible.

The logical development of this idea leads to the Grid Rectifying Triode Voltmeter, depicted in Fig. 6. Here the grid performs the dual function, acting as a diode to rectify the applied voltage, and by the negative bias set up across the load resistance (grid leak) causing the anode current of the valve to fall.

It is necessary that the grid condenser (C_1) should be of such a value as to offer a small impedance in comparison with the grid leak (R_1) at the lowest frequency at which it is intended to use the instrument. It will be noticed that there are two methods of connecting R_1: (a) across the grid condenser, in series with the input circuit; (b) between grid and filament negative, in shunt with the input circuit. Each method has its own purpose. If connected as in (a), the input resistance of the instrument is of the order of $\frac{1}{2}R_1$. If connected as in (b), the input resistance is of the order of $1/3R_1$, but this latter connection has the advantage that there does not need to be a complete D.C. circuit between the input terminals of the instrument, which is very useful when the A.C. potential across a condenser is to be measured, or the A.C. potential between two conductors between which there is also a difference of D.C. potential.

So far as the anode circuit of the voltmeter is concerned, it will be recollected that if this latter part of the circuit contains any considerable impedance at any frequency at which the instrument is to be used, the input impedance will undergo large changes owing to the " Miller effect." To obviate this, the condenser C_2 is connected, and it is important that this condenser should be of good quality, preferably with a mica dielectric, if the instrument is to be used much for very high frequencies.

The simple form of voltmeter shown suffers from the fact that there is a considerable " standing " anode current (of the order of 1.5 mA) the indication of which must be obviated. The simplest scheme for doing this is by means of a series resistance (R_2) and a potentiometer (P_1) across the filament battery, by which a " backing off " current is sent through the meter (M) in the reverse direction to the standing anode current. Since R_2 is virtually in shunt with the meter M, and the potentiometer P is in effect a variable portion of R_2, it is important that the resistance of R_2 should be high in comparison with the resistance of M and P. There is generally no difficulty with this.

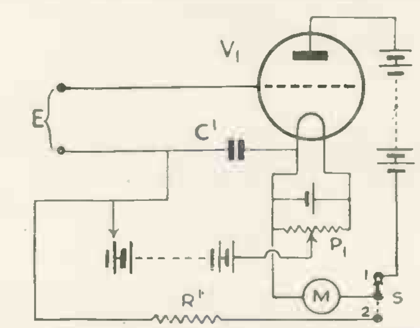


Fig. 5b. The triode slide-back valve voltmeter.

Sufficient anode voltage is used to give a standing anode current well in excess of the full scale reading of the meter M. The voltage amplification factor (" μ ") of the valve is only of interest in so far as it determines the minimum anode voltage necessary to

* A recent version of this instrument gets over the initial current difficulty by using a gas-filled (preferably helium or argon) triode, in which case a peak voltage exceeding the cut-off value of bias by a very small amount causes the full value of anode current to flow immediately. The limiting factor on accuracy here is the constancy of the " firing point " of the gas triode. The circuit is otherwise identical with that given in Fig. 5b.

Anode Rectifying Voltmeters

attain sufficient standing current. For this reason a valve with a low μ is generally more convenient.

The indication on the meter for a given input voltage is directly proportional to the mutual conductance (" slope ") of the valve used, so it is desirable to use a valve of good mutual conductance, if sensitivity is required. Beware, however, of choosing a valve on this score alone, since some valves with an exceptionally good mutual conductance " age " rapidly, and one doesn't want to go

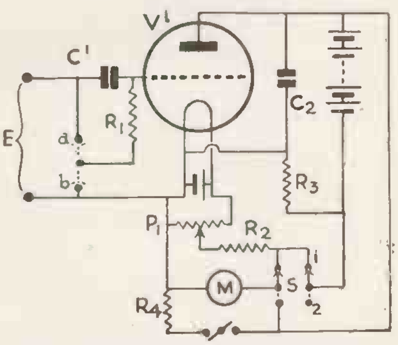


Fig. 6. Grid rectifying triode voltmeter.

through the process of re-calibration too often. It is sometimes advantageous on this score to use a valve that has been in use for some time.

In Fig. 6, a switch (S) is provided so that the same meter may be used for measuring the anode battery voltage. It is not necessary that the actual value should be known, so it is not necessary (unless desired) to calibrate M with R_3 as a voltmeter. When initially calibrating, it is only necessary to note the reading on M with the switch in position 2, and to adhere to this value of anode voltage whenever the instrument is to be used for important measurements.

Care must be exercised when the instrument is first brought into use, the shunt R_4 being used across the meter whilst carrying out the initial adjustments.

Each time that the instrument is brought into use, after making the first adjustments, wait for a few minutes before using, in order to let the instrument " settle down." This is an essential precaution with all triode voltmeters, and especially this type. After the settling down period, readjust the anode voltage and backing off, if necessary.

The general characteristics of the instrument are given below:—

The scale " law " is approximately linear at the upper end (80 per cent.), but departs considerably from linearity at the lower end (20 per cent.). The indication is not proportional to the r.m.s. value of the applied voltage in terms of which the instrument is customarily calibrated, so large errors may be encountered when measuring distorted waveforms. The input resistance may be fairly high, of the order of 2-3 megohms with the component values given in the appendix.

It is the most sensitive form of valve voltmeter, from the voltage input point of view. The instrument described would give full scale deflection with about 1 volt r.m.s. input.

One modification of this instrument dispenses with the grid leak entirely, relying upon random leakage. This results in great sensitivity and a much higher input resistance, but unless the valve is carefully chosen the instrument is not very stable.

The input capacity of this type of instrument will be between 10 and 15 micromicrofarads, unless a special low-capacity valve is used.

There are some purposes for which the G.R. voltmeter is unsuitable, notably the determination of voltages across low decrement (" high Q ") tuned circuits. For this can only be achieved if all sources of energy dissipation in the input circuit are minimised. Generally, grid current (essential in the previously described instrument) is the major cause of loss, so in the case of the type of voltmeter now to be described the valve is worked with the grid at a negative potential well in excess of any peak potential likely to be encountered in the course of measurement. This scheme depends for the

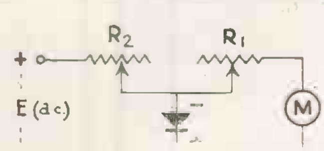


Fig. 8. Decibel valve voltmeter employing metal rectifier.

necessary rectifying action upon the bend at the foot of the valve anode current-grid voltage characteristic.

If the best results are to be obtained, some care is necessary in the choice of valve and operating voltages. In order to ensure absence of grid current, most valves have to be biased so that the peak value of the input voltage never makes the grid less than about 1 volt negative. With a valve in use having a mutual conductance of 3 mA.V., and an 0-1 milliammeter as the indicating instrument, about 2 volts r.m.s. input will be required to give full-scale deflection. This gives a value of 3 volts peak for a waveform not departing far from a sine wave, therefore in this case the value of negative grid

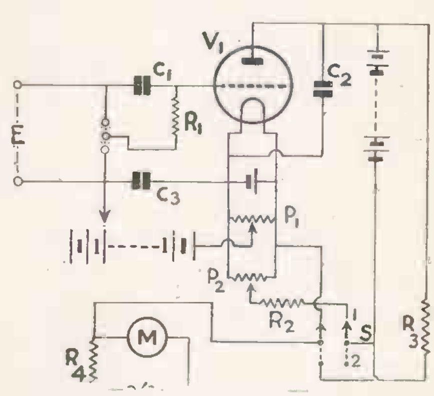


Fig. 7. The anode rectifying valve voltmeter.

bias should not be less than 4 volts, which with a suitable valve (μ between 9 and 10) will necessitate an anode voltage of between 30 and 40 volts. More bias and consequently higher anode voltage will do no harm, but high anode voltages are often inconvenient, especially in the case of a portable instrument. For the latter purpose a low μ valve and consequently smaller anode voltage will generally be more convenient.

The " law " of the curve at the foot of the valve anode-current characteristic varies somewhat in different valves. In some types it closely approaches a square law over a part of the curve. In the latter case the result is very useful, since the output indication will be proportional to the square of the input voltage, and therefore a true indication of r.m.s. values. Moreover, a standard square-law (" thermal ") scale will suit the instrument, instead of a specially calibrated one. Such a result can be achieved if the valve used is, for instance, a Mullard type PM202, with an 0-100 microammeter as the indicating instrument.

In this variety of instrument the standing anode current is small, of

Special Types of Valve Voltmeters

the order of 0.1 M/a., which renders the problem of "backing off" less difficult. One method of backing off which may be used in this connection (if the indicating instrument is not used for any other purpose) is to off-set the mechanical zero adjustment by the amount of the standing anode current.

If it is essential that the voltmeter should present the highest practicable input resistance, the valve cap will be removed, the connections being soldered direct to the lead wires, and the input terminals mounted in quartz bushings. In this connection no grid leak can be tolerated, and the instrument has the possible disadvantage in some circumstances that a complete d.c. circuit must exist between the input terminals.

Sometimes a grid condenser must be used, with a very high resistance leak (not less than 10 megohms) in order to block off d.c. voltages in the apparatus connected to the input. Since there is in this case no rectified grid current, the input resistance is substantially that of the leak, which is, of course, in parallel with the input circuit, as there is no object in using it otherwise. If (as in Fig. 7) an alternative series connection is provided, this latter does not result in any power dissipation in the leak since there is no rectified current, and so far as the A.C. input is concerned the leak is effectively short-circuited by the grid condenser.

Fig. 7 is self-explanatory. It is convenient to have two potentiometers, one for adjusting the standing current to the best value (generally that which gives the closest approximation to a square-law calibration) and the other for backing off. The same scheme as previously explained in the case of the G.R. voltmeter is used for checking the anode voltage.

The characteristics of this instrument are:—

If carefully constructed and adjusted, the scale "law" is of parabolic (square-law) form throughout. The indications in this case are proportional to the r.m.s. value of the applied waveform, so that when, as is usual, the instrument is calibrated in r.m.s. values, no errors arise due to distorted waveforms.

It is not so sensitive, on a voltage-input basis, as the G.R. voltmeter, having a sensitivity, with the same valve, of about half that of the latter instrument.

On the power input basis, however, it is superior, since the input resistance, with good design and operation, is the highest that it is possible to obtain, and should be, with a valve of other than special type, of the order of 20 megohms minimum.

For H.F. measurements solely, this type of valve voltmeter has almost completely displaced the G.R. voltmeter, on account of the comparatively low and variable input impedance of the latter.

Special Types

For certain purposes (e.g., photo-electric currents, and determination of hydrogen-ion concentrations) *the highest attainable input resistance* is essential. For these purposes the circuit used is of exactly the same form

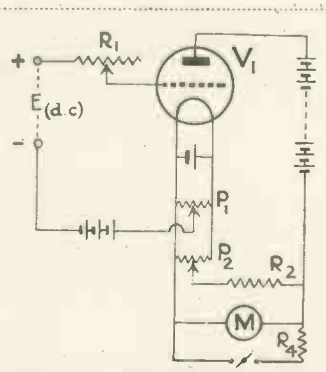


Fig. 9. Another type of decibel valve voltmeter.

as that just discussed, omitting the grid condenser and leak, since the object now in view is to measure D.C. and random potentials set up across resistances of the order of thousands of megohms. Consequently a special valve (triode or tetrode) is used, which has the following features:—

(1) The grid terminal is brought out through a special annexe made of glass of the highest possible specific resistance. The grid supports are also of the same material.

(2) The cathode is operated at a specially low temperature, in order to avoid the possibility of thermally agitated electrons or ions of greater than normal velocity impinging on the grid.

(3) The valve has a very low amplification factor (in some cases less than unity) so that the anode voltage can be kept well below 10 volts, in order to avoid the possibility of ionising any minute traces of residual gas, or causing the emission of secondary electrons.

(4) To help (2) and (3) the valve is, of course, exhausted to as high a vacuum as possible.

(5) Special "guard rings" are mounted at the foot of the electrode assemblies and at the foot of the bulb on the outside. These guard rings are earthed in order to by-pass any minute leakage currents over the glass surfaces, which might upset the indications of the instrument.

For the same reason, the valve is mounted in a special box containing some chemical (such as calcium chloride) to keep the air therein as dry as possible. These valves are generally referred to as being of the "electrometer" type, since they are used for purposes for which a sensitive electrometer would formerly have been used.

Decibel Meters

In some cases, a scale having a special deflection "law" is desired (e.g., a logarithmic, or "decibel" scale).

This latter type of valve voltmeter is nearly always employed for the purpose of measuring audio-frequency A.C., in circumstances such that a moderately low input resistance can be tolerated. If, however, a high input impedance is necessary, an amplifying (more properly speaking, an "impedance-selecting") stage is interposed between the source to be measured and the decibel-meter proper.

The principle upon which the usual types of decibel-meter operate is by the use of a device the D.C. resistance of which falls as the current through it increases. Two common and easily obtainable pieces of apparatus will do this, namely, a metal rectifier, or a thermionic diode. The foot of the E—I characteristic is curved in each case, the curvature being such that with an increasing voltage (or current) there is a decreasing resistance.

Figs. 8 and 9 show how they are

"Reflex" Voltmeter

employed as decibel meters. Notice that in each case the input has to be D.C., applied in the "forward" direction (direction of minimum resistance). For calibration purposes, this is rather convenient, since all that is required is a few cells, a potentiometer, and a D.C. voltmeter, together with a table of common logarithms, or "decibel equivalents."

In Fig. 8, the variable resistance element is the Westinghouse metal rectifier, type H.1, which is shunted across the meter M in series with a variable resistance R_1. This latter is necessary because the rectifier should shunt a resistance approximately equal to its own "forward" resistance; in order to give the closest approximations to a logarithmic calibration. R_1 and R_2 are adjusted during calibration (as explained above) until the best approximation to a logarithmic scale is obtained.

The second device (Fig. 9), as previously explained, operates in a similar manner. The grid of the triode acts as a diode, the input D.C. voltage being applied in the "forward" direction through the high resistance R_1. As the input voltage (and the resulting grid current) is increased, the resistance of the grid-filament path decreases, consequently a smaller proportion of the total input voltage appears between grid and filament. If now the valve is operated on the "linear" portion of the anode current-grid voltage characteristic, the resulting change in anode current is proportional to the logarithm of the applied input voltage, when the initial bias on the grid (one or two volts negative) and the value of R is correctly adjusted. The calibration is carried out as for the device of Fig. 8, except that a higher voltage (up to 30 or so) is required, because the valve decibel meter has a much higher input impedance.

Since these decibel meters are dependent for their action upon a D.C. input, it is necessary first to rectify the audio-frequency A.C. to be measured, the resulting D.C. being applied to the decibel-meter proper.

The complete instruments would look like Figs. 10 and 11, which each contain the following stages:—

(a) Impedance-selecting and "gain"-control.
(b) Rectifying and "time-constant."
(c) Decibel meter.

The value of the components in the output circuit of the rectifying stage (b) will determine the speed of response of the needle of the decibel meter. For some purposes (such as speech monitoring) this is important, since it determines the minimum period over which the power measured in terms of decibels "up" or "down" in reference to a standard "level" is integrated. This period is generally arranged to be of the order of that of an average syllable of speech, i.e., about 1/5th sec.

Special Circuit Arrangements

Most of the special circuit arrangements devised for valve voltmeters are applied with the object of either providing a more satisfactory "backing off" control or for protecting a delicate anode-current meter. Three of these arrangements are shown in Figs. 12 and 13. The voltmeter valve proper is in each case used as an anode-bend rectifier.

Fig. 12 shows a Wheatstone bridge arrangement for backing off the anode current. The resistance of the potentiometer P should be about double that of the meter M, and the resistance of R_3 equal to the D.C. resistance of the valve when adjusted to the correct working conditions.

Fig. 13 is the same arrangement, except for the fact that another triode replaces R_3. The essential point is that the filaments of the two valves are wired in series, so that a failure of either avoids the danger of sending a high unbalanced current through the meter and so damaging it. By using a high-impedance (R.C. type) triode for the balancing valve, sufficient bias may be obtained from the negative drop across the filament of the first valve, without recourse to a separate bias battery. The bias potentiometer is shown as being connected across the filament of the second valve, but this is only for clearness in the diagram, and to balance the filament currents in the case where two valves of identical filament rating are used. The potentiometer resistances should be high, so that in the event of a filament failure the potentiometer across the "dud" valve does not supply sufficient current to maintain the emission in the sound valve. Generally the ordinary 400-ohm potentiometer is quite satisfactory in this respect.

The "Reflex" Voltmeter

Fig. 14 depicts another special type of valve voltmeter. It is of the anode-bend type with the grid bias derived "automatically" from the voltage drop across the resistance R_3 in the anode circuit. The result is that as the voltage input to the grid increases, so does the mean value of the bias. This results in a scale which

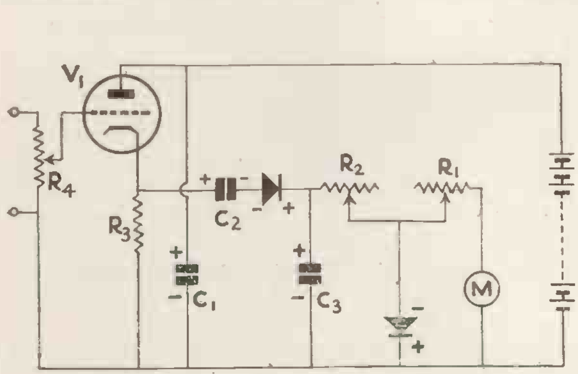


Fig. 10. A decibel meter with valve amplification.

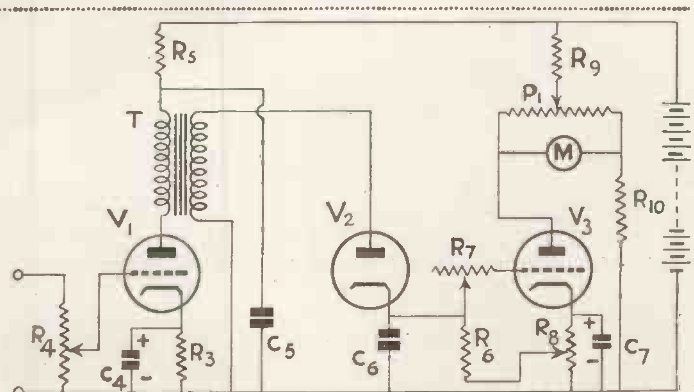


Fig. 11. Decibel meter with diode rectifier.

Calibration

is practically linear in calibration. The higher the value of the resistance R_3, the more linear the scale becomes, but in the latter case a higher anode voltage and more sensitive meter is required. Increase of R_3 can also be used to extend the scale in the direction of higher voltage calibration with the same meter. Since the value of R_3 is always chosen so that the initial bias is sufficient to

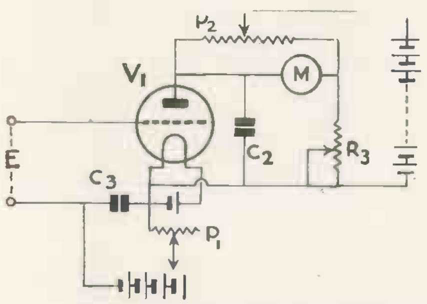


Fig. 12. Wheatstone Bridge circuit for " backing o$."

avoid grid current, the input impedance of the instrument is very high, as in the case of the ordinary anode-bend voltmeter previously described.

Unfortunately, in order to obtain the full advantage of this circuit, it is necessary to use a somewhat sensitive instrument (e.g., 100 microamps. for full-scale deflection) for M. Alternatively a D.C. amplifying stage may be used.

Calibration

Calibration is in general most conveniently carried out by use of the 50-cycle domestic A.C. supply. Diode and anode-bend voltmeters (sans leak) *may* be calibrated by D.C.

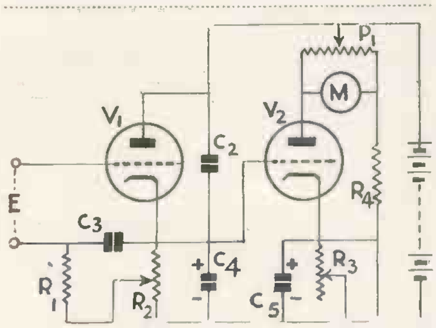


Fig. 13. A similar arrangement to Fig. 12. but with extra valve.

with battery and potentiometer, but the latter process, though accurate, is very tedious and involves integration, graphical or otherwise.

The voltmeters which have been described may, without practical loss of accuracy, be calibrated on 50-cycle A.C. The two alternative schemes of connection are shown in Figs. 15 and 16.

Both connections involve the use of a potentiometer, preferably calibrated. A slide-wire is suitable for this purpose, and is simply and easily constructed. If the actual resistance of the slide-wire is not known the arrangement of Fig. 15 is applicable. For all arrangements except the direct-reading diode voltmeter the A.C. voltmeter (V) may be used in position a, and the subdivisions of the voltage indicated obtained on the slide-wire. For voltages up to 4 volts r.m.s. (from a heater transformer, for instance) 1 metre of 34 s.w.g. Eureka wire is suitable, and should have a resistance approximating to 10 ohms.

When calibrating the direct-reading diode voltmeter, requiring some 15-20 volts r.m.s., a potentiometer of higher resistance will have to be used, say, of the order of 1,000 ohms, and the A.C. voltmeter placed in position b, to allow for the load imposed by the diode voltmeter under calibration. Alternatively the A.C. voltmeter, with the valve voltmeter in parallel with it, may be used as one arm of the potentiometer, the other arm being formed by a variable resistance of suitable value.

If the resistance of the slide-wire is known, the arrangement of Fig. 16 may be used, where M/a. is a thermocouple or A.C. milliammeter, P the slide-wire (or a decade-box) and R a variable resistance. R is adjusted until some convenient value of current is indicated on M/a. Applying Ohm's law, a known value of voltage can then be tapped off across the slide wire or decade box. The power required from the transformer is negligible, of the order of one or two watts, depending upon the resistance of the potentiometer.

Appendix

Values of Components

In all Figures except 1a, 2, 3 and 4, M indicates an 0-1 milliammeter having a resistance of about 30 ohms.

In Figs. 2a and 2b, E.S.V. represents an electrostatic voltmeter (see text) of range either 0-300 or 0-600 volts.

The usual L.T. and H.T. "on-off" switches are not shown in the figures.

Fig. 4 represents no valve in particular, and the anode current-anode voltage curves are " idealised " to simplify the drawing.

S represents a single or double pole switch (as shown) of any convenient type.

Fig. 1.—

V_1 = any convenient valve, if triode, anode not used. Preferably a small single diode (see text).

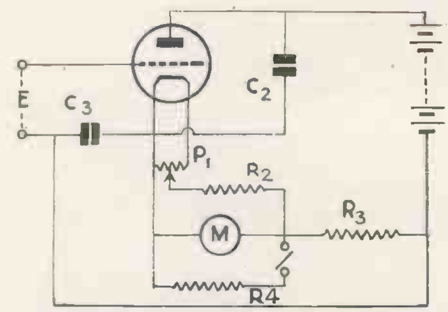


Fig. 14. Anode bend voltmeter with auto-bias.

C_1 = 4 mfd. good quality paper condenser.

P_1 = value, 400-500 ohms.

R_1 = value, 1,500 ohms, approx.

Figs. 2a and 2b.—

V_1 = as for Fig. 1 for low-voltage (0-300 volt) instrument. For higher voltage instruments see text.

C_1 = value, 0.1 mfd. 500 or 1,000 volt working. Preferably mica dielectric.

R_1 = value, 1 megohm.

Fig. 5a.—

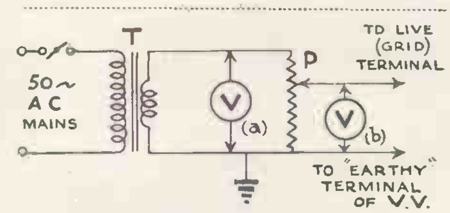


Fig. 15. Simple calibrating circuit.

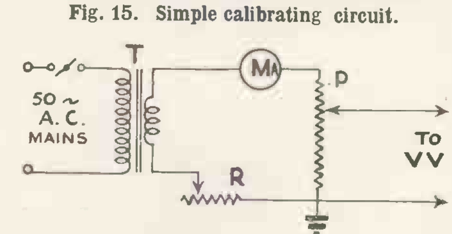


Fig. 16. Alternative arrangement.

V_1 = as for Fig. 1.

C_1 = value, 0.1 mfd., good paper or preferably mica dielectric (e.g., Dubilier type 577).

P_1 = as for Fig. 1.

R_1 = value, approximately 20,000 ohms, to make M read 0-20 volts. Bias battery, standard 0-16½ volts.

Fig. 5b.—
V_1 = Mullard PM202 or similar.
C_1 = value, as for Fig. 5a.
P_1 = ,, ,, ,, ,, ,,
R_1 = ,, ,, ,, ,, ,,
Bias battery, standard 0-16½ volts. Anode battery, standard 0-16½ volts.

Fig. 6.—
V_1 = as for Fig. 5b.
C_1 = value, 0.01 mfd., mica dielectric, T.C.C. type M, Dubilier type 670, or similar.
R_1 = value, 5-10 megohms.
C_2 = value, 0.1 mfd., mica dielectric (Dubilier type 577 or similar).
P_1 = as for previous circuits.
R_2 = value, 1,000 ohms (approx.) 1 watt type.
R_3 = value, approx. 20,000 ohms, to make M read 0-20 volts.
R_4 = 10-30 ohms (not critical, see text). Anode battery voltage, 16-20 volts approx.

Fig. 7.
All values as for Fig. 6, except the following:—
R_1 = value, not less than 10 megohms.
C_3 = as for C_2 in this and previous circuits.
P_2 = as for P_1 in this and previous circuits.
R_2 = value, 5,000 ohms, ¼ watt type.
R_3 = value, approximately 50,000 ohms, to make M read 0-50 volts.
Grid bias battery, 0-9 volts standard. Anode battery voltage, 30-50 volts.

Fig. 8.
R_1 and R_2 = value, 0.200 ohms each (see text).

Fig. 9.—All values as for Fig. 7 except:
R_1 = value, 0.5 megohm max.
R_2 = value, 250 ohms, 1 watt type.
Grid bias battery, 0-4½ volts standard.

Fig. 10.
R_1 and R_2 as for Fig. 8.
V_1 = Mazda AC/HL, AC/P or similar. Owing to the "cathode load" type of circuit, the factor is not important.
C_1 = 32 mfd. electrolytic, 100-volt working (T.C.C.).
C_2 = 500 mfd. electrolytic, 12-volt working (T.C.C.).
C_3 = 500 mfd. electrolytic, 12-volt working (T.C.C.).
R_3 = 500 ohms, 1 watt type.
R_4 = to suit input impedance required. For general purposes, 100,000 ohms.
The Westectors are both type H1. Anode battery voltage 60-120-volt (according to valve).

Fig. 11.
V_1 = Mazda AC/HL or similar.
(Note: Any good make of intervalve transformer of low ratio, say, 1:3, will serve for T.)
V_2 = Marconi-Osram D42 or similar.
V_3 = Mazda AC/P or similar.
R_3 = 500 ohms, 1 watt type.
R_4 = as for Fig. 10.
R_5 = 10,000 ohms, 1 watt type.
R_6 = 1 megohm.
R_7 = ½ megohm max.
R_8 = 500 ohms (potentiometer).
R_9 = optional, according to voltage of anode supply.
R_{10} = 20,000 ohms, 3 watt type.
C_4 = 50 mfd., 12-volt working.
C_7 = 50 mfd., 12-volt working.
C_5 = 8 mfd., 200-volt working.
C_6 = 0.25 mfd. paper.
P_1 = 500 ohms.
Anode battery voltage 150-200 volts.

Fig. 12.
V_1 = Mullard P.M.202 or similar.
C_2 = 0.1 mfd. mica dielectric (Dubilier type 577).
C_3 = 0.1 mfd. mica dielectric (Dubilier type 577).
P_1 = 400 ohms.
P_2 = 400 ohms.
R_3 = 100,000 ohms.
Anode battery voltage 30-36 volts. Grid bias 0-9-volt standard.

Fig. 13.
V_1 = Marconi-Osram L.210 or similar.
V_2 = Marconi-Osram H.2 or similar.
C_3 = as for Fig. 12.
C_2 = as for Fig. 12.
P_1 = as for Fig. 12.
P_2 = as for Fig. 12.
R_1 = 250 ohms, 1 watt type.
R_2 = 250 ohms, 1 watt type.
Anode and grid battery voltages as for Fig. 12.

Fig. 14—All values as for Fig. 7, except for the following:—
R_3 = 50,000 ohms.
M to read 0-100 microamps.
Anode battery voltage to be adjusted to give best value of standing current. Suggest 30 volts for first trial.

Figs. 15 and 16.—See text.

Mercury-arc Lamps for Studio Lighting

USE is now made in the General Electric (U.S.A.) television studios for illumination purposes of water-cooled mercury-arc lamps. A battery of four units containing 12 lamps is employed having the light output equivalent to that provided by nearly 30,000 watts of incandescent light and at the same time giving off no appreciable amount of heat.

The lamps are about the size of a cigarette and have an exterior of quartz. Surrounding the tube is another quartz jacket through which water passes at the rate of three quarts a minute, to prevent destruction of the lamp by intense heat. The water, in passing around the tube, transmits 90 per cent. of the heat away from the light source, and as a result, little heat is dissipated into the studio.

This new mercury lamp radiates more than two and one-third times the light given off by an incandescent lamp of the same wattage. The twelve 1,000-watt lamps used in the G.E. television studio have a total light output of 780,000 lumens, while the same wattage of incandescent lamps would give only 330,000 lumens. Also in the new lamps more than 90 per cent. of the infrared radiation is absorbed in the circulating water and there is no risk of burn.

The cooling system of the lamps is equipped with a pressure-operated switch and magnetic valve because the water in the jacket must be moving before the lamp is lighted and because the lamp must be turned off automatically in the event of failure or reduction of the water supply. The lamp is filled with argon gas and, when lighted, a pressure of more than 1,000 pounds per square inch is developed within the quartz jacket. Two rubber hoses connect to each of the lamp units, one leading from a tap at one of the studio walls to allow water to pass into the lamps, and another carrying the warmed water from the lamps to waste.

It is announced that Los Angeles will soon have the highest television aerial in the United States. Plans for the new site of station W6XAO call for an aerial at least 100 ft. above the transmitter building overlooking Hollywood. Since a nearby mountain is 17,000 ft. high, W6XAO's stream lined aerial will surpass the altitude of New York's Empire State Building by one and a half times.

Other eastern stations hampered by the lack of suitable sites have established their transmitters many miles from the populated centres. The Don Lee station is only 2½ miles from the centre of Hollywood.

THE SHORT-WAVE RADIO WORLD

A Review of the Most Important Features of the World's Short-wave Developments

A UNIQUE TWO-VALVE RECEIVER

WE are very interested in a most unusual two-valve receiver described in *Radio and Television Retailing*, an American publication. It uses two of the dual type valves, 25B8GT and a 70L7GT, the first being an R.F. pentode and triode, and the latter an output tetrode and rectifier.

The circuit of this receiver is shown in Fig. 1, from which it can be seen that the first valve operates both as an R.F. amplifier and grid bias detector, which is in turn coupled to an output tetrode. Combined with the tetrode is a half-wave rectifier. Filtering is obtained by means of a loudspeaker field plus 30 mfds. of capacity, while volume is controlled by varying the bias on the R.F. stage. By using 25 and 70-volt heaters the equipment can be run from the normal American low-voltage mains with a series resistor of only 140 ohms.

The whole receiver is mounted in a small steel cabinet, of unusual compactness. The audio stage is resistance-coupled while iron-cored coils are used in both R.F. and detector stages. For amateurs needing a monitor receiver, this unit appears to offer many advantages.

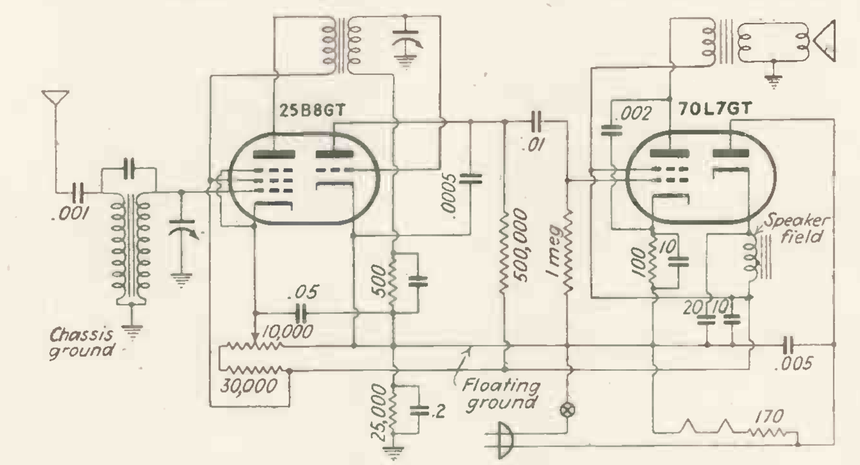


Fig. 1. A novel high-gain two-valve receiver using special valves.

5-20 METRE ADAPTOR

Many American publications are now publishing data on ultra-short-wave convertors and adaptors, principally because of the demand for simple equipment suitable for picking up television sound programmes.

In the current issue of *Radio Craft* is rather a flexible adaptor tuning between 5 and 20 metres which has been designed by the well-known American engineers Glenn H. Browning and F. J. Gaffney. Glenn Browning is famous for his activities in the design of switched coil units, and in this adaptor one of his units is included.

The adaptor utilises four of the new single ended valves plus a rectifier. The first valve is a mixer with separate oscillator followed by a high-gain I.F. pentode feeding a double-diode triode. The output from the triode section of this stage is fed into the audio amplifier of an ordinary broadcast receiver. In this way, as no part of the R.F. or I.F. circuit of the parent receiver is brought into use, there is no side band cutting so that really high tonal quality can be obtained.

An intermediate frequency of 1,600 Kc. has been chosen as it enables a wide band width to be obtained with the very necessary broad tuning. In addition there is very little difficulty due to signals being picked up by the I.F. circuit. A total of ten coils is required, five in the R.F. circuit and five in the oscillator and these are mounted around a four-section switch of the Yaxley type. A two-gang condenser having a capacity of 30 mfd. is used for tuning purposes, but across the R.F. coil is an additional condenser of 20 mfd. for padding purposes.

The designer mentions that considerable care must be taken in the wiring of the oscillator circuit and recommends that heavy gauge bare copper wire be used throughout and arranged so that there can be no mechanical movement. In the original adaptor, as great care was taken in the construction, frequency drift is negligible.

By the use of regeneration the gain is very considerably increased, but care must be taken to see that the regeneration control is not advanced so that the antenna circuit goes into oscillation.

The coil data is as follows:—

L1 (62/48 Mc.) $1\frac{3}{4}$ turns 16-gauge wire air spaced $\frac{1}{2}$ in. diameter, $\frac{1}{4}$ in. between turns tapped at $\frac{3}{4}$ of a turn from the low potential end.

L2 (50/39 Mc.) $2\frac{3}{4}$ turns 16-gauge

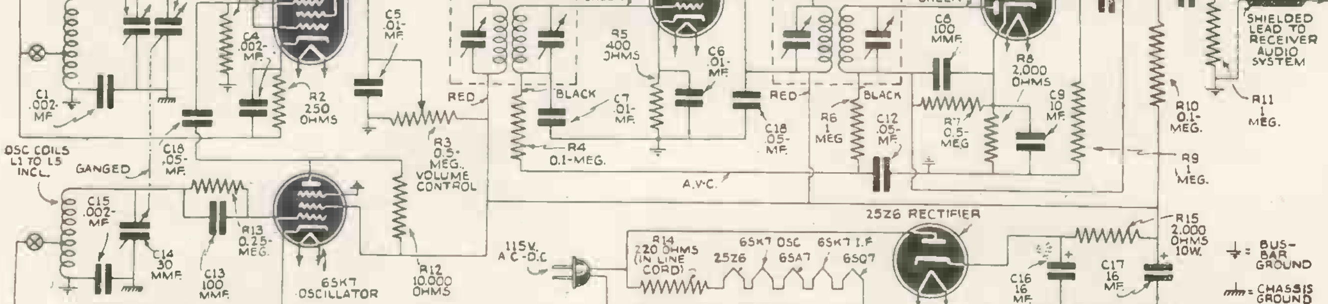


Fig. 2. This convertor, although designed primarily for the reception of television signals, is excellent for amateur service as it will receive unstabilised amateur transmissions.

SUPPRESSOR MODULATION :: SIMPLE TRANSCEIVER

wire, air spaced, ½ in. diameter, ¼ in. between turns, tapping point 1¼ turns from the low potential end.

L3 (40/31 Mc.) 4¼ turns 18-gauge wire, air spaced, ½ in. diameter, with a gap of ¼ in. between turns. The tapping point is 2 turns from the low potential end.

L4 (33/25 Mc.) total of 4¾ turns 18-gauge wire wound on ½ in. diameter low-loss coil form with turns spaced 1 wire diameter. A tapping is made 2¼ turns from the low potential end.

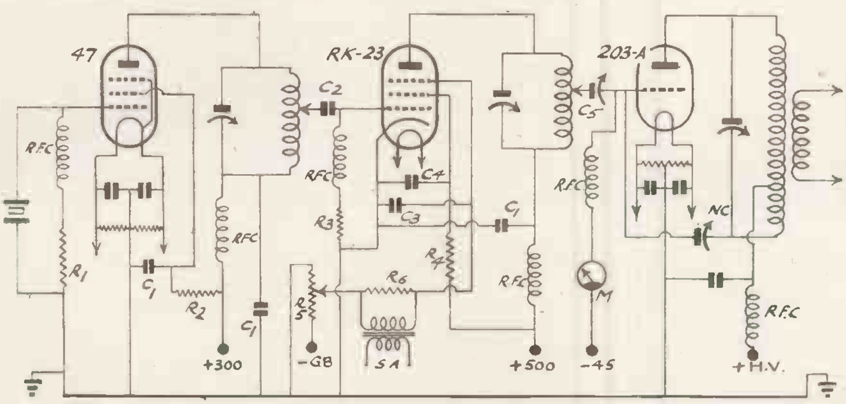


Fig. 3. A very low power audio system is required in this three stage transmitter which will provide a carrier power of 160 watts.

L5 (25/20 Mc.) made of 8.05 turns 18-gauge wire on ½ in. diameter low-loss coil form with a spacing of one wire diameter and a tapping of 2½ turns from the low potential end. The antenna and oscillator coils are of the same inductance, and are mounted on a four-section five-position switch similar to that used in the Browning tuning assembly.

A noticeable feature is the effect of the regeneration control. The designer mentions that on the higher frequencies the input resistance of the mixer valve begins to have a noticeable loading effect on the tuned antenna system, so materially reducing the Q of this system and the gain in the tuned antenna stage.

To reduce this loading effect controllable regeneration has been included so that a high-stage gain can be allowed for even on the highest frequency.

The regeneration is obtained by tapping the antenna coils and connecting the tap through a resistor and by-pass condenser to the cathode of the 6SA7 valve. Varying the screen grid voltage on the valve governs regeneration.

To allow for various antenna loadings a separate 20 mmfd. condenser controlled from the front panel is connected across the antenna tuning system.

SUPPRESSOR MODULATION WITH LINEAR AMPLIFICATION

W89CO has built a most effective 100-watt transmitter which is shown in Fig. 3. It is crystal controlled using a 47 crystal-oscillator, RK-23 buffer or doubler and a 203-A in the final. W8ICO mentions that normally this type of transmitter would be modulated by a class-B audio stage or grid modulated with consequent loss in efficiency. In this circuit, however, the pentode valve is suppressor modulated with the final stage used as class-B linear amplifier.

The carrier output is approximately equivalent to that obtainable with grid bias modulation in the final stage, but with less over-biasing and audio power. In connection with the adjusting W8ICO states that the transmitter is tuned up in the ordinary manner although the grid current is much lower than with the usual class-C amplifier. Input should be adjusted to a point approximately 30 per cent. higher than the rated valve dissipation.

The variable resistor R5 is adjusted to make the suppressor negative and the bias adjusted so that the antenna current drops by 50 per cent. If the antenna current does not show the normal modulation increases, it indicates that the buffer is not being heavily enough modulated. A carrier power of approximately 55-60 watts can be obtained with 1,250 volts at 190 mA. on the anode of the final.

A SIMPLE TRANSCEIVER

In Fig. 4 is illustrated a 5 metre or 2½ metre transceiver designed by W2DYR. Its main feature is the elimination of the normal L.F. microphone transformer, usually required in the average transceiver.

The valves ar ea 65 detector-oscillator, and a 56 modulator-amplifier. These valves must be adhered to particularly on 2½ metres as super-regeneration is only effectively obtained with these particular valves. The change from the "send" to the "receive" positions requires no more than the ordinary double-throw triple pole jack type switch, while provision has also been made for monitoring the transmissions.

Component values are approximately as follows:—

C1—.0001 mfd.
C2—.006 mfd.
C3—.01 mfd.
C4—10 mmfd.
C5—20 mmfd. on 5 metres and 5 mmfd. on 2½ metres.
C6—.00025 mfd.

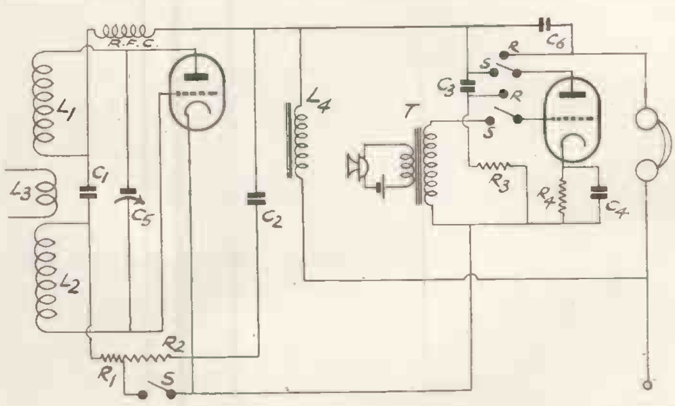


Fig. 4. Simplicity is the keynote of this transceiver which operates satisfactorily on both 5 and 2½ metres.

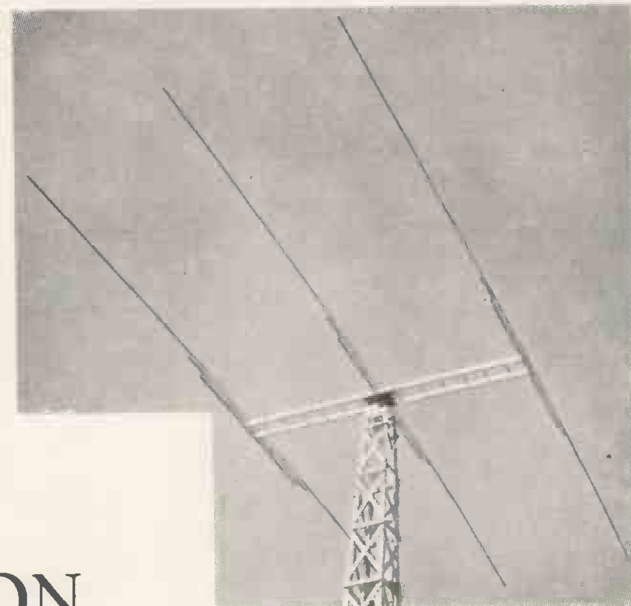
R1—7,000 ohms.
R2—100,000 ohms.
R3—300,000 ohms.
R4—2,500 ohms.

The condenser C6 makes possible monitoring of the transmission since a small amount of audio filters through this condenser to the headphones.

THE most common form of antenna used in recent years has been a half-wave dipole erected in either a vertical or horizontal plane. The correct length in feet of a dipole or any desired frequency may be ascertained by the formula FMGC $\sqrt{467.40}$ with FMGC being the desired frequency in megacycles.

High current and low voltage exists at the centre of a dipole, while high voltage and low current is found at each end. The radiation resistance or impedance of a dipole can be almost anything. It has been found, however, that while the theoretical impedance of a dipole "in free space" is a small fraction over 73 ohms, providing a perfect and uniform ground exists, to a

This information, provided by the courtesy of the Bassett Research Corporation U.S.A. was in preparation before the news of the closing down on amateur transmitters was received. It has been retained, however, on account of the useful nature of the contents. It will be of special interest to our readers overseas.



INCREASING ANTENNA RADIATION

radius of one-half wavelength below the dipole and in the same plane, this impedance can change over wide limits for neither a perfect ground nor "free space" actually exists.

Experiments have shown that particularly in amateur use, when the dipole is erected in small space and close to surrounding objects, this impedance averages close to 64 ohms. When the dipole is erected in a vertical plane, this impedance is approximately 95 ohms.

It is advantageous to know the impedance of a dipole, inasmuch as this knowledge helps in selecting or designing a transmission system capable of accurately matching this impedance. In this way, as little as possible of the energy output of the transmitter is lost in the form of reflected waves, or standing waves, on the transmission line. One thing to remember is that no matter how a dipole is fed, whether with a matched single wire, "Q" bars, non-resonant line, twisted pair, or concentric line, it is still a dipole and should be considered as such.

While the dipole is a simple antenna to erect and "get going," it also has some characteristics which are not always entirely satisfactory for the work it is called upon to perform. At the height above "ground" at which the dipole is usually operated, particularly in amateur application, the radiation leaving at the "vertical angle," or that radiation generally called the "sky wave," which leaves the antenna at a tangent to the surface of the earth, may be of such a high angle, i.e., 30 to 40 degrees, as to provide a fair field strength over moderate distances. At the same time, it may be placing a comparatively poor field strength over great distances.

If the horizontal dipole is elevated to a greater height, it usually reverses the procedure and eliminates the possibility of good field strength at 1,500 miles or so. This condition might be remedied somewhat by mechanically elevating the antenna for long distances and lowering same for short distances. See Fig. 1.

The dipole has another undesirable characteristic. It is bi-directional at 90 degrees off the plane of the conductor. This means that while communicating with a station in a given direction, the dipole also radiates an interfering signal of equal intensity in the opposite direction. Half of the radiated energy, therefore, is being wasted to the rear. When the dipole is used for receiving from a given direction, it is not uncommon also for signals of a greater field intensity to arrive from the rear and completely disrupt communication. It can be seen that with the prevailing interference in the amateur bands, the dipole, as such, might be anything but satisfactory for reasonably consistent communication.

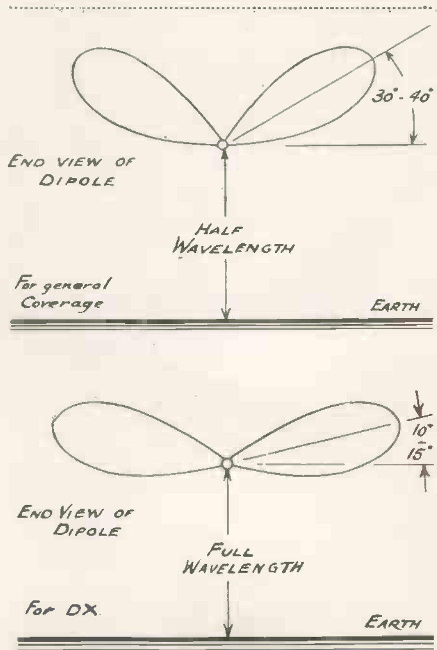


Fig. 1. Effect of elevation on range.

Improving the Dipole

The simple dipole can be improved enormously by adding more dipoles properly spaced in front of and behind the first dipole, as shown in Figs. 2 and 3. These may be either directly or parasitically driven. If they are of the correct length and are properly phased, they are capable of appreciably lowering the vertical angle of radiation for a given height above ground and practically eliminating the interference signal formerly radiated to the rear. When this "rearward" signal is eliminated, it tends to reinforce the forward radiation. This in turn provides considerably better field strength for the same power input at both medium and long distances in front of the array.

These additional dipoles also serve to eliminate practically all unwanted signals arriving from the rear when the array is used for reception. This forward increase in field strength is called "gain" and, up to a certain point, is almost proportional to the number of dipoles added to the array. The gain of an array is usually measured by using a simple dipole as a reference. An array of the above type generally consists of a primary, or driven, dipole and a single, or a number of parasitically excited dipoles. These are known as directors if they are placed in front of the primary dipole and as reflectors if they are behind it. In an array, all of the dipoles are generally referred to as "elements,"

Array Dimensions

i.e., a 3-element array can consist of a driven dipole, a reflector, and director.

From a mechanical standpoint, the multiple dipole array has in the past been more or less of a nightmare. Comparatively large spacing between elements was deemed necessary, and when the array was assembled, it took on the appearance of a barn roof. Much experimental work has been done in the last few years in connection with close

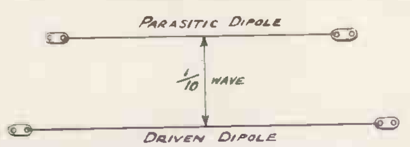


Fig. 2. Additional dipoles are capable of lowering the vertical angle of radiation.

spacing. The array has now been developed to a point where, from a mechanical standpoint, a very excellent airplane type support can be constructed, on which can be mounted as many as 3 or 4 closely spaced elements, at the same time maintaining the essential strength and rigidity of the system. From an electrical standpoint, it has been proved time and time again that close spacing down to 1/10 wavelength provides considerably more gain than that obtainable from the ¼ or ½ wave spacing formerly employed.

From an actual gain standpoint, it is quite probable that the multiple dipole array will never be able to compete with long wire arrays or aperiodic beam antennæ such as the "rhombic."

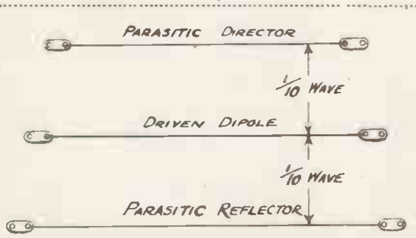


Fig. 3. A three-element array.

However, from a directional and non-interfering viewpoint, nothing has yet been developed that can compete with a well adjusted rotary antenna of the multiple dipole type. This type of radiator provides all that could be desired in the way of gain without sharpening the horizontal angle beyond useful limits. It lowers the vertical angle if properly installed, still further increasing the field strength at a remote point. It also provides a mechanical flexibility and a method of placing your signal wherever desired, and to the greatest possible extent, precludes the possibility of interfering with other services in other directions, or receiving interference from services in other directions than that desired.

Power Gain

Experiments have indicated that the following is about what can be expected in the way of front to back ratios and horizontal gain for the type multiple dipole arrays shown, providing these arrays are properly installed, adjusted and fed. A horizontal dipole one-half wavelength above ground is used as a reference.

2 Element Array.—1/10 wave spaced, radiator and director. Forward gain: 4 DB equal to raising power 2½ times. Front to back ratio: 10 DB or 10 times as strong a signal off the front as off the back.

3 Element Array.—1/10 wave spacing, radiator to director. 1/10 wave spacing, radiator to reflector. Forward gain: 10 DB equal to raising power 10 times. Front to back ratio: 30 DB or 1,000 times as strong a signal off the front as off the back.

4 Element Array.—1/10 wave spacing. radiator to 1st director. 1/10 wave spacing, 1st director to 2nd director. 1/10 wave spacing, radiator to reflector. Forward gain: 13 DB, equal to raising power 20 times. Front to back ratio: 35 DB or 3,162 times as strong a signal off the front as off the back.

In all the above arrays, the radiation off the ends of the dipoles is so little, by comparison, that it may be considered as being negligible. However, as the number of dipoles used increases, this endwise radiation goes down and also the forward lobe of radiation becomes considerably narrower so that it covers a considerably sharpened path in front of the antenna. From the above figures, it can be readily seen that little could be gained from employing more than 4 elements in this type of an array unless some practical means were devised for supporting them. Something can undoubtedly be gained from an electrical standpoint.

Dipole Impedance

As dipoles are added to the primary dipole in an array, the radiation or impedance of the array goes down. If these additional dipoles are widely spaced, the impedance does not drop to as low a value as it does when the elements are closely spaced. It is not advisable to allow the impedance of an array to drop to so low a value that the radiation resistance too closely approaches the loss resistance of the array, or the losses in the system may approach or exceed the actual amount of energy radiated into space.

This difficulty can usually be avoided to a great extent through the use of a fairly large diameter tubing for the elements, possessing a high "Q" and capable of maintaining the loss resistance at the lowest possible point. In-

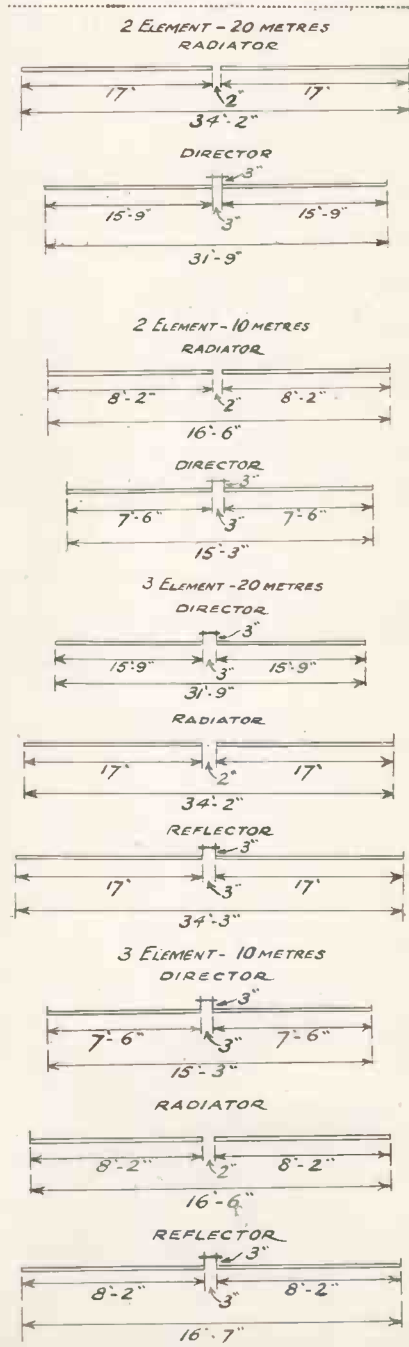


Fig. 4. Dimensional details of various arrays.

sulation of the elements is another important factor, and care should be exercised in the installation of all bolted loops on the systems. Experience has shown that plenty of air is the best possible insulation for all points of high impedance in the array. In other

Height and Coverage

words, hang the voltage loops slung in space as far as possible. For this purpose a tubing is required which will be as self-supporting as practicable.

Rotary Beam Design

In designing a rotary beam the following points should be taken into consideration:

(1) Tubing for the elements should be approximately 1 in. in diameter, either of a rigid aluminium alloy or of plated steel suitably weather-proof. The former is more desirable.

(2) The supports for the elements should be well designed to provide great rigidity and structional strength with the least possible amount of wind resistance. It will be found that no great torque is required to rotate the assembly. However, if the structure is not so designed that it eliminates all possible wind resistance it will be extremely hard to hold back even in a gentle ground breeze. Take advantage of modern aircraft fuselage construction in designing the elements supporting structure.

(3) Direction indicating perhaps offers the most serious design problem and as the multiplicity of dipoles in the array is increased, a direction indicating system becomes more of an absolute necessity. Even if it is possible to see the array it will be noticed that the perspective is such that it is impossible to tell precisely in which direction the beam is pointing without a positive system of indication.

(4) The array should be mounted on a tower or pole as far from surrounding objects as possible. Placing it so that half or part of the system is at times over an object such as a roof or tree, when the other half is not, does not always prove entirely satisfactory. Always attempt to balance the system to earth throughout its length. If the antenna is over a roof for example, place it so that all the antenna is above the roof and not half overhanging.

(5) In order that the array may be fairly in the clear, it is advisable to consider rotating it electrically by remote control. This method perhaps offers less possibility of absorption of power than would a complicated system of wires and pulleys operated by hand from a remote point. It also offers ease of control and positiveness of indication found in no other way. Many methods of motor control will suggest themselves to the ingenious amateur, such as old steering gear, theatre sound system turntables, and similar motors.

(6) A method of feeding the array should be considered which provides the highest degree of flexibility, freedom from mechanical trouble, ease of adjustment and freedom from effects of weathering. The feed system must be capable of consistently maintaining a desired surge impedance, so that the array will always be fed a desired amount of energy and will operate as an array. Many methods of feeding an array are apparent, such as the open wire line delta matched, transformer sections of twisted pair, and co-axial line. If open wire feed is employed, it is well to make certain that it is accurately matched to the array and that reflected waves do not exist on the line. It is also well to shelter the open line as much as possible because in rainy weather a film of water over the conductors and separators tends to increase their effective diameter so causing a decrease in the surge impedance of the line. This in turn may cause a change in loading of the amplifier, a mis-match at the antenna can cause standing waves capable of upsetting the performance of the array to appear on the line during bad weather.

Element Lengths

It is absolutely impossible to give the exact element lengths to use in an array except for a given diameter of element tubing. The exact lengths depend to a great extent on the capacitive and inductive reaction of the system and to a lesser extent on other factors. The sketches in Fig. 4 are given to show the correct length to employ in the 2, 3 and 4 element, one-tenth wave-spaced arrays only when the element tubing is approximately 1 in. in diameter *throughout its entire length.*

If smaller tubing is used, these lengths may increase as much as 10 per cent. or with larger tubing decrease by the same amount. The following formula is used to determine the approximate length of each element in the array and is the result of much experimental work in connection with developing a formula for determining with the greatest possible degree of accuracy the correct length for these elements.

While in most cases it will be possible to build from this formula either a 2, 3 or 4 element array and obtain satisfactory operation, with no further correction of element lengths, it is highly recommended that the elements be accurately adjusted, as half an inch inaccuracy may upset the operation of the entire system.

The formula is:—

$$AL = \frac{492}{FMGC}$$

$$DL = \frac{460}{FMGC}$$

$$RL = \frac{499}{FMGC}$$

AL—Radiator length in feet.
DL—Director length in feet.
RL—Reflector length in feet.
FMGC—Frequency in megacycles.

In the dimensions given, it will be noted that a radiator is considered for example as being 34 ft. long, when each tube is 17 ft. long and a small air gap exists at the middle. The air gap is not considered as being part of the dipole. When a director length is given, this length is the overall length of the conductor, and includes not only the length of each tube, but also the length of each side of the stub plus the length of the jumper necessary to complete the stub.

Optimum spacing are: 1/10 wave spacing for 20 metres, 6 ft. 11 in., and 1/10 wave spacing for 10 metres, 3 ft. 5 in.

Height Above Ground

It has been definitely proved that there is no optimum height above ground at which to instal the array. The correct height depends to a very great extent on the type of operation contemplated. The height above ground at which the array is placed will determine for the most part the angle of vertical directivity or the tangent with respect to the earth at which the strongest portion of the radiated signal leaves the array as shown in Fig. 1.

If extreme distances are to be covered the array should be as high as possible and at least one full wavelength above ground. If moderate distance and occasional long distance is required, it is well to erect the array at a one-half length elevation. Erection of the array at a full wavelength above ground will probably affect the signal locally (1,000 to 2,500 miles), but by concentrating the lower angle radiation (10 to 20 degrees) long distances can be covered with comparative ease. Erection of the array at a half wave-length above ground tends to favour the higher angles (20 to 30 degrees) and make for consistent coverage of distances between 1,000 and 3,000 miles.

It also provides an excellent signal at great distances when the reflection layers of the ionosphere are at the right height.

Tilting the Array

The vertical angle of radiation cannot be lowered by tilting the array in respect to the surface of the earth. The only result of tilting is to *raise* the angle which will help the signal locally but lower the field strength at the distant point. The only known method of controlling the vertical angle of radiation is by raising and lowering the entire array between limits of half and one wavelength.

A most interesting booklet entitled the *Bassett Handbook of Rotary Beam Design* is now available in this country through *Webbs Radio* of 14 Soho Street, London, W.1.

A RECORD OF PATENTS AND PROGRESS

RECENT DEVELOPMENTS

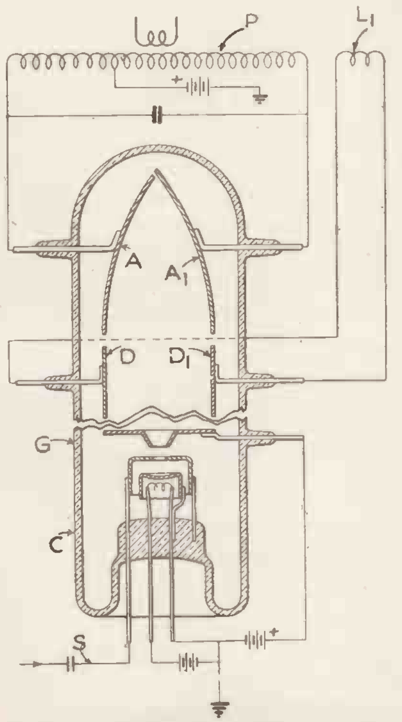
PATENTEES

Farnsworth Television Inc. :: Marconi's Wireless Telegraph Co. Ltd., and D. L. Plaistowe :: Hazeltine Corporation :: Radio Akt., D. S. Loewe :: Ferranti Ltd. :: F. Ring :: Scophony Ltd., G. Wikkenhauser, and J. Sieger

Cathode-ray Tubes

(Patent No. 506,454.)

The figure shows a cathode-ray tube designed to generate oscillations of a sharply-peaked character. The electrons from the cathode C are first focused into a narrow beam, which is then deflected from side to side by the plates D, D1 so that it strikes first against one and then the other of a pair of anodes A and A1.



Transmitting tube with sharply peaked output. Patent No. 506454.

These are curved to the shape shown, with the end of plate A1 overlapping, but not touching the plate A. They are connected by external leads to the primary winding P of an output transformer, which is also coupled to a coil L1 which feeds back deflecting-voltages to the plates D, D1, so that the oscillations are self-sustained.

The curvature of the anodes A, A1 is such that all the electrons in the deflected beam strike simultaneously, so as to produce the maximum voltage across the output coil P in the minimum time. In other words they produce a large peak of current of relatively short duration, which can be modulated by signals applied to the control grid G through a lead S.—*Farnsworth Television Inc.*

Adaptors for Producing Colour Pictures

(Patent No. 505,912.)

In the standard B.B.C. television transmission, four-fifths of the time between one frame and the next is occupied by the train of picture signals plus the associated line synchronising impulses. The remaining one-fifth is occupied by the framing impulses only, and contains no picture signals.

Advantage is taken of this fact to convert a black-and-white picture into one in natural colours.

An adaptor box is inserted before the camera at the transmitting end. It contains three coloured glasses one red, one yellow, and one green. The glasses are carried on an endless band which is driven at constant speed so that during the time-interval occupied by one frame the red filter is operative, during the next the yellow, and so on. The filters are changed-over during the idle "fifth" of each framing period, when no picture signals are being transmitted. A similar adaptor, controlled to run at synchronous speed, is used at the receiving end. —*Marconi's Wireless Telegraph Co., Ltd.*, and *D. L. Plaistowe.*

Iconoscope Tubes

(Patent No. 506,237.)

The usual method of generating television signals in a transmitting tube of the Iconoscope type is to project the picture on to a mosaic screen of photo-sensitive cells, so as to form an "electrical image" on the screen, which is then discharged by a scanning stream of electrons from the gun of the tube. As each of the mosaic cells is discharged, a pulse of current flows to a metal plate at the back of the screen, and then through a load resistance to form the signalling current.

According to the invention, the signal currents are collected by a second anode, mounted near to but separate from the mosaic screen, and coupled to an output resistance. As the scanning-stream moves across the mosaic cells, electrons are liberated partly by photo-electric action and partly by secondary emission, and both streams are utilised to build-up a stronger signal.—*Hazeltine Corporation.*

Scanning Discs

(Patent No. 506,691.)

One method of reducing the effect known as "keystone distortion" in mechanical scanning-systems is to project the light at an angle to the plane of the scanning-disc instead of at right-angles to it. This naturally reduces the effective cross-section of the emerging ray of light by a factor proportional to the sine of the angle of incidence of the light. It is also found to increase the loss of light due to reflection and dissipation by some fifty per cent.

According to the invention, these disadvantages are avoided by first punching out from the scanning-disc holes of a comparatively-large diameter, and then "backing" them by a thin sheet of copper in which holes of the right diameter have been made. The latter are preferably made slightly longer in one direction than the other, i.e., rectangular or oval, instead of square or circular, so as to reduce the "shuttering" effect on the inclined ray of light.—Radio-*Akt. D. S. Loewe.*

Time-base Circuit

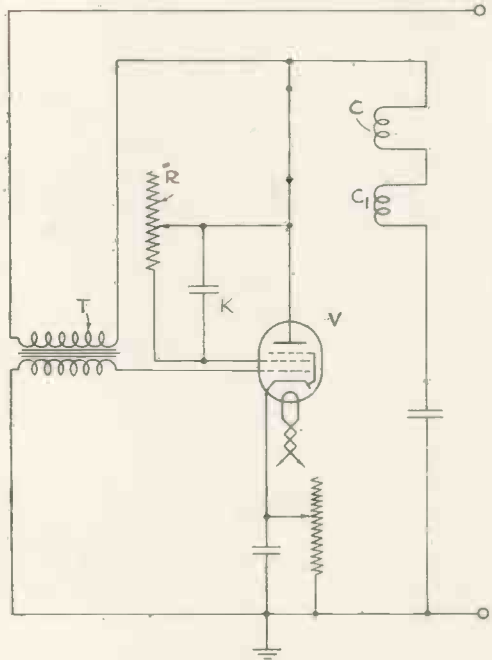
(Patent No. 506,856.)

The figure shows a back-coupled saw-toothed oscillation-generator in which the amplitude of the currents fed to the deflecting coils can be regulated, without any falling-off in linearity.

The valve V is a low-frequency power pentode, back-coupled at T and feeding saw-toothed currents to

The information and illustrations on this page are given with permission of the controller of H.M. Stationery Office.

the deflecting-coils C, C1, of a cathode-ray television receiver. Connected between the anode and the screening or accelerator grid of the pentode is a shunt circuit consisting of a high resistance R and parallel capacity K. By adjusting the tapping-point on this resistance the voltage applied to the screening grid



Linear time-base circuit. Patent No. 506,856.

can be altered to regulate the anode current fed to the deflecting coils.

Since the resistance is not directly included in the anode circuit, and since it carries only a small current, there will be no resultant variation of the anode voltage, and therefore no departure from linearity in the scanning voltage.—*Ferranti, Ltd.*

Preventing Flicker

(Patent No. 506,911.)

The picture produced on the fluorescent screen of a cathode-ray tube is made to " persist " between one frame and the next, in order to reduce flicker. It is then deliberately " extinguished " just before the next frame is formed.

For this purpose the fluorescent screen is " sprayed " with a uniform stream of electrons from a second cathode, whilst the picture is being formed by the primary or scanning stream of electrons. A positively-charged " open " grid is placed close to the fluorescent screen, and serves to accelerate the uniform stream of electrons, so that they produce secondary emission when they reach the fluorescent screen.

Those parts of the screen that are already fluorescing remain illuminated because their potential is such that they emit more secondary electrons than they receive, while the dark portions do not. In this way the picture is kept alive for a certain time, until it is deliberately wiped out by another " quenching " stream of electrons.—*F. Ring.*

" Supersonic " Cells

(Patent No. 507,481.)

Relates to light-modulating systems of the kind in which the light is passed through a medium in which compression waves of supersonic frequency are set up, usually by a piezo-electric crystal. The high-frequency train of compressional waves acts as a diffraction grating on the light to be modulated, so that the undeviated image of a slit is accompanied by a series of " side images " the amplitude of which increases (with that of the compression waves) at the expense of the central or undeviated image, thus giving the modulation effect.

As shown in the drawing, light from a source S passes on each side of the bar B through a lens L into the modulating cell C, which is the seat of compressional waves produced by a piezo-electric crystal Q and a high-frequency oscillator O. Under the influence of signals applied at A the ray of light, after passing through the cell C and the lens L1, produces " fringe " images of the bar B about an aperture K in a screen P.

If no signal is present, only a single image of B is produced, and this blocks the aperture K. The effect of an applied signal, however, is to allow a modulated ray of light to pass through the aperture K.—*Scophony, Ltd., G. Wikkenhauser,* and *J. Sieger.*

Summary of Other Television Patents

(Patent No. 505,448.)

Preventing " hum " in a mains-operated television receiver from producing visual interference, particularly when using interlaced scanning.—*Radio-Akt. D. S. Loewe.*

(Patent No. 505,618.)

Television tube in which a " permeable " photo-sensitive screen, on which the picture is focused, is sprayed with electrons, some of which pass through to form a modulated electron stream.—*H. G. Lubszynski* and *J. D. McGee.*

(Patent No. 505,764.)

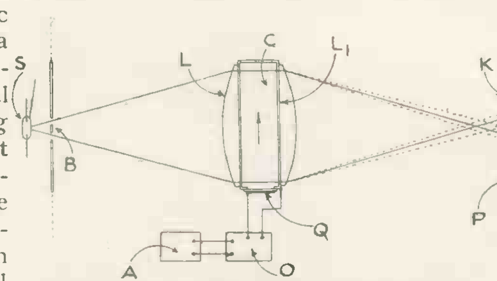
Separating frame and line impulses of similar amplitude, but different duration, and preventing mutual interference or interaction.—*E. L. C. White.*

(Patent No. 505,899.)

Television receiver in which the ratio of the D.C. component to the A.C. signal can be regulated.—*C. L. Faudell.*

(Patent No. 506,112.)

Television receiver in which the



Supersonic light cell. Patent No. 507481.

anode potential of the cathode-ray tube is also used to charge the condenser in the time-base circuit.—*R. J. Berry (C. Lorenz Akt.).*

(Patent No. 506,143.)

Construction of a mosaic-cell screen for a cathode-ray television transmitter in which scanning takes place on the opposite side of the screen to that on which the picture is projected.—*N. V. Philips Gloeilampenfabrieken.*

(Patent No. 506,189.)

Means for preventing the weakening of signals due to fatigue in a television transmitter.—*Radio-Akt. D. S. Loewe.*

(Patent No. 507,059.)

Preventing " tilt " distortion in television transmitters using a double-sided mosaic-cell screen.—*J. D. McGee* and *H. G. Lubszynski.*

(Patent No. 507,144.)

Projector adapted to be used at will, either for reproducing television signals, or for projecting from an ordinary cinema film.—*Kolster Brandes, Ltd.*, and *C. N. Smith.*

(Patent No. 507,239.)

Means for stabilising the picture signals and synchronising impulses used in television.—*A. D. Blumlein* and *E. L. C. White.*

News Brevities—

Commercial and Technical

THE British Kinematograph Society has decided that some restriction of the Society's activities was unavoidable until the situation becomes more clarified.

For the moment, all general meetings are cancelled. The possibility of resuming such meetings at a later date is to be considered.

With a view to assisting members to play a part in the national effort, the President, Mr. A. G. D. West, M.A., B.Sc., is making arrangements for all members with special qualifications to be enrolled, if they so desire, in the Central Register of Specialists, organised by the Department of Scientific and Industrial Research.

* * *

The U.S.A. Federal Communications Commission has assigned new call letters to the American short-wave broadcasting stations which will in all cases eliminate the letter "X" which has been used up to now to indicate that the station was operating on an experimental basis.

* * *

Permission has been given to the Don Lee Broadcasting System to erect and operate a television transmitter on the Hollywood Hills. This will be the highest television station in the United States. The transmitter W6XAO, will therefore be moved six miles across town from Seventh and Bixel Streets, where it was established eight years ago, to Mt. Lee, which is 1,700 feet high.

* * *

KGEI, located at the Golden Gate International Exposition, in San Francisco Bay, California, is to add a new frequency to its two already in use. The station will broadcast on 6,190 kilocycles (48.46 metres) from 9 p.m. to midnight, PST. It also broadcasts on 9,530 kilocycles from 4 a.m. to 9 a.m. and 15,330 kilocycles from 3.30 p.m. to 8.15 p.m., PST.

* * *

More than 50 per cent. of the visitors to the New York World's Fair since the outbreak of war when asked if they had any questions about television, inquired about the possible uses of television as an aid to warfare. Most of them asked if television would not be a great help to commanding officers behind the lines in keeping watch on progress at the battlefront. Some envisioned television cameras in airplanes over the battlefield.

One visitor asked if underwater television were possible, and then revealed that he was thinking of television as a means of submarine detection. Others suggested that television "with long-range focus" could be used to give advance warning of air raids.

* * *

An increased operating schedule to Europe for General Electric's international radio station WGEO will provide European listeners with three more hours of American programme time daily.

Directional antennas will be used, pointed on London, for the additional service from 3 to 6 p.m., EDST. General Electric's service to Europe heretofore has been confined to WGEA, which transmits from 11.15 a.m. to 6 p.m., EDST. This station will retain the same schedule in addition to the new service from WGEO, which broadcasts on 9,530 kilocycles. WGEA broadcasts on 15,330 kilocycles to Europe.

* * *

The Chloride Company advise us that they have temporarily transferred their London Exide and Drydex Sales Department from Shaftesbury Avenue, to 178 Kew Road, Richmond, Surrey, temporary telephone number Richmond 4490, to which all orders and correspondence should be addressed.

* * *

All current models of DuMont television receivers are now equipped with the intensifier-type cathode-ray television tube, providing a more brilliant screen image than heretofore. It is claimed that this new feature permits DuMont sets to be operated in well-lighted rooms because of the vivid screen illumination.

Three models are being sold at present, namely: Type 180X, a table model; type 183X, a console model; and type 181X, a large console model with all-wave broadcast receiver.

Please ask your bookstall or newsagent to reserve a copy of ELECTRONICS AND TELEVISION & Short-wave World each month and avoid disappointment.

* * *

The call sign of W2XAD, the General Electric powerful international short-wave station in Schenectady, has been changed to WGEA to comply with a new assignment of calls made by the Federal Communications Commission. The station has been on the air since 1926; its old call letters, the "2" meaning second radio district and the "X" standing for experimental, are among the most famous in the radio world. It operates on 9,550, 15,330 and 21,500 kilocycles.

The other long service Schenectady short-wave station has been changed from W2XAF to WGEO. Operating on 9,530 kilocycles, it earned renown by relaying weekly programmes to Admiral Richard E. Byrd during his expeditions to Little America in the Antarctic.

* * *

On page 536 of the September issue there was a paragraph headed "Gaumont-British and Television" in which it was stated that Mr. Isodore Ostrer announced that television of the big screen type would be installed in all suitable "Odeon" cinemas just as fast as the equipment could be obtained. This was an error and readers will probably be aware that Gaumont-British do not at the moment instal Baird big screen equipment in Odeon cinemas, but in Gaumont-British cinemas. Scophony apparatus is installed in some of the Odeon cinemas.

* * *

WGEA (formerly W2XAD) and WGEO (formerly W2XAF) located at Schenectady, New York, U.S.A., commenced on September 24 to broadcast their regular scheduled programmes one hour later, due to the change in time in New York from Eastern Daylight to Eastern Standard Time. California will *not* change with the change of time in New York.

* * *

A device termed the Radiotype, which sends printed messages through the air to appear on a large screen, is being exhibited by the International Business Machines Corp. at the New York World's Fair. The mechanism automatically prints at a speed of 100 words a minute on a transparent roll which is fed through projection apparatus that throws images of the letters on a large screen.

MORE NEWS BREVITIES

The Radio Manufacturers' Association is giving careful consideration to the problems with which the Radio Industry is faced as a result of the present emergency.

Realising the importance of radio in the national life—particularly in these days of war—it is desired to state that it is the intention of the British Radio Industry to " carry on " to the best of its ability with the service which it is rendering to the community.

Difficulties of an unusual kind have to be met, and it is inevitable that costs of production will tend to increase.

It is unavoidable that this increase in cost must be reflected as time goes on in some rise in the prices of radio sets and components, but it is the policy of the industry that such price increases as do occur shall be limited to meeting the extra charges which may be placed upon the industry.

* * *

A 100-kilowatt valve of which the filament can be replaced has been developed for use in the new transmitter being completed for short-wave station W2XAF. Two of these valves are to be used and they are the largest of their kind yet built. They are expected to produce an effective directional power output of more than 600,000 watts.

* * *

Four mobile radio units will be used in the Lawrence Thaw trans-Asiatic expedition. In order to maintain contact with each other, they have been equipped with apparatus which will have a 200-mile radius. Standard car batteries are employed to provide the necessary power. Aerials, ranging from the standard fishpole type to a 128-ft. flat-top, are being provided.

* * *

Dr. Lee DeForest has been devoting a considerable amount of time recently in the development of diathermy and similar medical equipment.

* * *

Dr. Wilmer C. Anderson, of Harvard University, has devised new equipment for measuring the velocity of light with which no visual observations will be required, the entire system being completely automatic in operation. It is expected that the speed of light can be measured by this system with an error of only $2\frac{1}{2}$ miles per second, a precision of one part in 75,000.

* * *

A typewriter has been produced that has been specially designed for scientific work. It has 135 characters but only the normal number (45) of keys. This is done by using two shifts and the particular machine is fitted with an assortment of Greek letters and mathematical symbols such as are required by technical writers.

* * *

Mr. H. T. Stott, Chief Technician of A. F. Bulgin & Co., Ltd., has now been elected to the Board of Directors of the company. Mr. Stott has been an active member of the executive staff for the past eight years, in the capacity of chief technician, and he is well-known in the industry.

* * *

The Council of the R.S.G.B. have made arrangements whereby they hope to continue the work of the society for as long as possible. The registered address will remain at 53 Victoria Street, London, S.W.1, but the business of the society will be carried on from the private address of the secretary-editor (John Clarricoates), at 16 Ashbridge Gardens, London, N.13. Telephone: Palmers Green 3255. All correspondence should continue to be sent to Victoria Street, but members should not call at that address.

The Society's journal, the " T. and R. Bulletin," will be published monthly as hitherto, although in a somewhat reduced form.

The Society will continue its service of distributing QSL cards to members at reasonably frequent intervals, and cards for overseas amateurs will be forwarded as circumstances permit. The QSL service is now operated by Mr. A. O. Milne from 29 Kerchill Gardens, Hayes, Bromley, Kent, to whom all cards should be addressed.

The Council of the R.S.G.B. regret to announce that all arrangements for the 1939 Convention have necessarily been cancelled.

* * *

Owing to the widespread distribution the General Electric Co., Ltd., is able to maintain through its branches and depots regular supplies; Osram valves will be easily obtainable in all districts.

In view of the restricted transport facilities caused by the present state of emergency, it is in the interest of readers to take note of their local source of supply for Osram valves. All G.E.C. home branches and depots have recently been mailed with injunctions to stock up all types, and for this reason any demands will be readily met.

A copy of the useful Osram Valve Guide, which covers tables showing the equivalent for other makes, is obtainable on application.

Branches and depots of the G.E.C. from which Osram Valve supplies can be obtained are as follows:

ABERDEEN ..	Magnet House, 32, Market St.
BELFAST	Magnet House, Queen Street.
BIRMINGHAM, 4 ..	Magnet House, Moor Street.
BLACKBURN ..	Magnet House, 40/42, Dawn Street.
BLACKPOOL ..	Magnet House, 214, Church St.
BOURNEMOUTH	63, Holdenhurst Road.
BRADFORD ..	109, Thornton Road.
BRIGHTON, 1 ..	Regent Hill, Western Road.
BRISTOL, 1 ..	Magnet House, 26, Victoria St.
CANTERBURY ..	Beer Cart Lane.
CARDIFF	Magnet House, Womanby St., and Castle Arcade.
CORK (EIRE) ..	20, South Mall.
CROYDON (WEST)	516, London Road.
DUBLIN	13, Trinity Street.
DUNDEE	26/30, North Lindsay Street.
EDINBURGH, 2. ..	Magnet House, 8, George St.
GLASGOW, C.2. ..	Magnet House, 71, Waterloo Street.
GLOUCESTER ..	Magnet House, 2, St. Aldate Street.
HULL	Magnet House, 83/84, Wright Street.
INVERNESS ..	13, Falcon Square.
IPSWICH	Electric House, Lloyds Avenue.
LEEDS	Magnet House, Wellington St.
LEICESTER ..	Magnet House, 33, Rutland St.
LIVERPOOL, 1 ..	Magnet House, Church Alley.
LONDONDERRY	12, Foyle Street.
LUTON	39/43, John Street.
MANCHESTER, 3 ..	Magnet House, Victoria Bridge.
MIDDLESBROUGH	Magnet House, 52/58, Corporation Road.
NEWCASTLE-ON-TYNE	Magnet House, Gallowgate
NORTHAMPTON ..	32a, Newland.
NOTTINGHAM ..	25, Stoney Street.
PLYMOUTH ..	Magnet House, 175, Union St.
READING	72/74, Castle Street.
SHEFFIELD, 1 ..	Magnet House, Fitzalan Sq.
SOUTHAMPTON ..	Magnet House, Commercial Road.
STOKE-ON-TRENT	South Wolfe Street, Stoke-on-Trent.
SWANSEA ..	Magnet House, Northampton Place.

WAR-TIME ECONOMY

During the present emergency it is absolutely essential to conserve supplies of paper and facilitate distribution. Readers, therefore, are earnestly requested to ask their newsagents or bookstalls to reserve a copy of this journal for them each month or alternatively place an order for regular delivery. (Order form on page 623).

In Case of Emergency

MAKE SURE YOU HAVE ADEQUATE STOCKS OF

Osram valves

MADE IN ENGLAND

For full information and technical data of any OSRAM VALVES, write to the Osram Technical Dept. of

THE GENERAL ELECTRIC CO., LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

A HOME INSTRUCTIONAL COURSE

EDITORIAL NOTE

The present position has led to the suspension of evening classes in many of the Technical Institutes and added to the difficulties in attending those that are available. Some thousands of students of radio engineering will miss the opportunity of improving their knowledge of the theoretical side of the subject.

Unfortunately the brain is like a precision tool—it is apt to become rusty from neglect. Practice is not always enough to keep abreast of the subject, and the radio engineer or serviceman must understand fully the theory underlying the practice in order to cope with the frequent "out of the ordinary" jobs that come his way.

With the object of filling the gap which has been temporarily caused in the education of the radio student, we are commencing this series of articles on various theoretical aspects of the subject.

They are not intended to compete with or in any way displace the "correspondence course" in which the subject is dealt with fully from beginning to end, but are aimed to give concise information on certain fundamental theories which will be of direct use to the student in his work.

Each article will be complete in itself and in order to give mental exercise, examples will be given at the end. While we cannot enter into correspondence with readers on the subject matter of the articles, it will be found that the examples given are answered in the succeeding article and numerous explanatory foot-notes should make the discussion as clear as possible.

Suggestions are invited from students for special aspects of the subject to be dealt with in later articles.

THE SINE WAVE

ITS IMPORTANCE TO THE RADIO ENGINEER

Preliminary Note

BEFORE reading this article, if you decide that you wish to study the subject carefully, there are two things to be done:

(1) Provide yourself with a loose-leaf notebook and a graph pad ruled in millimetre squares, together with the usual drawing instruments, and a small drawing board if possible.

(2) Make a point of seeing that you understand the reasoning or explanation thoroughly. If it is not clear (and in a short written article some intermediate steps may have to be omitted) try and look it up in another reference book to get another viewpoint. Work out the examples properly (not on bits of odd paper) and file them for future use. The model answers given next month will help you to set out your answers neatly and check your working.

The Sine Wave

The sine wave has been called the "curve of Nature's rhythm." It occurs in all branches of physics and engineering—in the motion of a pendulum, a crankshaft, vibrating strings, organ pipes, and in a variety of ways in alternating current and radio engineering.

The most complex wave shapes which occur in radio can be analysed into sine waves of varying heights and frequencies. The sine wave is used as the basis of calculation for all the circuit constants in alternating current work.

First, the explanation of the word "sine." To students of trigonometry the term is familiar, but if you do not know trigonometry it is not difficult to understand the term if we briefly outline the theory.

Trigonometry deals with the science of angular measurement in terms of linear dimensions or ratios rather than in degrees.*

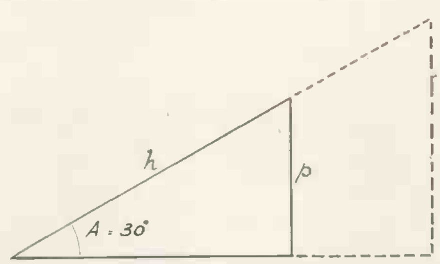


Fig. 1. Illustrating the meaning of the "sine" of an angle.

If we take a right-angled triangle with one angle 30° and the other 60°, such as a set-square, we can measure accurately the lengths of the sides. Call the perpendicular "p" and the hypothenuse (long side) "h" (Fig. 1).* Then the ratio of the perpendicular "p" to "h" is called the sine of the angle 30°.

The angle has thus been expressed as a number—the ratio of two lengths, and provided the angle does not alter the ratio is constant whatever the size of the triangle. Compare the ratio of the dotted lines in Fig. 1, which are $1\frac{1}{2}$ times as long as the full lines. In the particular case of the angle of 30° the ratio is $\frac{1}{2}$, h being twice p in length. For an angle of 45° the ratio is .707 (1/2), and for each angle there is a corresponding constant value of the "sine."

Sine 0° and Sine 90°

There are two extreme cases of interest—one where the angle at the base of the triangle is very small indeed and the other where it is nearly 90°. As A in Fig. 1 gets less and less the triangle gets flatter and flatter if h remains constant in length, until when A is practically 0°, p is so short that it almost disappears. If A became 0° the triangle would exist in theory and would look like a straight line! Then the sine of 0° would be $p/h = O/h = O$. Similarly, if A gets larger and larger till it approaches 90° the triangle becomes tall and thin until the base line disappears and p and h coincide. Then $p = h$ and sine $90° = p/h = 1$.

Plotting the Curve

We can now plot a curve of sines of angles from 0° to 180° by marking

* The degree as a unit is useless for calculation as it is an arbitrary division of a circle. Trigonometry provides the link between angular measurements and ordinary algebraic calculations.

PREMIER

A.R.P. ALARM SYSTEMS

WE HAVE HAD CONSIDERABLE EXPERIENCE OF THE INSTALLATION OF CALL SYSTEMS FOR A.R.P. ALARMS. OUR TECHNICAL STAFF WILL BE GLAD TO SOLVE YOUR PARTICULAR PROBLEM.

Designed along the most modern lines and incorporating the very latest developments in radio technique, these amplifiers can be relied upon to give a continuous dependable performance.

All models up to 15 watts can be purchased in Kit form if desired, with the necessary straightforward diagrams and wiring instructions.

The 6-, 8-10 and 15-watt systems incorporate the new Premier Matchmaker Output Transformer, enabling any single or combination of speakers to be used. Two separate input channels are provided which can be mixed at any level. Built-in Pre-Amplifiers ensure that the gain is sufficient for any low-level crystal or velocity microphone.

The actual gain of the 6- and 15-watt units is over 100 decibels. A Tone Control is provided varying in all models, permitting compensation for varying acoustical conditions.

The 4-watt A.C. Amplifier has provision for energising a 2,500 ohm field speaker. All amplifiers are designed for 200-250 volt mains (A.C. Models 40-100 cycles).

	Kit with Valves	Complete wired and tested
4-watt A.C.	**£2 6 6**	**£3 2 6**
4-watt A.C./D.C.	**£2 6 6**	**£3 2 6**
6-watt A.C.	**£6 2 6**	**£6 17 6**
8-10 watt A.C./D.C.	**£5 5 0**	**£6 0 0**
15-watt A.C.	**£6 14 0**	**£7 19 6**

Black Crackle Steel Cabinets **15/-** extra.

30-60 watt A.C. Amplifiers wired and tested in Black Crackle Steel Case, Power Pack in separate case to match, 30 watt, £14 14 0. 60-watt, £18 7 6.

New Premier Self-Powered Tuning Unit, designed for high fidelity reception. wave range 200-260 and 800-2,000 metres, Price £5 5 0.

SPECIAL RACK-BUILT SOUND SYSTEMS (*as illustrated*) **FOR SCHOOLS AND INSTITUTIONS ARE AVAILABLE. WE ARE PREPARED TO MAKE COMPLETE RECOMMENDATIONS AND SUPPLY SUITABLE EQUIPMENT AT LOWEST PRICES.**

PREMIER 1939 "5. v. 5" COMMUNICATION RECEIVER

5-valve Superhet, covering, 12-2,000 metres in 5 wave bands.

- Beat Frequency Oscillator
- 2-Spread Band-Spread Control
- A.V.C. Switch
- Illuminated Band-Spread Dial
- Send-Receive Switch
- Iron-Cored IF's
- Phone Jack
- Over 4-Watts Output

Provision for single wire or Di-pole Aerial. International Octal Valves. For 200-250 v. mains (A.C.). Built into Black Crackle Steel case providing complete screening, 10½ in. Moving Coil Speaker in separate steel cabinet to match.

Receiver, Complete with all tubes and Speaker ... **£9 9 0**

NOW READY! NEW PREMIER 1939/40 GIANT ILLUSTRATED CATALOGUE AND VALVE MANUAL. OVER 100 PAGES. SEND 6d. IN STAMPS FOR YOUR COPY!

ALL POST ORDERS to:— Jubilee Works, 167, Lower Clapton Road, London, E.5. *Amherst* 4723.

PREMIER RADIO

CALLERS to:—Jubilee Works, or 169 Fleet St., E.C.4. *Central* **2833 or 50 High St., Clapham, S.W.4.** *Macaulay* 2381

Alternating Current Theory

out a horizontal scale in 10° steps (1 cm. = 10° is a good scale, but use the full width of the paper and start on the left-hand side) and a vertical scale marked from 0 to 1.0.

The vertical scale can be as long as desired—say, 5 cms.

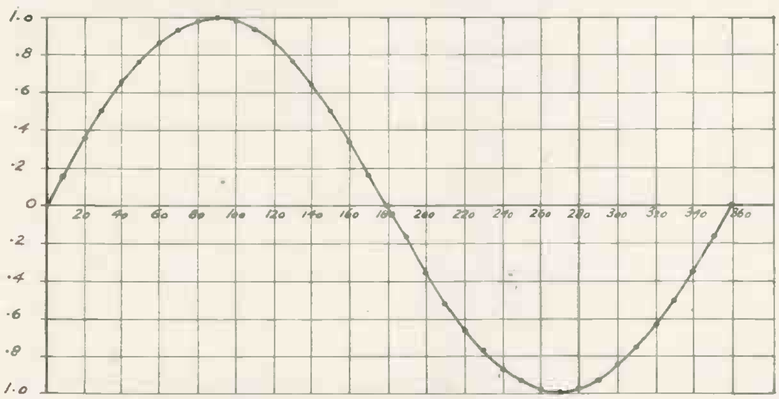


Fig. 2. A sine curve constructed from the readings given in the table in the text. The horizontal scale is in degrees.

The values of the sines are given in the following table:

Angle.	Sine.	Angle.	Sine.
0	.0	50	.766
10	.174	60	.866
20	.342	70	.940
30	.5	80	.984
40	.643	90	1.0
100	.984	150	.5
110	.940	160	.342
120	.866	170	.174
130	.766	180	.0
140	.643		

Note that after 90° the values decrease uniformly at the rate at which they increased.

If you require to draw a rough and ready sine curve a fair accuracy can be obtained by memorising the sines of 30, 45 (.707) and 60, with, of course, 0 and 90.

When the curve is drawn in through the points it should be perfectly smooth in ascent, slowing off as it reaches the top values, and should be quite symmetrical about a line drawn through the 90° point. To complete the other half of the A.C. wave it is only necessary to turn the paper round and plot the points on the other side of the horizontal line (See Fig. 2)

A.C. Generator Theory

This wave represents the natural variation of voltage in an alternating current circuit, and the relation between the wave and the voltage or current changes can be briefly explained as follows:

In order to generate an electromotive force (voltage is the more common term) it is necessary to rotate a coil in a magnetic field—the principle of the dynamo. If we assume that the field is perfectly uniform and that the coil consists of a single loop, the value of the e.m.f. generated in the coil at any instant will be proportional to the angular position of the coil with regard to the field. In Fig. 3, the coil is represented by the thick line and the field by the thin vertical lines. At the instant that the coil is passing across the field the angle made with the horizontal is 90° and the e.m.f. generated is a maximum. At any other angle A the e.m.f. will be proportional to the vertical projection of the coil; the line " a " for example, which is one of the factors in the ratio of the sine of A. The other factor, the line h is the dimension of the coil and is fixed.

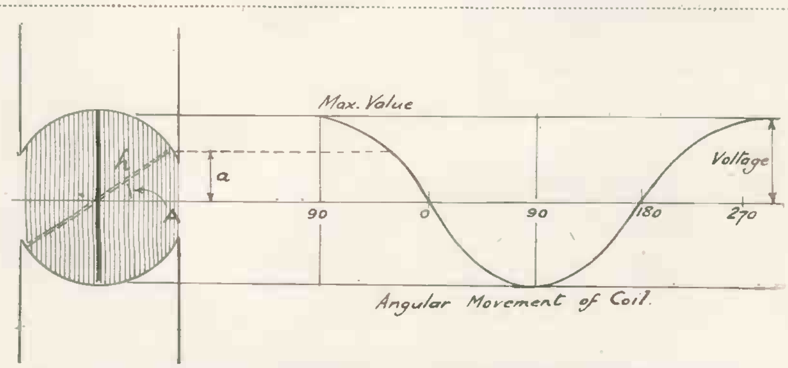


Fig. 3. The relation between the sine curve and the voltage generated by an A.C. machine. The value of the voltage at any point on the cycle is proportional to the angular position of the coil in the magnetic field.

The e.m.f. is therefore proportional to the sine of the angle of the coil as it rotates, and a curve of sine values will thus represent variations in e.m.f. in a simple alternating current generator. For a complete revolution of the coil it will be necessary to draw the full wave as in Fig. 2, since the polarity of the voltage is reversed when the coil enters a field of opposite polarity.

In practice the coil will consist of many turns and the field will not be the simple uniform one sketched in the figure. Nevertheless the sine wave form is always taken as the ideal to be aimed at and modern A.C. generators are designed to produce as close an approximation as possible to the theoretical wave

In radio engineering we have no immediate connection with rotating machinery. True, the source of supply for the transmitter is A.C., rectified, but the sine wave shape in broadcasting is usually originated by some form of oscillatory circuit. Any oscillating or vibrating system can be made to produce sine-wave variations of voltage provided that it conforms to the simple fundamental method of vibration of which the pendulum is an example. If we plot the movement of a pendulum against a time scale we will obtain the same fundamental sine curve. A vibrating string or a vibrating crystal will give the same curve—in fact it is " Nature's rhythm."

Constants of the Sine Wave

There are certain definitions and constants which are frequently re-

BUSINESS AS USUAL

at

WEST STREET FARNHAM SURREY

Telephone : Farnham 6461

Concentrating on the good cause—Production for Government requirements

★ ★ ★ ★ ★ ★

Specified by the Experts

SOUND SALES

PRODUCTS

can be obtained from the above new address

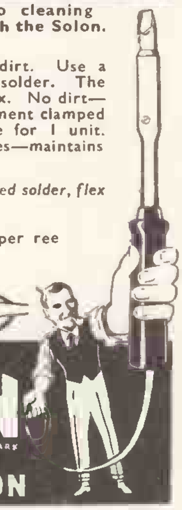
Why Solon *Electric* Soldering is easier

Ordinary iron requires cleaning after heating. No cleaning with the Solon.

Don't worry about flux or dirt. Use a Solon and Solon resin-cored solder. The resin runs out and acts as a flux. No dirt—the Solon is heated by the element clamped *inside the bit.* 15 hours' use for 1 unit. Ready for use in 4 minutes—maintains constant heat at the point.

Supplied complete with Resin-cored solder, flex and lamp adaptor, 8/6.

Solon resin-cored solder 6d. per ree



It's Easier with a

SOLON

TRADE MARK

Electric

SOLDERING IRON

W. T. HENLEY'S TELEGRAPH WORKS CO. LTD. (DEPT 2/V), HOLBORN VIADUCT, LONDON, E.C.1

"Building Television Receivers at Home"

Is a practical handbook giving precise instructions that will enable any amateur to build Television Receivers guaranteed to produce pictures of present-day standards both as regards definition and brightness. Three designs are provided with a wide range of picture size and the constructional information and illustrations are in such simple detail that they can be understood and carried out quite easily by the average wireless amateur. Results are assured.

CONTENTS INCLUDE :

- How a Television Receiver works
- Receiver giving pictures up to 12 inches
- The Time Base, Cathode-Ray Tube network and Receiver Power Unit
- Adjusting the Vision Receiver, the Tube and Time Base Power Unit
- Adjusting the Time Base
- Adding refinements
- Small-picture Receivers
- Receiver giving a 4-inch picture. The simplest Home-Built Televisor
- Time Base for the 4-inch Tube Receiver
- The Power Units of the 4-inch Tube Receiver
- Long Distance Reception with a 4-inch Tube
- Simplified Receiver using a 1-inch Cathode-Ray Tube

100 ILLUSTRATIONS — **112 PAGES**

2/6 net FROM ALL BOOKSELLERS OR **2/9 post paid** FROM THE PUBLISHERS

BERNARD JONES PUBLICATIONS LIMITED,

CHANSITOR HOUSE, CHANCERY LANE, LONDON, W.C.2

(Proprietors of "ELECTRONICS AND TELEVISION & SHORT-WAVE WORLD")

The Meaning of R.M.S.

ferred to in connection with the sine wave. Some apply to any wave, whether of the sine shape ("sinusoidal") or irregular. The terms used are marked in Fig. 4 which shows one complete *cycle* of the wave, i.e., from zero to maximum in one sense then through zero to maximuum in the opposite sense and finally back to zero again.

The *frequency* is, of course, the number of cycles per second. It is not necessary to start the cycle from zero—any point on the wave to a corresponding point on the next wave constitutes a cycle. For conveni-

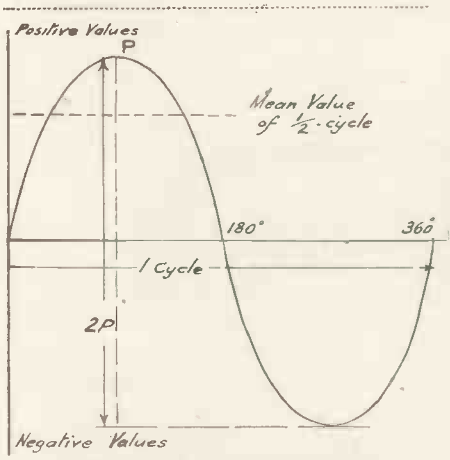


Fig. 4. The various terms used in connection with the sine wave.

ence it is usual to consider the values of voltage above the horizontal to be positive and those below the horizontal to be negative, although the terms are arbitrary.

The height P is the maximum value which is reached by the voltage or current and is therefore called the *peak value*, or *maximum value*, or *amplitude*. The total distance between the two peaks is the peak-to-peak value, marked on the curve as 2P. This value is often used in calculations of valve input voltage in amplifiers. If the wave is irregular, i.e., is not sinusoidal, the peak-to-peak value need not necessarily be twice the normal peak value.

For some calculations it is necessary to know the mean value of half the wave. The mean value of the whole wave or cycle is, of course, zero since there are as many values above the line in the positive half-cycle as below the line in the negative half-cycle. The mean value of the half-wave can be found by measurement of the area and works out to .637 of the peak value.

R.M.S. Value

The most important constant of the wave is that value of voltage known as the "R.M.S. (root-mean-square) value," and its derivation is as follows

For calculations and measurement in A.C. working we must have a value of voltage or current which will be equivalent to a corresponding value of direct current.

Suppose, for example, that we have 5 amperes D.C. flowing through a resistance of 4 ohms. The power lost is then $5^2 \times 4$ or 100 watts. In the A.C. wave we have values of current which vary from instant to instant and it will be necessary to find an average of these values which will give the same power as in the D.C. case. This average value will not necessarily be the mean value referred to above, and it is in fact higher.

To find it, we must remember that so far as power expenditure is concerned, we are dealing with values of current squared, since the power in either a D.C. or an A.C. circuit is given by I^2R.

Commencing, we square all the values of current in the sine wave and re-plot them as in Fig. 5, giving an I^2 curve. Note that since $-I \times -I = +I^2$ the negative values of the current become positive and are plotted above the baseline in the second half of the cycle. We can now say that the mean value of the "current squared" curve must be equivalent to the square of the value of direct current. This mean value can be found by drawing a line half-way through the curve as shown (marked $I^2/2$). It cannot be used conveniently, however, as it is a mean of "current squared" values and not a mean of current. To find the current we have only to take the square root of the mean value, giving as a result the *square root of the mean value of the current squared* or, in short, the root-mean-square value.

In tabular form the reasoning can be set out like this:

	D.C.	A.C.
Power is proportional to	I^2	Mean of values of I^2
Current is	I	Square root of this

If the mean is $I^2/2$ the square root will be $I^2/\sqrt{2}$, or .707 times the peak value.

This is the value which is shown on all indicating A.C. instruments and for the purpose of calculation can be considered as the effective value of A.C.

The relation between the peak value and the R.M.S. value is of importance in radio engineering practice. Although an instrument shows the R.M.S. value it must not be forgotten that during a cycle the voltage or current will rise to 1.4 times this reading. A condenser built to withstand 250 volts D.C. will therefore be overstressed by the application of 250 volts A.C. as read on a meter,

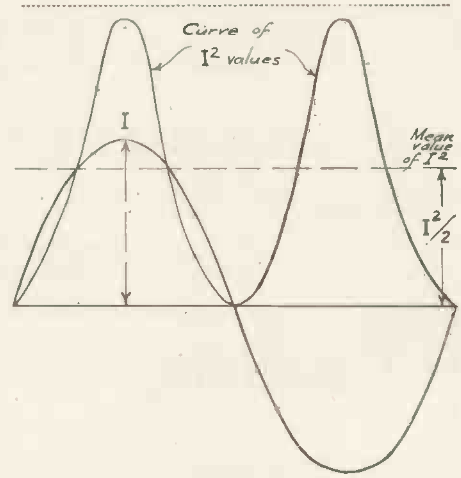


Fig. 5. How the r.m.s. value of an alternating potential is derived from the curve.

since the voltage peak will be 350 volts (1.4 × 250).

The figure given is only true for sine-shaped (sinusoidal) waves and is modified if a peaked wave shape is used. Some instruments are designed to read the peak value, but unless specially marked it is always safe to assume that the R.M.S. reading is given.

A cathode-ray tube gives a deflection proportional to the instantaneous value of the applied voltage or current and therefore indicates the peak value at the extremity of its deflection. The total length of the line drawn on the screen is then proportional to twice the peak value.

As an example, suppose the sensitivity of the tube is 5 volts per mm. and the total deflection on the screen is 2 cms. This corresponds to 100 volts deflecting potential, which is that from peak to peak. The peak value of half the wave is then 50 volts and the R.M.S. value 35 volts. A voltmeter across the deflector plate circuit would therefore only read 35 volts.

Examples

(1) Using the table give above, draw half a cycle of an A.C. sine wave having a peak value of 25 volts. (To obtain the volt readings for other points on the curve, multiply the values of the sines by 25).

(2) The frequency of an A.C. mains supply is 50 cycles per second. How long does one cycle occupy in decimals of a second? How long does the voltage take to rise to its peak value?

(3) A cathode-ray tube with a sensitivity of 2 volts per mm. shows a deflection of 3 cms. What is the peak and R.M.S. value of the deflecting voltage?

Television Signal Generator

A PRACTICAL, constant, portable means of supplying a radio or a direct video television signal for the investigation of circuit characteristics during development and for routine production testing and servicing of television receiving equipment has been developed by the DuMont Laboratories. This signal generator has been designed to supply a high-definition television picture signal, with sufficient video output to modulate an external ultra-short-wave signal generator such as the Weston Model 787 high frequency oscillator. The carrier frequency of this oscillator is variable from 30 to 150 megacycles, and its modulation carries a standard high-definition television signal with synchronising and blanking impulses.

The television signal generator may also be used as a source of signal for direct application to video amplifier testing, since an output of positive or negative phase of variable amplitude is supplied.

The DuMont instrument has three output circuits supplying the following video signals: Output A is a composite video signal of positive phase, containing the picture signal and synchronising and blanking pulses. Output B is a composite video signal of negative phase, containing the picture signal and synchronising and blanking pulses. Output C is the same as B, with the exception that the video signal is superimposed on a D.C. component of approximately 30 volts. The composite video signal in all cases has a maximum potential of approximately 10 peak-to-peak volts.

The pickup source is a DuMont phasmajector cathode-ray tube with suitable test pattern or picture. The output of this tube is fed to the first stage of the video amplifier, the latter being designed for a substantially flat frequency response between 20 and 3,600,000 cycles per second. Compensating circuits are employed to correct both high and low frequency response to the amplifier.

The gain control has sufficient range to provide for a wide variation in phasmajector output signal, and the cut-off point of the blanking amplifier is also adjustable to provide for various blanking output levels. The output stage is a Type 6L6 operated as an impedance transformer to provide a low-impedance output for these high-frequency signals.

The instrument is entirely self-contained, with necessary power supplies for various functions and circuits. It also includes the phasmajector, horizontal and vertical sweep circuits, etc.

In his "outpost of Empire," old Wright
Is at work on his set, with FLUXITE.
"I learnt this trick," says he,
"Back in England you see.
Now I'll be there for 'In Town Tonight!'"

See that FLUXITE is always by you—in the house—gargage—workshop—wherever speedy soldering is needed. Used for 30 years in government works and by leading engineers and manufacturers. Of Ironmongers—in tins, 4d., 8d., 1/4 and 2/8. Ask to see the FLUXITE SMALL-SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6. Write for Free Book on the art of "soft" soldering and ask for Leaflet on CASE-HARDENING STEEL and TEMPERING TOOLS with FLUXITE.

To CYCLISTS! Your wheels will NOT keep round and true unless the spokes are tied with fine wire at the crossings and SOLDERED. This makes a much stronger wheel. It's simple—with FLUXITE—but IMPORTANT.

THE FLUXITE GUN

is always ready to put Fluxite on the soldering job instantly. A little pressure places the right quantity on the right spot and one charging lasts for ages. Price 1/6, or filled 2/6.

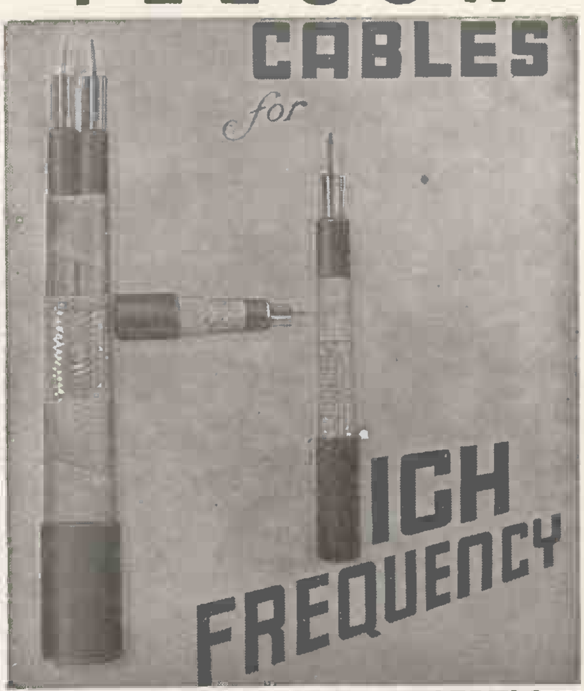
ALL MECHANICS WILL HAVE

FLUXITE

IT SIMPLIFIES ALL SOLDERING

FLUXITE LTD (DEPT T.V.), DRAGON WORKS, BERMONDSEY ST., S.E.1.

TELCON



TRANSMISSION AND RECEPTION

Full particulars of all TELCON PRODUCTS from:

THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO., LTD.

Head Office: 22, OLD BROAD ST., E.C.2. Telephone: LONdon Wall 3141. *Works:* Greenwich, S.E.10. Telephone: GREenwich 1040

THE GUTHMAN "SILVER-SUPER"

The present international trouble has shown clearly the need for obtaining the latest news from all quarters. Many listeners apart from the radio amateur are purchasing receivers which will enable them to receive news from all stations on the medium and short wave bands. This description of a first-class communications receiver will be of interest to all and may assist them in making their choice.

THE name of McMurdo Silver is familiar to all radio enthusiasts as associated with receivers of the highest quality, and in this Guthman kit receiver the reputation of the name is fully maintained.

The principal features of the circuit are extremely low noise level and the wide variation in selectivity obtainable.

It is recognised that high sensitivity can be easily obtained by regeneration, but the usual objection to its use is in the erratic nature of the results obtained in unskilled hands, combined with a certain amount of fear that the circuit will "re-radiate." In the hands of a skilled designer a regenerative circuit can be made to yield the maximum results with no special demand on the skill of the user, and in this particular receiver the designer's boldness in using double regeneration has been fully justified.

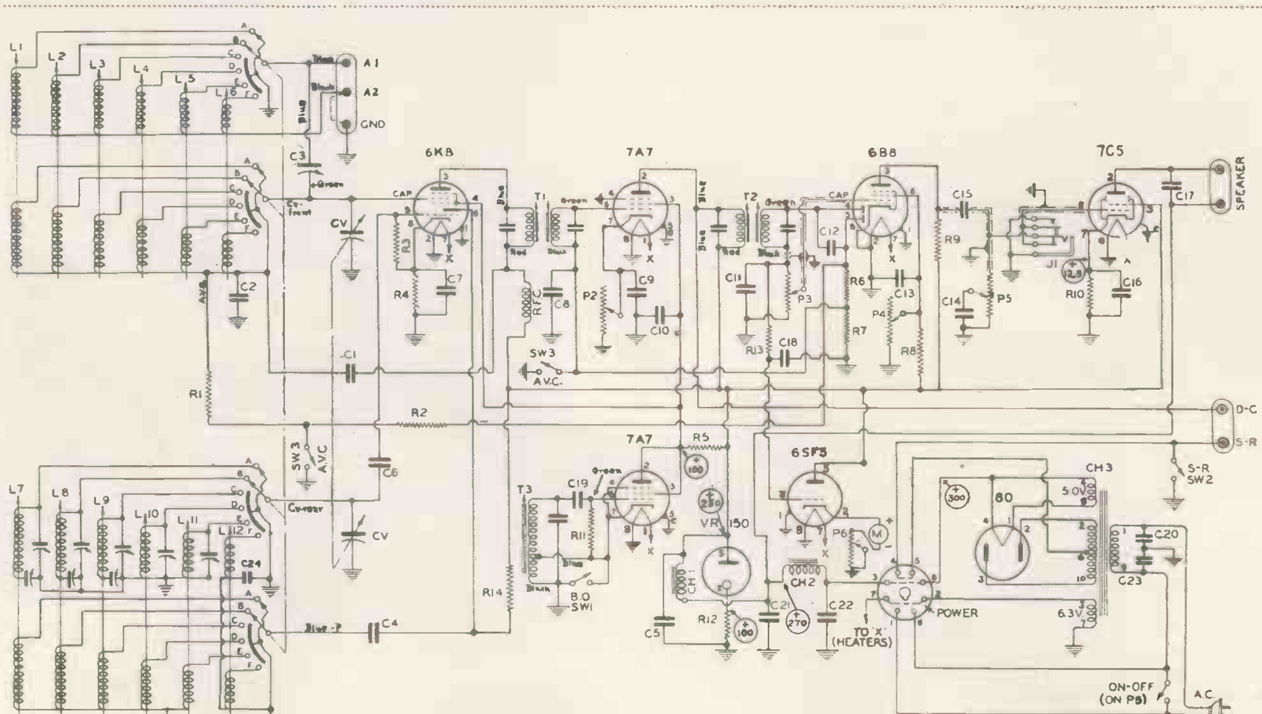
The Circuit

The receiver consists of a detector-oscillator (6K8) I.F. amplifier (7A7), second detector (6B8) which provides A.V.C. and noise limitation, and a beam tetrode output valve (7C5).

In addition there is a b.f. oscillator (7A7) and valve voltmeter 6SF5. Power is supplied from a type 80 rectifier with a voltage regulator tube VR150.

The circuit diagram is shown below. The aerial sockets are intended for use with any type of aerial. With single wires (such as the "Skyrod") the terminal A_1 is used, A_2 being connected to Ground terminal. Both A_1 and A_2 are used with doublets.

The wave range covered by the coils is 480 kc to 61 mc.—the amateur band, medium waveband and the 600 m. commercial band. Six coils are used to cover the range, each being individually switched and short-circuited when not in use.



The circuit of the Guthman "Silver-Super."

The frequency changer provides regeneration in a neat manner, an R.F. choke in the anode circuit of the mixer providing the necessary R.F. voltage for feeding back to the grid. The choke has been specially designed to cover the whole frequency range and the degree of feedback is governed by the ratio of C_1, the feedback condenser, to C_2. The valve is never operated in a fully oscillating condition, and hence there is no risk of re-radiation.

The I.F. stability is ensured by automatic voltage control with the stabiliser V150 and "warming up" is avoided by the operation of the send-receive switch, which leaves the heaters on while disconnecting the H.T. The I.F. amplifier is of the "Loktal" type having a higher gain and lower input capacity than the 6K7. The I.F. is 455 kc. Regeneration is again provided in this stage by a slight grid-anode capacity coupling and is controlled by the cathode bias. It is not used for C.W. reception, a b.f. oscillator being provided.

The A.V.C. voltage obtained from the second detector is divided between the mixer and I.F. valves, and is controlled by a separate switch on the panel.

The valve voltmeter is connected to read the signal voltage across the diode load, the meter in the anode circuit reading "S" values. The meter can be calibrated by means of an adjustable cathode resistance.

The use of a diode-pentode in place of the more familiar diode-triode enables noise limiting to be done in this stage.

The pentode of the 6B8 is used as an A.F. amplifier, the saturation current being controlled by the screen voltage. By setting the screen voltage to a predetermined value the noise transients are automatically limited to the level of the signal.

The H.T. supply is fed through the eight-pin socket shown in the diagram, and by removing a dummy plug it is possible to convert the receiver to battery operation. The send-receive switch and the main switch are also connected to the socket so that they will operate on either mains or battery supply.

A parallel connection for the send-receive switch is provided by the terminal marked SR, to which a remote control may be attached. The terminal DC is for the connection of a diversity coupler, the other terminal on the coupler going to "Ground."

Controls

The front panel of the receiver is shown in the photograph. The main tuning dial is accurately calibrated, but is naturally slightly affected by the selectivity setting on the knob marked "Sel." The bandspread dial is visible through the square window at the right upper corner of the main dial.

The short wave bands are located at approximately the following settings:

50 m.	Band B	1.6-1.7 and 2.3-2.5.
30 m.	Band D	5.8-6.5.
25 m.	Band D	9.4-10.
20 m.	Band E	15.0-15.4.
16 m.	Band E	16.5-17.0.
13 m.	Band E	21.0-22.0.

The other controls shown are as follows:

A.F. Gain.—A volume control in the grid circuit of the 6B8.

Tone.—In the grid circuit of the output valve, acting as a top note cut-off. It also reduces background hiss.

A.V.C. Switch.—Marked SW.3 in the circuit diagram.

B.O. Switch.—On panel between A.F. Gain and Sel. knobs.

Sel.—This knob controls the I.F. gain and I.F. regeneration. As it is turned up selectivity increases up to a point where the I.F. amplifier oscillates. Maximum selectivity is just below this point. It is not necessary to have the I.F. oscillating for C.W., owing to the separate B.F.O.

Silencer.—It is only necessary to use this control when noise is excessive on weak signals. In tuning, the control should be set at maximum and then gradually reduced until the signal becomes appreciably weaker. At this point the noise is almost completely suppressed. Adjustment of the silencer must be made for change in stations as a setting for a weak station will suppress a stronger signal. A little practice will enable the optimum setting for noise level to be found. If the receiver appears to be "dead" it is probable that the silencer control has been turned too low to allow a signal to be passed through the limiting circuit.

Ant.—The aerial trimmer knob which gives maximum gain on weak signals.

In addition to the above, a jack is provided for phones. The panel is finished black with silver facings and the cabinet is of steel, grey enamelled, with a hinged lid for easy inspection.

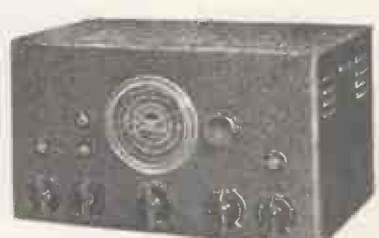
The receiver is marketed in kit form with full instructions for assembly and all the necessary wires, etc. The price is very moderate considering its capabilities—£18 15s. od. at the present rate of exchange. The agents in London are Messrs. Radio Clearance, of 163 High Holborn, who will be pleased to send full particulars to inquirers.

DON'T believe
all You Hear
BUT Hear All
Get a
TROPHY Communication Receiver

Ensure
WORLD CONTACT. From every corner of the World these days comes Short-Wave messages of some significance but only the possessor of a specially designed recever—like the TROPHY 6 for example illustrated above—hears everything. English broadcasts—impartial, important or enlightening in character—all of these are to be heard by a TROPHY owner. The new TROPHY 6 A.C. communication Receiver has a continuous wave-range of 6.5 to 550 metres (covering therefore the B.B.C. Home Service). Separate dial electrical bandspreading is employed and all essential Short-wave tuning refinements and built-in speaker and 'phone jack. The TROPHY 6 is used and recommended everywhere for all-World listening and the present low price is £10. 19. 6. Guaranteed. Delivery, at the moment, FROM STOCK.

Low-Priced
2-Stage PRESELECTOR
Connect to your present set for increased—
● Range.
● Signal strength
● Selectivity
and . . .
Reduction to a minimum of 2nd channel interference.

The most useful acquisition for your present set. Suitable for any battery or mains type receiver. Two "E" series valves stages. Wave range, 7 to 550 metres. Directly calibrated frequency scale. Positive slow-motion tuning. Noise free in operation. Self-powered for 200/250 v. A.C. Complete in crystalline finish metal cabinet, ready for immediate use. Price, £7. 8. 6. A real investment for every set owner.
LISTS FREE
TROPHY 8 Communication Receiver



This 8-valve A.C. receiver with all essential tuning refinements for efficient short-wave operation still remains unbeatable in performance and price. Wave-range 7 to 550 metres, continuous bandspread tuning. R.F. on all 5 bands. For use with separate P.M. type speaker. 'Phone sockets. Accurately aligned and ready for use. Price £13. 17. 3. Matched Cabinet Speaker available, 46/3d. extra.
SEND NOW for full technical specifications. TROPHY models from £6 . 6 . 6
PETO-SCOTT CO. LTD.,
77 (T2), City Road, London, E.C.1. Tel. Clissold 9875.
41 (T2), High Holborn, London, W.C.1. Tel. Holborn 3248.

IF **YOU** WANT THE **BEST WAR PICTURES** YOU MUST HAVE

WAR PICTORIAL

PUBLISHED FRIDAYS PRICE 3D

PRINTED IN PHOTOGRAVURE "WAR PICTORIAL" WAS AN INSTANTANEOUS SUCCESS AND IS NOW RECOGNISED AS THE

BEST WAR WEEKLY

To avoid disappointment place a regular order with your newsagent ***TODAY***

WAR SECRETS! WAR FEATURES! WAR PICTURES!

Frequency Modulation for Broadcasting

EQUIPMENT is now being built for the construction of a new broadcast station in Schenectady that will operate on the recently announced frequency modulation system developed by Major Edwin H. Armstrong.

The transmitter for the new station will be located in the building now housing General Electric's television transmitter on the Helderberg Mountain, 12 miles from Schenectady. It is expected that the new station will go on the air in about two months time.

General Electric has been conducting frequency modulation tests for some time on its 150-watt ultra short-wave station W2XOY. These tests and subsequent ones have shown that at least 96 per cent. of all natural and man-made static is eliminated in the new system. Coverage is limited to approximately twice the distance between the transmitting aerial and the horizon, which should provide good reception for about 100 miles from the Helderberg transmitter.

Standard broadcast receivers are unable to receive programmes transmitted on the new system and General Electric recently announced regular production of a full line of sets built to receive the staticless programmes, one of which also makes available standard American broadcasts, foreign and domestic short-wave stations, as well as television sound programmes and which can be used in conjunction with a television picture receiver.

The radio stations familiar to everyone to-day employ what is known as the amplitude method in broadcasting programmes. This system projects a constant carrier stream of waves which produces the humming sound that is heard when a station is quiet.

Sounds striking a microphone produce waves which mix with the carrier wave, and they leave the studio together. Unfortunately, static also mixes easily with this carrier wave.

With the frequency modulation system, the carrier wave is juggled so that it vibrates at the same frequency as the sounds in the studio. Because the carrier wave is constantly shifting, static has no opportunity to mix with the carrier wave. All who have heard programmes broadcast by the new system praise its improved fidelity. The frequency modulation system operates on an ultra short-wave band.

Besides its sound qualities, the new system makes room for many new stations, since many stations may operate on the same channel. In standard broadcasting in U.S.A. some 730 stations now occupy 105 channels. Under frequency modulation it will be practicable to assign frequencies to as many or more stations by using only the five channels already established, since the characteristics of the new system result in the elimination of interference between stations. It is impossible for one station to interfere with another, since no two stations can be heard at the same time even though both may be broadcasting on the same wavelength. In tests conducted from a station in Albany and another experimental station in Schenectady, both broadcasting on the same wavelength, it was found that a receiver installed in a motor car travelling between Schenectady and Albany would first receive the Schenectady programme and when half-way to Albany would suddenly receive the programme from Albany. At no time was there interference between the two stations, and it was even found that at a certain point between the two cities it was possible to alternate reception from the two stations simply by bending the horse-whip-type aerial used on the car.

THE ELECTRON

The ELECTRON is a minute particle with a negative charge equal to 4.77 $\times 10^{-10}$ electrostatic units.

Its mass is a hypothetical quantity which is expressed as the ratio of the force applied to the acceleration produced, and is equivalent to 8.96 $\times 10^{-28}$ gms.

Because of the charge on the electron the apparent mass increases as the velocity increases.

The ratio of the charge to the mass of the electron is 5.32 $\times 10^{-17}$ electrostatic units per gm. This ratio is usually written e/m.

The velocity imparted to an electron by an accelerating potential is given by the equation :

$$5.32 \times 10^{7}\sqrt{V} \text{ cms. per sec.}$$

where V is the accelerating potential. This is only true for slow moving electrons.

LISTENING ON THE SHORT WAVES

The present state of World affairs has created exceptional interest in the news and views expressed over the World's Short-wave broadcasts. It has also reduced to a considerable extent the entertainment over the medium and long wave bands, therefore, anything you can do to improve your reception on the short waves will add to your pleasure.

CLIX offer a CONTROL PANEL which carries out an important duty, since it obviates the sudden cessation of load on the output valve. In the case of a Pentode it can be very disastrous since the voltage on the auxiliary grid will build up and seriously impair the emission of the valve. This must happen when an Internal speaker is disconnected before connecting to Headphones or Extension speaker.

CONTROL PANEL

Gives instantaneous method of switching Extension Speaker in or out and allows Internal Speaker to be kept in operation or cut out. Also excellent for switching in Headphones for DX listening, etc.

Price complete as illustrated 1/-

CLIX also have a range of Frequentite (ceramic) components which prevent losses in high frequency circuits.

Full details of these components is given in CLIX latest Catalogue. Free on request.

CLIX

British Mechanical Productions Ltd.,
1 Church Road, Leatherhead, Surrey.

RADIOMART

Business as usual

LARGE STOCKS OF ALL TYPES OF SHORT-WAVE & COMMUNICATION EQUIPMENT INCLUDING AMERICAN VALVES.

Accredited NATIONAL *Agents*

CONTRACTORS TO : *G.P.O., Air Ministry, Crown Agent for Colonies, Signal Corps, Police Forces, etc.*

SPECIAL NOTE TO AMATEURS

We are still receiving enquiries for second - hand Communication Receivers, and are open to buy certain types, particularly those manufactured by our Principals, the National Company, and including H.R.O., ONE/TEN, etc.

Send us particulars and your lowest price.

RADIOMART

44, HOLLOWAY HEAD, BIRMINGHAM, 1.

Telephone : MIDLAND 3254.

Dits and Dahs !

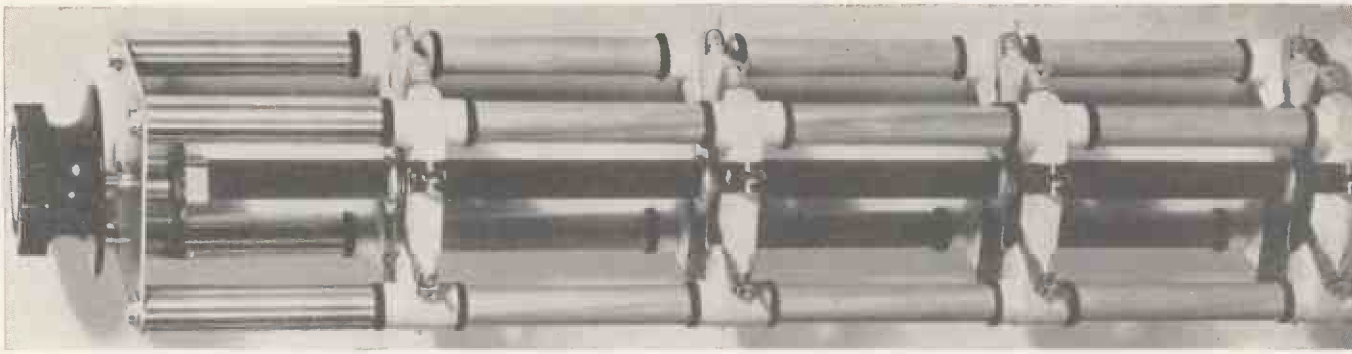
The language of the air that all amateurs should know.

CANDLER CODE COURSES

not only teach you the right way to *send*, but the right way to *read* code sound just as easily as you read print by sight. Courses for Beginners and Radio Operators. *Terms : Cash or Monthly payments.*

Send for FREE "Book of Facts"

CANDLER SYSTEM CO.(55B), LONDON OFFICE 121 KINGSWAY, W.C.2



A four-unit bandspread with 6 contacts on each element.

A NEW GANGED SWITCH

The simplicity of transmitter band switching is indicated in this article which describes the new H.K. band switch.

THE Heintz, Kaufman Company, well known in England as the manufacturers of H.K. valves, have produced a type 892 band switch which although comparatively small will accommodate transmitters up to 1 kilowatt.

It is a very reliable switch with silver nickel contacts and a stainless steel spring which eliminates poor contact which is sometimes very noticeable on ordinary switches and caused by corrosion.

Ceramic insulation, actually Alsimag, is used, ensuring very low dielectric loss and maximum insulation. The index head should be long wearing for moving parts are case-hardened, while eddy current losses are low as dural spacers are used where strong fields would be encountered.

It requires a "behind the panel space" of $2\frac{5}{8}$ in. square with a depth of $3\frac{1}{2}$ in. per single section. An additional 3 in. is required for each section which can easily be ganged.

Six positions per section are provided on a ceramic wafer base and in order to handle a high current these contacts are double and of wiping action. The voltage rating between contacts is 5,000 and from contact to ground 4,000. This rating is reduced above 15 megacycles because of the heating of the bakelite drive shaft.

A special ceramic shaft is available where maximum power handling is required on the ultra-high frequencies. Current ratings are as follows:

Frequency.	Current.	Voltage
60 cycles	15 amps.	4,000 volts
1 mc.	15 amps.	4,000 ,,
2 mc.	14 amps.	4,000 ,,
3.5 mc.	11 amps.	4,000 ,,
7.5 mc.	9 amps.	4,000 ,,
15 mc.	7.5 amps.	3,600 ,,
30 mc.	6 amps.	3,000 ,,

The sketch on this page shows how single ended or push-pull transmitter can be built for band switching. It is recommended that each separate tank coil has its own parallel pre-set capacity, rather than to use tapped coils plus

A close-up view of one switch unit.

a trimmer condenser. For push-pull operation a double-unit switch is required as shown, while with single ended operation as the high voltage side of all coils can be connected together, a single unit switch is satisfactory.

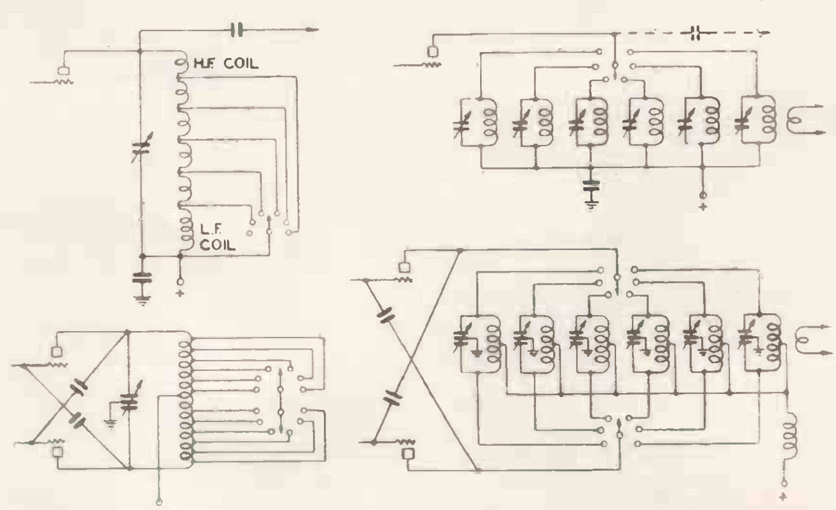
Alternative methods are shown with tapped coils, but this is only to be recommended on the lower frequency bands, or where maximum efficiency is not required.

With a 6L6 and KT8 plus the HK switches, a three-band transmitter can be made quite simply to provide an output of 25 watts on all bands.

War News from U.S.A.

Since the crisis began, W2XE, the Columbia short-wave foreign broadcasting station, worked day and night, averaging nine broadcasts in every 24-hour period.

This intensified operation was instituted to give Europe and South America fullest coverage possible by immediately translating and broadcasting all important news, also, by monitoring short-wave stations of foreign capitals, to keep listeners advised of the general activity. It is believed that European listeners are tuning in more and more to American stations which bring them accounts of latest happenings.



Four recommended methods of band switching.

Multiple Interlaced Scanning

Attention has been directed to a particular type of multiple interlaced transmission with an interlace ratio of 4 to 1 adapted to be received either with an interlace ratio of 4 to 1 or 2 to 1. This system may be briefly described as interlacing two consecutive complete images, each of which consists of two interlaced groups of lines. It is suggested to combine the usual form of 2 to 1 interlace, having an odd number of lines per frame with an interlace produced by additionally shifting the whole group of lines.

The combination of interlaced scanning with single channel colour television transmission has been considered. Each form of interlace in combination with a periodic change of three colours requires a definite number of lines per frame in order to give correct repetition. For obtaining a higher rate of colour repetition resort may be made to overlapping of lines. The colour sequence of the first line of each frame of a 4 to 1 interlace should correspond to the location of these lines as defined by a characteristic number.

World's Largest Speaker

The enormous perisphere which in conjunction with the 700 ft. Trylon has become the symbol of the New York World's Fair, has been utilised by R.C.A. sound engineers to form the horn of the largest loudspeaker ever constructed—a sound reproducer so vast that thousands of persons are able to stand at one time at its periphery. The huge speaker is used to produce music at the Theme Centre.

A battery of 36 high and low frequency sound reproducers is installed in a concrete chamber below ground level at the base of the perisphere. This chamber, which is entirely concealed from view, effectively couples the reproducers to the horn created by the perisphere and and the surrounding ground surface forming a horizontal 360-degree circular speaker. The massive unit is designed to cover the audible range of sound from 20 to 10,000 cycles. It reproduces sounds so low in the lower register that they are felt rather than heard.

PLEASE FILL IN THIS ORDER FORM NOW

Owing to unavoidable war-time restrictions, there may be difficulties in many localities in getting copies of "Electronics and Television and Short-wave World."

You will definitely get the journal promptly each month if you will fill in this order form and hand it to your usual newsagent. Do it to-day and make certain of your copy.

Date..............................

.... *Name and address of your newsagent.*

Please reserve/deliver "Electronics and Television and Short-wave World" every month until countermanded.

Name ....

Address ....

Published by Bernard Jones Publications Ltd.

Chansitor House, 37/38 Chancery Lane, London, W.C.2

GALPINS

ELECTRICAL STORES

75, LEE HIGH ROAD, LEWISHAM, LONDON, S.E.13

Telephone : LEE GREEN 5240

Terms :
Cash with Order or C.O.D. Charges extra.

ALL GOODS SENT ON THREE DAYS APPROVAL AGAINST CASH

CROMPTON DYNAMO, 4-pole shunt wound, 1,750 r.p.m. 100 volts 10 amps., 70/-. Ditto, 50/75 volts 15 amps., 75/-. Carriage forward.

MACKIE MOTOR GENERATOR, 220 volts 3.35 amps. D.C. input, 10 volts 30 amps. D.C. output, 37/6. C/F.

CROMPTON DYNAMOS, 4-pole shunt wound, 1,750 r.p.m., 22 volts 10 amps., 70/-. Ditto, 50/75 volts 25 amps., 90/-. C/F.

NEWTON MOTOR GENERATOR, 220 volts D.C. to 16 volts 10 amps. D.C., 30/-. C/F.

MACKIE MOTOR GENERATOR, 220 volts D.C. to 400 volts 170 m/A. and 15 volts 8 amps. D.C. Three pieces coupled together on bedplate, 55/-. C/F.

CROMPTON MOTOR GENERATOR, 220 volts D.C. to 500/750 volts 200 m/A. D.C., 40/-. C/F.

DYNAMO BY ELECTROMOTORS, 400 revs., 100 volts 10 amps., shunt wound, 90/-. C/F.

SMALL MOTORS. Beckenham Motor Generators, 220 volts D.C. to 500 volts 300 m/A. and 12 volts 12 amps. All three coupled together on slide rails. 35/- each. C/F.

E.C.C. SHUNT WOUND DYNAMO, 100 volts 50 amps., 1,500 r.p.m., £6 10s. C/F.

MACKIE ALTERNATOR, 120 volts D.C. input, 65 volts 1 ph. 150 cycles ½ kW. output. Vertical type, 45/-. C/F.

MACKIE DYNAMO, shunt wound, 75/90 volts 8/10 amps., 1,500 r.p.m., 55/-. C/F.

C.A.V. SHUNT WOUND DYNAMOS, 25 volts 8 amps., 1,750 r.p.m., 32/6. C/F.

G.E.C. SHUNT WOUND DYNAMOS, 50 volts 6 amps., 1,500 r.p.m., 30/-. C/F.

CROMPTON SHUNT WOUND DYNAMO, 100 volts 4 amps., 1,750 r.p.m., 35/-. C/F.

HIGH-VOLTAGE TRANSFORMERS for Television, Neon etc. 200/240 v. 50 cy. 1 ph. primary, 5,000 and 7,000 volts secondary, enclosed in petroleum jelly. Size : 5⅝ in. × 4½ in. × 4½ in., 7/6 each, post 1/-. Ditto, Skeleton type, 5/6, post 9d, All brand new.

EVERSHED EX-R.A.F. HAND-DRIVEN GENERATOR, in new condition, 800 volts 30 m/A. and 6 volts 2½ amps. D.C. Useful as megger genies and all test work. 20/- each, post 1/6.

EX-G.P.O. GLASS TOP RELAYS, Type B. Useful as Keying Relays, 5/- each, post 6d. Also a few only that need points, which are easily fitted, 2/6 each. P/F.

T.C.C. 2,000 MF. ELECTROLYTIC CONDENSERS, 50-volt working (brand new), 5/- each, post 6d.

STANDARD TELEPHONE BELL WIRE, all brand new. 150-yd. coils, twin 22 gauge, 4/-, post 9d. ; 250-yd. coils, single 16 gauge, 4/-, post 1/- ; 300-yd. coil, single 22 gauge. 3/-, post 6d.

P1 STANDARD TELEPHONE PUSH-BACK CONNECTING WIRE (new), 220-yard coils, 12/6, post 1/-.

SAVAGE MAINS TRANSFORMERS, 200/250 volts input, 50 volts 8 amps. output, 12/6 each.

STANDARD TELEPHONE MAINS TRANSFORMERS, input 200/250 volts, output 250/0/250 volts 200 m A., 3 × 4 volt windings and a 50-volt winding, 12/6 each.

JOHNSON & PHILLIPS HOT-WIRE RADIO FREQUENCY METERS, 4-in. dial, 0 to 1.2 and 0 to 2 amps., 12/6 each, post 1/-.

MACKIE DOUBLE WOUND EX-R.A.F. GENERATORS, 1,200 volts 100 m/A. and 10 volts 4 amps., 3,000 r.p.m., 12/6 each. Carriage 1/6.

ELLIOTT MOVING COIL METER MOVEMENT, first grade, approx. 2 m/A., full scale of 6 inches, 10/6 each, post 1/-.

MUIRHEAD 1 MF. CONDENSERS, 1,000-volt working, 1/- each, post 6d. ; or three for 2/6, post 1/-. Philips' 1 mf., 3,000-volt working, 5/-. T.C.C. 4 mf., 3,000-volt working, 9/6 each. Standard Telephone 1 mf., 400-volt working, 4d. each, or in lots of 100 for 12/6, post 1/6.

ERNEST TURNER & WESTON 2-in. DIAL MOVING COIL MILLIAMPMETERS, B.S. first grade, 0 to 5 and 0 to 50, 20/- each.

X-RAY TRANSFORMERS, by well-known makers, all fully guaranteed. 50 cycle mains, 40,000 volts, 10 m/A., £5 ; 68,000 volts, 20 m/A., £7 10s. ; 100,000 volts, 30 m/A., £10 10s. All carriage forward.

"The Murphy Noise Limiting Circuit"

(*Continued from page* 593)

The second grid leak and condenser C49 and R64 are necessary for two reasons.

Firstly, the action of the diode is apt to upset the mean potential in its anode circuit, and such changes, if they reach the grid of the output valve, will change its mean current and so vary the rather critical focusing current of the C.R. tube.

Secondly, in order that the noise suppression circuit shall work correctly, very good low frequency response must be maintained up to the diode, and if a cut of low-frequencies is not put in by C49 and R64, the receiver will sound very "boomy."

The voltage supplied to the diode cathode is obtained from the secondary of the output transformer, supplemented with extra turns. The bass cut effected in the grid circuit of the output valve is, from this point of view, a disadvantage, and in order to enable the cathode of the diode to follow its anode voltage (that is, to "track") down to low frequencies, a low frequency correction circuit comprising R59, R58 and C48 is inserted. The delay in the signal fed to the diode cathode is supplied by shunting R58 and C48 in series by C47.

The higher frequencies fed to the diode cathode are also attenuated by this arrangement, but although this causes high frequency loss on the signal when the noise suppressor is working, it is not considered a disadvantage. The resistances R62, R63 are inserted in order to provide a rough adjustment on the gain of the circuits interposed between the diode anode and its cathode, which should, of course, be unity, but may vary somewhat from one receiver to another, depending on the output valve and exact circuit values.

Noise Suppressor Adjustment

More important is the adjustment on the D.C. bias applied to the diode cathode. The grid leak R57 is returned to the junction of R69 and R72, so that the mean potential of the diode anode is somewhat less positive than the output valve cathode. The mean potential of the diode cathode can be set by means of the potentiometer R73 to any value between chassis potential and the output valve cathode potential.

At the most positive setting the diode cathode is always positive with respect to its anode, and the diode and noise suppression circuit is therefore inoperative. As the diode cathode is made less positive, the diode begins to act first as a limiter, and then as its potential is reduced, the noise suppression becomes more and more effective. Quite a high degree of suppression can be obtained before any distortion is noticeable.

If the potential of the diode cathode is reduced beyond this point, the suppression becomes somewhat better, but the distortion and loss of high frequencies becomes rapidly worse. The potentiometer R73 is controlled by a knob on the front of the receiver so that when not required, the suppressor can be cut out and sound reproduction is as good as possible. At the same time, when it is required, the best compromise between suppression and quality can be secured.

The R.S.G.B. is CARRYING ON

The Council of the Incorporated Radio Society of Great Britain has decided that in the best interests of the Radio Amateurs of Great Britain, it is essential for the Society to carry on.

THE T. & R. BULLETIN will, as hitherto, be published monthly. Its primary function will be to give members latest technical information, besides keeping them in touch with one another.

The Experimental Section and QSL Bureau will continue to function.

REDUCED War-Time **SUBSCRIPTION RATES** are now in force :—

BRITISH ISLES ... ... **15**/- per annum
OVERSEAS ... ... **12/6** per annum
BRITISH ISLES (Service Members) ... ... **10**/- per annum

New Members will be welcomed.

SPECIAL NOTICE

The Amateur Radio Handbook (296 pages) has been reprinted. The most up-to-date publication of its type on the British market.

GET YOUR COPY TO-DAY

Price **3/-** Post free

All communications **by post only** to

The Secretary-Editor **R.S.G.B.**
53 VICTORIA STREET, LONDON, S.W.1

Telephone enquiries to Palmers Green 3255

TELEVISION DEVELOPMENTS

Are you keeping abreast of modern television developments ? Whether amateur or professional you *must* be in touch with the latest trend of research.

The Television Society enables you to meet fellow workers in the field of television, both in this country and abroad.

Founded some 10 years ago **The Television Society** provides a scientific and non-partisan platform for discussion on all aspects of the subject. Meetings are held monthly during the session (October-June) and are reported in full in the Society's Journal which is sent free to all members.

The Society's activities have just been enlarged to meet the growing interest in the subject and members will have a unique opportunity of furthering their knowledge by contact with well-known television engineers.

Full particulars of membership qualifications may be had from the Hon. General Secretary :—J. J. Denton, 17, Anerley Station Road, London, S.E.20.

THE TELEVISION SOCIETY

(Founded 1927)

President : Sir AMBROSE FLEMING, M.A., D.Sc., F.R.S.