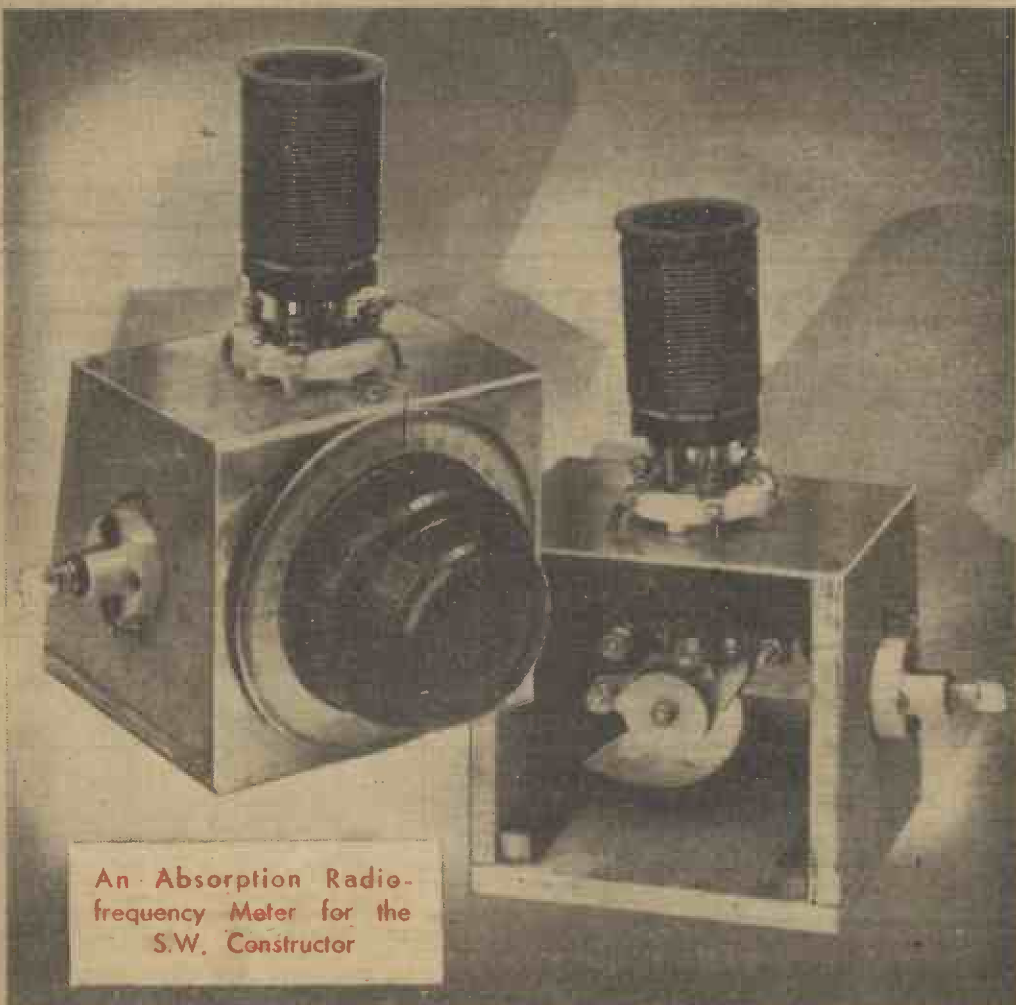
INEXPENSIVE D.C. ELIMINATOR

Practical Wireless 9D EVERY MONTH

Editor F. J. CAMM

Vol. 19. No. 440. NEW SERIES. FEBRUARY, 1943



An Absorption Radio-frequency Meter for the S.W. Constructor

# Practical Wireless

and PRACTICAL TELEVISION

EVERY MONTH
Vol. XIX. No. 440. FEBRUARY, 1943.

Editor F. J. CAMM

Staff:
L. O. SPARKS.
FRANK PRESTON.


*COMMENTS OF THE MONTH* *BY THE EDITOR*

# Television in the War—and After

ALL wars are responsible for technical developments. The reason is that the State can afford to spend large sums of money on experiment and development which would be quite outside the scope of ordinary commercial enterprise. The way of the inventor has always been hard. It has always been difficult for him to find money to conduct his experiments. Banks and financiers are difficult to convince of the practicability and commeroial possibilities of an idea. They are interested not so much in the invention as in what amount of money it will make. Very often they will stifle an invention if it tends to compete with existing methods and thus would render them obsolete.

When a war arrives, however, technical developments and new inventions which will shorten the war and help towards victory become an asset to the State and money is freely forthcoming for their development. Thus a war, while largely destructive is also creative, even though science seeks to destroy that which it creates.

In the last war wireless telephony was developed for war purposes, and now it provides the major part of our entertainment. It is also a useful means of disseminating news and views, and of educating the public on such diverse subjects as gardening, music, religion and science.

### Opposing Interests

NATURALLY enough in the early days it was opposed by interests with which it was thought it would compete. The gramophone industry particularly thought that the broadcasting of gramophone records would destroy sales. The very reverse has proved to be the case, for the sale of gramophones and gramophone records has never been on a higher level. Those who earn their living on the stage similarly thought that people would not wish to visit theatres if they could sit in their homes and be entertained. That belief, too, has been proved wrong.

When television, that newest of sciences born in an era which has been the most remarkable in the world for scientific achievement, first blushingly reared its tiny head, it was pounced upon by rival interests and almost throttled at birth. The old fears returned. It was argued that although radio had proved to be an aid rather than a competitor to the gramophone and the theatre, television would provide the missing link, which by its absence had confounded the critics.

Television had made rapid strides in the two years before the war, and the ill-fated Wireless Exhibition which prematurely closed when war was declared saw a number of satisfactory television receivers exhibited and a growing demand for them on the part of the public.

The new science had broken down the apathy of financiers and it was thought that the war would deal the death blow which commercial opposition had failed to inflict. But the war has not delivered the sockdologer, and it is now certain that it will not receive its congé: you can only hold back progress for a time, as has been done in the case of the photo-electric gramophone which does not need gramophone discs or a needle, but makes use of a strip of celluloid with a sound track upon it. That will come in time.

For years it has been thought that television would be useful in war, and when the story comes to be told it will be found that it has been of great use in this war. Its particular use in hostilities is for reconnaissance so that the results of aerial survey can be transmitted back visionally and immediately to the generals. Scout cars, for example, equipped with television apparatus could transmit pictures taken by the television camera to their base, and thus the information they are sent out to collect would be received by the commanders even though the car or the aeroplane concerned is captured or destroyed. Of course, somewhat similar results could be obtained by means of radio telegraphy or telephony, but the visual part is of greater value.

### Weighty Equipment

EXPERIMENTS in this direction revealed two important snags. The weight of the equipment necessary was excessive and the definition left a great deal to be desired. As we all know definition has greatly improved, in fact, images can be received which were equivalent to a good photograph, and the weight of the equipment, while still on the heavy side, has been considerably reduced. In any case, mechanisation of the Army has made weight a secondary consideration. It has been reported, although it has not been confirmed, that the Italians have used television for reconnaissance purposes. It is impossible to believe that Great Britain is behind Italy, for we were leading the world before the war in the field of television. Like radio telephony in the last war nothing will be known of what we are doing until the war is over, when television will revert to its original purpose of entertainment. It is known, however, that long before the war methods had been devised for steering vehicles and aircraft by means of television, for the technical press dealt with this. We are all acquainted with the device which provides the navigator of a ship or vehicle with a picture of a compass scale on the end of a cathode-ray tube, and on this compass is marked the bearings of the craft. Thus it would not be necessary for the navigator to understand the morse code.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*Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.*

# ROUND THE WORLD OF WIRELESS

## New Radio Board

MR. OLIVER LYTTELTON, Production Minister, revealed to M.P.s recently that the Government have set up a Radio Board as the supreme co-ordinating body in regard to inter-service radio operations, research development and production. The step has been taken "in view of the great increase in the importance of wireless communication and radiolocation during the war." Sir Stafford Cripps has succeeded Colonel Llewellin as chairman.

## Better Short-wave Reception

SHORT-WAVE reception throughout the world is expected to be clearer this year than for many years as a new minimum phase is reached in sunspot activity. The last sunspot minimum was in 1933, and it is predicted that during the present year the weather should undergo certain well-marked changes.

## German Troops Listen to the B.B.C.

IT is reported from Oslo that because so many members of the German troops in Norway defy orders not to listen to the London radio, all radio sets belonging to German soldiers and officers, up to the rank of captain, have been confiscated by the Gestapo.

## Seven-tongued Broadcast

IT is now revealed that the mystery broadcaster who has been addressing many parts of the world in seven languages from New York is Adolf Menjou. He talks for five minutes in one language, five minutes in another, and so on over the official United States short-wave network.

## Bruce Belfrage and Crooners

WHEN Bruce Belfrage, former B.B.C. announcer, visited the Hayes Round Table recently he answered questions taken at random from his postbag. One correspondent asked: "Why so much or any crooning? All crooners should be strangled at birth." To which Mr. Belfrage replied: "I find it difficult to answer this question, because I agree entirely."

## B.B.C. Variety Dept. Returns

EARLY this year the B.B.C. director of variety, Mr. John Watt, and his immediate staff will be transferred to London from North Wales, where they have been since leaving Bristol two years ago. This arrangement will enable Mr. Watt to be in closer contact with programme direction and with the entertainment world generally.

## More Troops To Broadcast Home

BRITISH fighting men in India and Kenya are the latest to have the chance to broadcast to their families and friends at home.

This new series of message programmes goes out weekly on Mondays. First messages were received from India for the London area, the Midlands and the North on November 23rd and on November 30th the messages came from Nairobi. Subsequently India will broadcast two programmes to Nairobi's one.

Facilities for a radio link between the troops and home have now been extended to many of the areas where British men are fighting.

## New Indian Transmitter

WHEN the Government of India took over the small broadcasting station at Peshawar in 1937, there were only a few villages equipped with communal receivers. The situation has changed and there are now sufficient receivers installed to warrant the erection of a new 10 kw. transmitter, for working on a wavelength of 476.9 metres.

## U.S. Replacement of Valves

THERE appears to be some delay in the release of the American Lease-Lend valves for replacements in "silent" sets which was announced recently. Some difficulty has arisen in connection with the scheme of distribution to ensure that the valves supplied are for the purpose intended.

## B.B.C. Recordings

SEVENTEEN major programmes per week are at present being recorded by the Recorded Programmes Department of the B.B.C. for re-broadcasting at a later date and at a different time of day. This department handles at least 2,000 recording commitments each week

*A Wren wireless mechanic making adjustments to a receiver.*

for the Home and Overseas services. Some 12,000 discs and 50 miles of film are used in recording one month's assignments. It is interesting to recall that in 1933, when the service was begun, only about two recording commitments were undertaken weekly.

## Radio in U.S.A.

ACCORDING to statistics issued by the National Broadcasting Company, 13,800,000 radio sets were purchased by Americans in 1941. It is also estimated that there are more than 56,000,000 receivers in use in the country, where 90 per cent. of the houses have radio sets.

## One-armed Pianists

A PIANIST who lost his right arm might be expected to give up his musical career. Not so Paul Wittgenstein, for whom the great French composer, Ravel, wrote his piano concerto for the left hand. Wittgenstein, a brilliant Viennese pianist, who has frequently visited this country, lost his right arm when he was wounded in the last war. Instead of abandoning his career, he devoted himself to playing with his left hand, and acquired amazing technical facility. In the end he could do with one hand with ease what many pianists find difficult with two.

Listeners heard this work of Ravel's in the B.B.C. Symphony Orchestra's lunch-hour concert on November 27th, conducted by Constant Lambert. The pianist was Douglas Fox, and he, too, lost his arm in the last war, and by a process similar to Wittgenstein's, made for himself a fine "left-hand" career at the piano.

Lambert's scherzo for his own "King Pest" was also in the programme, with Balakirev's Overture on a Spanish March.

### B.B.C. Man Gets the News

THIRTY-TWO-YEAR-OLD ROBERT DUNNETT, B.B.C. correspondent in North Africa, has had an exciting broadcasting career. He interviewed survivors of the torpedoed liner *Athenia*, thus getting the first sea story of the war, described the arrival of H.M.S. *Cossack* with survivors from the *Altmark* and interviewed them, and broadcast one of the most piquant events of the whole war, the flight to England of Hess. Dunnett interviewed the ploughman who picked up Hess. So as to be the first to interview officers returning from sinking the *Bismarck*, he slept all night in a recording car in a lane. Dunnett has also been to sea in a collier, North Sea escort vessel, a minesweeper and Atlantic convoy ship. He was born in Cockburnspath, Berwickshire, a son of the manse, and went to Edinburgh Academy and University. After joining the B.B.C. in 1936, he specialised in topical news stories and sports commentaries.

### "For the Armchair Detective"

THIS new series, written and spoken by Ernest Dudley, is designed for all who enjoy detective fiction. In it Ernest Dudley will give thumbnail reviews of three or four of the latest and most popular detective novels of the week; illustrated with small dramatised excerpts acted by members of the B.B.C. Variety Repertory Company. Dudley will introduce biographical notes on some of the novelists concerned and will talk about a particular detective novel chosen by a celebrity.

### "Bandstand"

"BANDSTAND," this time more varied in scope, is coming back to programmes. It was first broadcast as "Saturday Bandstand," in April last, and ran for six weeks. It returned in August simply as "Bandstand," for six more programmes.

Previously the show has been given by the Revue Orchestra, conducted by Mansel Thomas; now the Revue Orchestra will be combined with the Dance Orchestra, so that items will be played by a straight band and a dance band, or a combination of the two. Anne Ziegler, Webster Booth, Anne Lenner, John Ansell, and Charles Smart, are in the first of the new series. Henry Reed will produce.

### B.B.C. Military Band in Ireland

UNITED STATES and British troops in Northern Ireland gave the B.B.C. Military Band a great reception recently.

The band gave a total of fifteen concerts in the course of a quick and busy tour. Eleven of these were for the Forces and at one of the concerts for United States troops a doughboy introduced himself to P. S. G. O'Donnell, the conductor, and said he had often heard the band playing on the B.B.C. short wave when he was back home. A concert given by the band for the American Red Cross was advertised on the club notice board under the slogan, "What's Cooking Tonite?" A large audience of Navy men took special pleasure in the band's playing of sea shanties. The tour started in Belfast with a public concert at which the Governor of Northern Ireland, the Duke of Abercorn, and the Duchess were present.

### Officers' Radio Training

THE Royal Corps of Signals have their own O.C.T.U. where cadets who have passed the War Office Selection Course are trained under war conditions to fit them as leaders. Basic training, technical training and battle training are carried out in courses lasting about 22 weeks.

In technical training much time is devoted to wireless theory and practice (see illustration on this page). Days and nights are spent with vehicles equipped with most modern sets and maintaining communications.

### B.B.C.'s Woman Dance Band Supervisor

THE B.B.C. have appointed Mrs. Tawny Nielson supervisor of their dance music programmes. One of her first introductions to the B.B.C. programmes will be an all-women's band. Mrs. Nielson, who is well known in the music world, will control the B.B.C.'s four resident bands, which are Jack Payne's, Geraldo's, the B.B.C. Variety Orchestra, and Ivy Benson's All-Women Band. The four bands will broadcast on the Home, Forces, Empire and Overseas services.

### H.T. Battery Prices

THE Board of Trade, after consultation with the Central Price Regulation Committee, have made an Order controlling the prices to be charged by official selling agents, wholesalers and retailers of all high tension dry batteries imported under the Lease Lend provisions. The maximum prices are set out in a schedule to the Order.

The Order provides that all agents or wholesalers dealing in these batteries must supply, either before or at the time of delivery to their customers, a written notice (which can, if desired, be incorporated in the invoice) stating the correct maximum prices for the batteries in question. All retailers selling these batteries must display in a prominent position in their shops a notice giving the maximum price appropriate to any of these goods offered for sale by them.

This Order, which is to be known as the High Tension Dry Batteries (Maximum Prices) Order, 1942, S.R. & O. 1942 No. 2512, came into force on December 10th, and is obtainable on ordering from any booksellers, newsagents or direct from H.M. Stationery Office, York House, Kingsway, London, W.C.2, price 1d.

*Army officers making and testing wireless sets during their technical training course at the Royal Signals O.C.T.U. in the Northern Command*

# Reproducing High Audio Frequencies

## Methods of Dealing With Frequency Distortion to Ensure Quality Reproduction

By S. BRASIER

THE aim of all listeners interested in quality is to reproduce signals from the loud-speaker exactly as it is performed by the artist, orchestra, etc., as the case may be. This state of affairs is unfortunately not yet possible, although tremendous strides have been made both from the point of view of transmission aud reception.

The quality sent out on the B.B.C. transmissions is of an extremely high order, and if every receiver reproduced these signals as transmitted we should not have much to worry about.

The reasons for poor response are due, in the main, to bad receiver and amplifier design. Most constructors strive to ensure that the low notes are amply reproduced, under the delusion that providing this end of the audio scale is satisfactory, then everything is in order. Actually, this is far from correct, and whilst admitting that a good bass response is necessary, the writer considers that good top note reproduction is the all-important factor to pleasurable listening.

High notes give life and colour to an orchestra, "timbre" to a female voice, and personality to a speaking voice, etc. When next you are in a ball-room or concert hall and hear the exhilarating and rather blatant notes of the trumpet or similar instrument, and hear also the clash of cymbals with their tingling vivacity, try and remember the intensity with which these sounds strike your ear, and compare them with similar sounds which emanate from some receivers. Unfortunately, a direct comparison in this case is not usually possible, but if it were you would probably be very surprised at the results. Incidentally, a piano, if you have one, affords an extremely good way of comparing the original with the reproduced.

There are many forms of distortion which can affect the reproduction of the higher frequencies, such as harmonic and transient distortion, combination tones, etc., but it is with frequency distortion that this article deals, since if the frequency response is reasonably level, the resultant effect upon the output cannot be anything but pleasing. If you are a super-quality enthusiast other things have, of course, to be taken into consideration, but real quality costs money, and here we are dealing with the normal domestic receiver that is so often lacking in high note response.

It is surprising what one can get accustomed to in the way of quality. The tone control is turned down to "deep" because it "sounds nice and mellow," and there it is left, irrespective of the nature of the programme matter.

### Tone Control

Tone control can be a menace to reproduction, and were it not for the fact that it is necessary to provide some form of high note cut-off for occasional use, would be best omitted altogether. Much can be done, though, by seeing that the values of the components constituting the tone control system are such that the attenuation is not too severe. In this connection it is not possible to give any definite values, since they depend mainly on the output valve, output transformer, and the loud-speaker employed. It is, however, always advisable to arrange matters so that even when the tone control is turned to "deep," some resistance (about 10,000 ohms) is always in circuit. This might necessitate a larger value of condenser than would otherwise be required. The arrangement is shown in the diagram of Fig. 1, by R4, RV5, and C4.

C4 restricts the output of the higher frequencies by virtue of its reactance, which all condensers connected in such circuits possess. Reactance varies with frequency, so that a .1 mfd. condenser, for instance, at 50 cycles, has a reactance of 31,800 ohms, while at 5,000 cycles the value is only 318 ohms. The effect, therefore, is to by-pass or short circuit the highest frequencies to a large extent, the attenuation decreasing as the frequency becomes lower, until at the bottom end of the audio scale no apparent effect is noticeable. Actually, one receives the impression that the low notes are strengthened, but this is merely due to the fact that they are louder *in comparison* with the now reduced top notes.

The reasons given above are applicable also to the anode by-pass condenser C1 in Fig. 1. Its value should be kept low if high note loss is to be avoided and capacities of .0001 to .0003 mfd. are usually effective from the H.F. by-pass point of view, without affecting the audio range to any great extent.

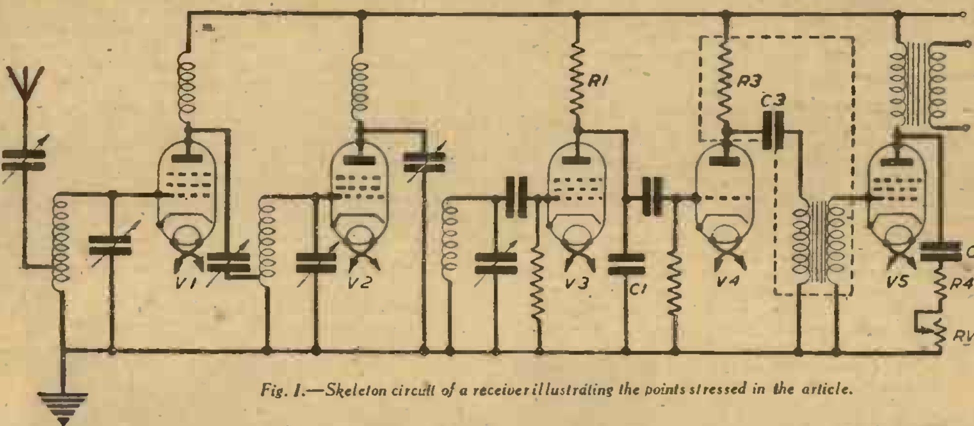



*Fig. 1.—Skeleton circuit of a receiver illustrating the points stressed in the article.*

### Transformers

Most constructors use an L.F. transformer in their receivers, and this component in itself, unless a really good quality one is used, is a prime offender in respect of the subject under discussion. It is better to employ a component of the type which requires to be parallel fed, since the frequency response, when used with the recommended components is infinitely superior. The connections are shown in Fig. 1, the transformer and its associated parts being enclosed within dotted lines. R3 is the load resistor, a function of which is to relieve the L.F. transformer primary of the steady D.C. from the anode of V4. The coupling condenser C3 assists in this operation by holding back the D.C., yet allowing the passage of the audio speech currents to the transformer primary.

Thus the excellent characteristics of this type of transformer can be relied upon. The critical point in retaining the top register is the condenser just referred to, C3. Its capacity should be kept on the small side for this position, say .1 mfd., unless, of course, your receiver is particularly lacking in its bass response also. Almost any value from .1 mfd. to 2 mfd. *can* be used, the *lowest* notes being strengthened as the capacity increases. It is useless to state definitely that this or that capacity will be best for any particular receiver,

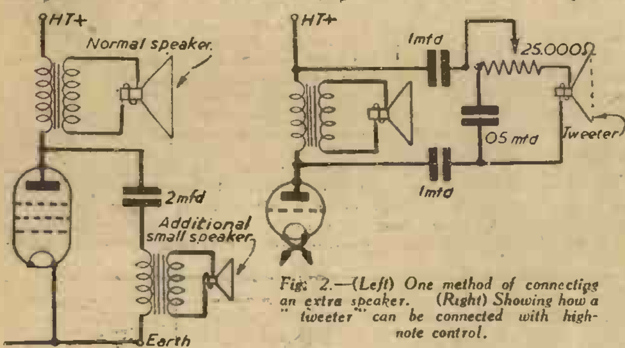



*Fig. 2.—(Left) One method of connecting an extra speaker. (Right) Showing how a "tweeter" can be connected with high-note control.*

since one thing is dependent upon so many others, and the best way of finding the optimum value—unless the design has been extremely carefully calculated beforehand—is to experiment with different capacities. These remarks are also true of the coupling condenser C2 in the R.C.C. stage, where the usual value lies between .002 and .1 mfd. It is somewhat dependent on the grid leak R2, which, in its turn, should be kept low if high-note loss is to be avoided. In fact, all the elements that go to make up an R.C.C. stage have some bearing on the subject. The anode load resistance R1, for instance, if high—a condition required for maximum amplification—may result in some cutting of the treble. Particularly is this so where an H.F. pentode is employed, owing to the valve's extremely high anode impedance, which is virtually in parallel with the anode load resistor.

### Output Stage

Turning now to the output stage, it is essential that the ratio of the output transformer be fairly accurate. For instance, if the ratio should be, say, 75-1, no noticeable difference would be perceived if a 70-1 or 80-1 component were used. This is what is meant by "fairly accurate," but it is not unusual to find some constructors using a transformer with a pentode, which is really only suitable for a low impedance triode. The ratio under these conditions is probably round about 30-1, which would affect quality—and, incidentally, the volume—very considerably.

Most loud-speakers give a reasonably good overall response, but sometimes one comes across a unit that is particularly lacking in its upper register—possibly because it was designed for some special purpose—so that it is well to make certain of this point before condemning the receiver. A thin cone usually reproduces the top notes well, while the bass is accentuated by a thick one, the method of suspension also having some bearing on the matter. However, a comparative test with one or two other types of speaker should prove whether the one under test comes up to expectations. If it does not, there are one or two ways of overcoming the difficulty, apart from discarding the unit altogether.

The use of an additional loudspeaker of small size is an extremely effective and inexpensive method of getting an increased frequency range. A small permanent magnet unit of 4in. or 5in. diameter should be mounted as near as possible to the main speaker, and their speech coils tried first in parallel and then in series in order to find which connections are most suitable.

### The "Tweeter"

It must be pointed out, however, that the resultant impedance of the two coils may necessitate a different ratio output transformer. Another method of connection which is independent of the main speaker is shown in Fig. 2. Of course, if you are fortunate enough to possess, or can procure, what is known as a "tweeter"—which is a special unit for reproducing the very high frequencies—you are in a position to get the very best from a good receiver. The connections of a typical crystal tweeter are shown in Fig. 2 (Right), the results using this combination with a good output being absolutely outstanding.

In addition, there are room acoustics to be considered. The sound from your speaker will be totally different in a room sparsely furnished from what it will in a room with a thick carpet, heavy curtains and heavy armchairs, etc. However, we cannot upset the household arrangements for the sake of our radio enthusiasm, so that the problem must be attacked from the other side of the speaker fret.

One could go on and on talking about this absorbing subject of good quality reproduction, but there *is* one more point of great importance that should be noted before finishing.

### Band-pass Tuning

It is useless to strive to obtain something that is not there, therefore it is well to ascertain that the high frequencies are appearing across the tuned circuits. Fig. 1 shows a tuning system—admittedly not good—that is often used with a two stage H.F. receiver. If these circuits are adjusted so that the receptive band

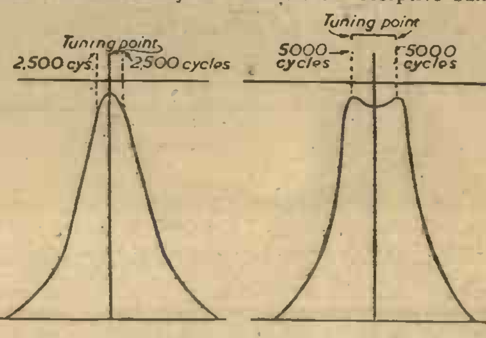



*Fig. 3.—Two curves illustrating high note cut off, and how the response is levelled up by a band-pass system.*

width is inadequate as shown diagrammatically in Fig. 3, good quality reception will not be possible. The solution in this case would be to interpose a band-pass system tuning the second H.F. stage. This alteration would result in increased band width as shown by the square-topped peak arrangement of Fig. 3 (Right). It is also possible for the above trouble to occur where only two tuned circuits are used, as in a single H.F. stage, where they are adjusted for utmost selectivity. A solution would be to either reduce selectivity or apply the band-pass system.

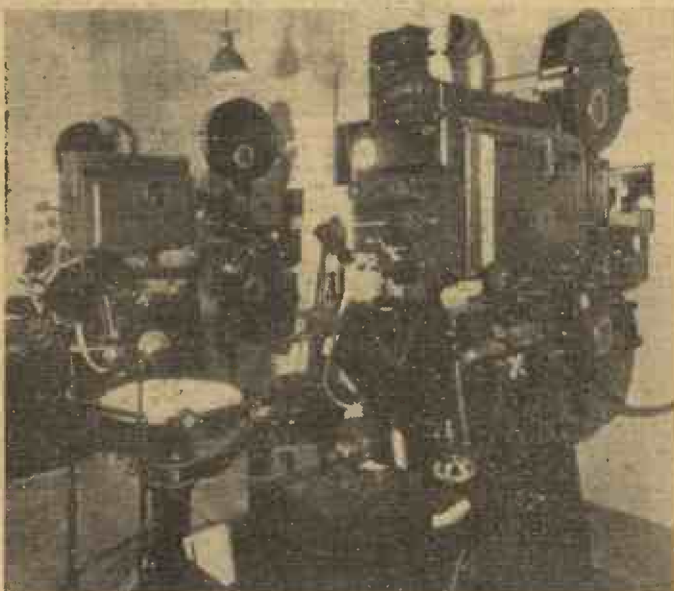
# Maintenance of Talking Picture Equipment

## A Paper Read Before the Institute of Practical Radio Engineers by EDWARD EMMETT

A BREAKDOWN of the talkie equipment in a modern cinema, if but for a minute or so, not only results in financial loss, but loss of some goodwill as well, so that every reasonable precaution is taken to guard against it happening, and this by routine inspection and cleaning by residential staffs or employees, and at intervals by engineers from the particular maker of the equipment in use. Firms such as Messrs. Western Electric, Thomas Houston, R.C.A., etc., usually arrange for a monthly overhaul by their own experts. Where, however, the equipment is the sole property of the owner, and there are many such, an independent engineer is engaged to inspect and maintain the equipment at agreed rates of remuneration; a point worth noting by radio servicemen.

**Regular Maintenance Procedure**

Maintenance, to be effective, must be done systematically and thoroughly. To simply clean soundheads, remove dirt from the outside of amplifiers and then trust to chance and hope for efficient functioning of the apparatus is simply not done. The careful and competent engineer compiles a list of all the parts of the equipment needing inspection—some 30 or 40 in all. Checking against this list is done by noting the dates when last serviced and then re-noting what has been done to date. As examples, such notations might be: Soundheads 15th (month). Cleaned soundgate 16th (month). Cleaned projector heads 17th (month), and so on. Or a chart is prepared on which daily, weekly, fortnightly or monthly operations are clearly shown, with dates, enabling the engineer to see at a glance what has to be done on particular days, when last done, etc.



*The theatre review projection room booth of the sound division at the United Artists Studios, showing the two projection machines and the turntable for the wax records after they have been made and ready to be heard.*

The basic principles employed in the design and construction of sound equipment apparatus are very similar, though an engineer must note any minor or outstanding features, or operational peculiarities on his charts. What may be termed standard sections of such equipment, the inspection, cleaning and adjustment of them will now be dealt with.

**The Soundhead**

A special lamp is used here for the production of the scanning beam, one with a high standard of efficiency but a low standard of "life" term; and since the failure of this lamp during a show results in silence, it gets a daily inspection not only for life but for filament-sagging and envelope-black, two faults causing inequality of production, high settings of faders, and extraneous background noises. Lateral and vertical position is also checked, and should a replacement be necessary care is taken to see that the central contact is clean, flat and that the plunger in the holder is free to move. The relatively high amperage, between 3 and 7 amps., for various set-ups, can cause contact heating at the base of the lamps if not meticulously clean or well pressed together. When a new lamp is inserted, switch on and then adjust the height until the largest possible light-area is got on a card that is held between the photo-electric cell (P.E.C.) and the optical unit. Vertical or lateral adjustment can be effected by the manual turning of knurled screws on the soundhead, these being locked into position when the maximum light-area appears on the card. The life of these lamps may be lengthened if operated slightly below rated capacities. If, say, a 5-amp. rating is specified operation can be satisfactorily carried out with 4.8 amps. applied current.

**Adjustment of Film Guides**

The film has to be guided quite accurately through the soundheads if the scanning beam is to be correctly focused on the soundtrack, the lateral position for it being usually determined by the position of a set of flanged rollers near the scanning point. That of the one nearest the soundtrack is provided with means for accurate adjustment, the other one being free to slide on its shaft to spring-bias in the direction of the adjustable roller and keep the film gently pressed against the adjustable-set one. Inspection of the film position relative to the scanning light beam is best done by aid of a small mirror when the film is in motion, and if this shows the light beam quite steady and in the centre of the track nothing more is done. But should the light get over to one side or the other or the soundtrack weave back and forth across the beam, corrective measures are called for. In a very bad case of this form of trouble, sprocket-hole or frame-line noise is audible in monitor loudspeakers. Such erratic operation may be due to dirt, a faulty roller-spring, an incorrect film-loop between the projector-head and the soundhead, or to a defect in the soundgate proper. If the film passes through the guides and gates properly, yet be out of track with the light-beam, resetting of the lateral guide-roller must be resorted to. On gate-type soundheads the guide-roller shaft is an integral part of the assembly, the rollers capable of being moved in a lateral direction by the rotating of a threaded shaft, adjusted with a screwdriver and a locknut tightened when the adjustment is carried out satisfactorily. It is quite possible to do this even when the film is in motion, as it allows it to be seen in its true scanning position.

**Soundgates**

These, too, need a daily cleaning, and should a "green print"—one that is quite new and not before run—have to be shown, soundgates must be cleaned immediately the film is through. Spring pressure on the gate should be maintained as light as possible, though not so light that it will introduce flutter.

**Optical Units**

Lenses must be kept extremely bright, either soft tissue paper or cotton-wool impregnated with (a spot) of methyl alcohol or spirits being recommended for the purpose. If oil or dirt is on the lenses it is conducive to poor reproduction, loss of volume and possibly complete absence of sound. Usually the optical unit is sealed, in which case it must be cleaned in situ; but if it should be one that can be dismantled the greatest care must be exercised in doing it. A very satisfactory method of focusing these units is to use an output meter and a special length of test film, the latter carrying a continuous I.F. note of a frequency in the neighbourhood of 6,000 c.p.s., the length being made into a loop so as to enable a continuous run through the soundhead. The output meter is shunted across the output terminals of the amplifier, the projector set in motion and the fader control set to half-way. The optical unit is then adjusted until the highest (not lowest) deflection point is got on the meter. Two movements assure accurate focusing, the first being that of the rotation of the slit about the axis of the unit, the correct position being that of right angle to the film edge; the second being the movement of the entire optical unit along its axis until the slit is exactly focused on the emulsion side of the film, a screw, in most units, being available for the purpose. So that, with the frequency film-loop running, rotation is carried out until the high-point reading on the meter is reached, the screw then being locked into position. As a guide, the meter (d.c.) should be some 250 volts.

With no meter available a fairly accurate adjustment can be got by moving the film slowly through the soundgate and observing the soundtrack image on the card held between the optical unit and the P.E.C. as previously mentioned. If the unit is out of focus shadows cast by the soundtrack appear to move up and down as the film moves, this necessitating the finding of a position where the light just blinks without apparent movement in either direction. This position obtained, it can be assumed that the light is fairly well focused on the film when it is stationary. Finally, all rollers, guide-rollers, film-guide rollers, pressure pads, sprockets, etc., must be kept free from oil and dirt. Oil must, of course, be used, though sparingly, in order to avoid gumming due to heat from the exciter lamp housing. An over-application of oil can positively ruin a good film in short time.

**Fader Equipment**

Following through the signal path the fader, or volume control, must be considered, these varying in design from commercial half megohm controls to complicated relay panels with indicators, etc. From the viewpoint of the maintenance engineer, switch contacts here are a trouble-source. The small values of current flowing in the P.E.C. and signal circuit are amplified enormously before reaching the loudspeakers, therefore, any slight imperfection of fader or switch reaches the output as extraneous, magnified noise, the obvious procedure being to keep such parts meticulously clean. For this purpose any of the proprietary switch-cleaning compounds used for similar work on radio receivers, etc., may be used to advantage.

**Amplifiers**

Modern mains-operated amplifiers do not generally give a great deal of trouble, cleaning and valve replacements being, however, routine work. All covers are removed once a month, the valves taken from the sockets, and, with wiring and terminal strips, thoroughly cleaned. All components making up the amplifier network are then closely inspected for deterioration, compound running from transformers, corrosion on electrolytic condensers, etc. The valves are tested and notations taken of the readings as a guide to probable dates for replacement.

Insulated sleeving is placed over any wires that may have become frayed, and thus reconnected to terminals, etc., which must be kept tightened. The neglecting of what may be regarded as trifling matters not worthy of attention can possibly result in a breakdown right in the middle of a show.

**Batteries**

These are used for emergency purposes and lighting, and on some makes of equipment for the supplying of current to P.E.C. lines and exciters. Maintenance work in this respect is quite similar to that undertaken by a battery-charging firm. Charging apparatus is kept clean, charging rates never exceeded, acid kept at defined levels, the specific gravity maintained in accordance with maker's label, and petroleum jelly smeared on accumulator terminals.

*Film printing machine. This is one of the machines on which positive prints of film are made from negatives. The spool at the top left contains raw film, and the one on the right holds the negative. The two strips of film are threaded into the machine so that they are held tightly against one another. They pass over the circular surface in the centre of the machine. A strong light shines through an aperture in this and exposes the raw film to the image on the negative. The raw film then passes to the spool on the lower left, and the negative to the one on the lower right.*

**Motor Generators**

These require special attention, because the running-time may continue for the period of the daily shows. Carbon brushes must be examined at least once every two weeks with the object of replacing any that may have worn down to a minimum of one-quarter the original length. Care must be exercised in the bedding down of new brushes so that the fitting to commutator or slip rings is such that only sufficient pressure is present to prevent sparking on load. Should commutators or slip rings show signs of wear a motor must be taken down and the grooves or worn parts trued up on a lathe, the work being usually done in a local machine shop, and while this is taking place it is sometimes possible to borrow a replacement motor, though having one's own spare is better. The cleaning of a motor entails that of brush gear, keeping brushes free from oil or dirt, and commutator faces—and, in the case of the latter, never use emery cloth; the same cleaner as used for switches is quite suitable, and after cleaning apply a thin coating of petrolatum or petroleum jelly. Bearings should be replaced at approximately six-monthly intervals; insulation tests are also essential at predetermined dates; while starters and control-gear are taken care of according to chart. Where motors are used for curtain hoisting the cables must be kept at an even tension, sliders and pulleys be sufficiently greased so as to take the "pull" from the motor and its component fitments, thus helping to prolong motor life.

**Loud Speakers**

These, one of the most important adjuncts of sound equipment, call for a weekly inspection, each unit being examined—in the "speaker chamber" behind the screen—to see that all termini are tight and in proper position as a guard against loss of volume; a useful piece of apparatus for cleaning loud-speakers is a vacuum cleaner, it being ideal for the purpose of sucking back that dirt or grit filtered through the screen perforations, that lodges in horns, crones and crannies, and cuts down efficient working. A keen sound technician makes it a practice once each day to sit in the body of the hall or theatre, shifting from one seat to another, in order to test the sound for quality and even distribution.

**Breakdowns**

If the inspection and cleaning has been done as here suggested the engineer has every right to consider all reasonable precautions as having been taken to assure efficient working; but, in spite of all this, trouble will, and does, occur at unexpected times. Breakdowns, generally, may be divided into four groups. (1) Complete absence of sound. (2) Sound absent from one projector. (3) Inferior quality of reproduction, to which is allied distortion, low volume, extraneous noise, etc. (4) A breakdown of the soundhead.

(1) and (3) are generally simple types of breakdown often due to incorrect operating procedure; a suggested sequence of suspects being a burnt-out exciter lamp, incorrect movement of film through the projector soundhead, incorrect or trouble in a fader circuit, and a dead amplifier. This series of checks not isolating the breakdown cause, fade over to the other projector and check for sound by recourse to the flickering-card system, and if this machine is "alive" suspect the first projector soundhead, centring the attention on its associated power supply and fader switching. If a switch is at fault, the soundhead is also dead. Next try the non-sync. (gramophone turntable), and if working normally suspect the fault as one common to both soundheads and pointing to the P.E.C., the soundhead wiring, or to a faulty fader. If the non-sync. is silent, suspect either an amplifier or the loudspeakers. Tap the first-stage valve with a flip of the finger or use a short length of rubber rod in an endeavour to get a microphonic response in the monitor loudspeaker, thus proving, or disproving if silent, the condition of the amplifier. If the response is satisfactory, the amplifier is alive and is indicative of the fault being centred somewhere between the tapped valve and the soundheads; otherwise, no microphonic response, suspect the amplifier proper and more especially fuses blown.

To isolate the circuit at fault in the amplifier, extend the valve-tapping from the output stage back through the network until a silent one is located and replaced, the non-sync. being allowed to run during the diagnosis to act as a general signal response for volume, quality, etc. If the amplifier is stil inoperative after a new valve is inserted, its associated circuits of resistors, condensers, etc., need going over to locate the fault, paying particular attention to grid or anode signal-input circuits.

**Low Volume**

Before concluding that the amplifier is the cause of low volume, make sure that the symptom is common to both soundheads and the non-sync.; then see that the loudspeakers are fed with correct energising current values, a quick test in this respect being to test the "pull" of the field magnet poles with a screwdriver. Next rotate the fader controls to note whether or not the signal retains one level regardless of attempted attentuation or amplification. If it does, suspect a faulty fader or a part of the amplifier, in the direction of the input, ahead of the fader. All the valves, rectifier included, are then subjected to checks against operating data.

**Noise and Distortion**

If either is in evidence rotate the fader control and listen for an increase in amplification as the control reaches maximum. If this occurs, assume the fault to be in the signal section and carefully check all points for breakdown of condensers and resistors.

**Soundhead Faults**

Loss of volume from one soundhead—or both—may be due to dirt or oil on the optical lenses, the exciter lamp being loose in its holder, or to a faulty P.E.C. due to poor contact or a broken joint. Another contributing factor to this form of trouble can be emulsion from a film clogging the scanning-beam slit, and thus keeping light from striking the cell. Excluding poor or badly-recorded film, distortion may take the form of "wows" or some other form of accompanying noise. Ripple or high-speed film fluctuations at the scanning point are chiefly due to worn sprocket teeth; while "wows" of slow fluctuation or interval are caused, possibly, from slack pressure on damper pads.

**Emergency Repair Procedure**

Should the mains step-down transformer that feeds an exciter lamp fail during a show, quickly connect the lamp leads to a 10-volt car accumulator kept handy for the purpose; this will get an operator through a show. If the P.E.C. fails on one machine with no spare one on hand, quickly connect up to the P.E.C. in the other machine by joining two wires in parallel from one machine to the other setting the fader at a higher amplification point.

If a mains transformer feeding an amplifier breaks down during a show there is no chance whatever to replace it in the time available, though a useful substitute, for a small amplifier, is to disconnect the filament and H.T. wiring from the rectifier section of the power unit, then reconnect the car batteries for filament heating, and use heavy-duty radio batteries or an eliminator for the anode supply lines.

**Photo-electric Cells**

As previously mentioned, trouble with cells may come from broken leads or a poor nesting of the cell in its holder. When installing a new one great care should be exercised to see that the energising voltage is kept as low as possible. On most cinema amplifiers a separate control, in the form of a potentiometer, will be found fitted for the setting of energising voltage to cells. If this voltage is not kept low, especially on the caesium-type, cells become ionised and become inoperative in a very short time, possibly a matter of hours only. The point is worthy of stress because the cost of P.E. cells for use with sound equipment is a considerable item. Treated properly under normal running conditions the life of a cell can be from two to three years and be in operation from 10 to 12 hours a day, though it is noteworthy to mention that during its working process it gradually falls off in efficiency, necessitating a continual setting of fader controls as compensation.

# An Inexpensive D.C. Eliminator

## To Satisfy Many Requests, We are Reprinting the Constructional Details of an Efficient D.C. Unit Which Will Eliminate the H.T. Battery

THERE are still quite a number of readers in various parts of the country who have access to direct-current mains, but who run their sets entirely from batteries. Apparently the chief reason for this is that they would very much like to convert to "all-mains," but do not care to go to the trouble and expense when they know that existing D.C. supplies will eventually be converted to the A.C. system. Nevertheless, in many districts this conversion may not take place for several years, and in the meantime H.T. batteries are not too easy to obtain. However, there is no reason why at any rate the high-tension current should not be drawn from the present D.C. supply.

Unlike a complete conversion to "all-mains," this can be carried out easily and cheaply and will not only dispense with H.T. batteries but give more power to the receiver.

### For the Cost of Two H.T. Batteries

I think few constructors would hesitate a moment to make use of the D.C. mains if they knew that a compact and highly-efficient H.T. eliminator could be constructed in a few hours for the modest sum of about 30s.

It is designed to meet the need for an inexpensive but thoroughly reliable component which can be slipped inside any battery set in place of the usual 120 or 150 volt H.T. battery. It has a simple control which enables the voltage to be adjusted to the correct figure with receivers taking anything from 10 to 30 milliamps. This is a wide range and embraces the average two- and three-valvers, and also the majority of "fours." It will work from any D.C. mains between 200 and 250 volts.

### No Unnecessary Frills

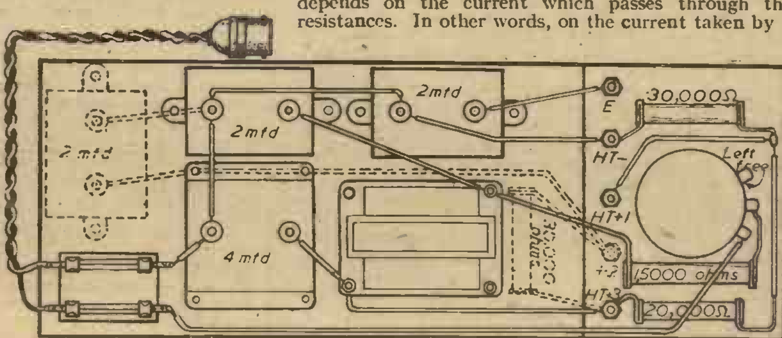
It is common practice nowadays to include decoupling resistances inside receivers, and this is always advisable when working from the mains. Incidentally, if the proper values are chosen they act as voltage-dropping resistances as well, and there is then no need to have more than one H.T. positive tapping. This is why the eliminator described here is not embellished with a multiplicity of tappings as are many commercial instruments. This naturally simplifies its construction and keeps down the expense. Of course, if you wish to include an extra tapping, this can be very easily arranged by the addition of a fixed resistance and condenser, as will be described later. However, there is no point in including these if your set is already provided with all necessary voltage dropping resistances.

In this connection it is a good plan if the receiver has several H.T. tappings to determine before making up the eliminator whether these are all really necessary. If not, you can save the trouble of including extra tappings on the unit. Try connecting all the various leads, with one exception, to the 120 or 150-volt socket of the H.T. battery. The exception is the lead from the screening grid of the S.G. valve, which is usually marked "H.T.+1." This must remain in the 60 to 80-volt socket in which it is usually placed.

Apart from this, all the L.F. and output valves, the detector and the screen-grid valves should all take the full 120 to 150 volts on their anodes. Admittedly, in many sets the detector valve seems to give smoother reaction if plugged in at 80 or 100 volts instead of the full 150, but as there should be a decoupling resistance in the anode circuit of this valve, that should suffice to give the necessary drop. Of course, this resistance may be lacking, in which case one should be incorporated together with the usual 1 mfd. or 2 mfd. condenser; for, as already stated, it is always advisable to provide decoupling when working from a mains unit. If, on the other hand, the set already has this device and the valve will still not stand the full voltage, then the resistance should be increased. For instance, if its value is 30,000 ohms, then replace it by one of, say, 50,000 ohms. This alteration will appeal to most constructors as being cheaper than providing another tapping on the mains unit.

### Suits Small or Large Receivers

The theoretical circuit of the unit is shown overleaf; it is quite simple. The full mains voltage is first reduced to a suitable figure by means of the 5,000 ohms variable resistance, the 1,500 ohms fixed resistance, and the resistance of the L.F. choke (which is approximately 850 ohms). The reason why the variable resistance or potentiometer is included is because the voltage dropped depends on the current which passes through these resistances. In other words, on the current taken by the set. For instance, to supply a voltage of 150 from 220-volt mains requires a drop of 70 volts. If the set only takes 10 milliamps, then a total resistance of 7,000 ohms will be required. On the other hand, if the set takes 20 milliamps, then only 3,500 ohms will be required to give the same voltage drop. By means of the potentiometer the total resistance can be varied from 1,350 ohms to 7,350 ohms, a refinement which is not found in the majority of D.C. units. Thus by adjustment of the control the eliminator will give the correct working voltage with sets of widely differing characteristics.




*Plan view of the unit showing layout and wiring in detail.*

The smoothing arrangements are taken care of by the L.F. choke and the two condensers C1 and C2. The choke can be any reliable make, having an inductance of, say, 25 henries at 50 mA.

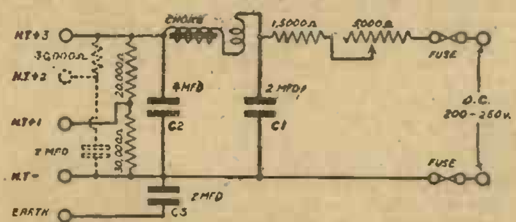
The condenser C3 is used to provide the earth connection for the set. It is most important to note that *with receivers operated from the D.C. mains the earth wire must not be directly connected to the set*, but must be insulated with a good quality condenser. It is usual to incorporate this condenser in the mains unit, as is done here.

### A Tapping for S.G. Valves

The two resistances connected across the output form a potentiometer, which supplies the screen of the screen-grid valve. The values chosen are those which will give about 80 volts with the average valve. If two S.G. valves are used, then the voltage will be slightly lower than with one valve. It can be increased, however, by using a 15,000 ohm resistance for the upper one instead of the 20,000 ohm one shown. Of course, if there are no screen-grid valves in the set then there will be no need for the extra tapping, and the resistances need not be included. Incidentally, this tapping is quite suitable to supply the detector if desired, although it should not be used for both the detector *and* the screen of the S.G. valve.

### The Construction

The lay-out and wiring of the eliminator are quite




*The complete circuit. The component between the choke and resistor is a heavy duty H.F. choke.*

clearly shown by the plan diagram shown overleaf. There is, therefore, no need to go into lengthy details. It will be seen that the overall dimensions, including the control-knob, are only 9½in. × 3½in. × 4¼in., the baseboard being 8½in. × 4¼in. × ⅜in., and the panel 3½in. × 4¼ in. × ¼in.

The quickest way to proceed with the construction is to mount all the components on the baseboard and wire them up as far as possible. Then mount the potentiometer and sockets on the panel. After this, cut all the necessary lengths of connecting wire for joining the components on the panel to those on the baseboard and fix them to the potentiometer and sockets on the panel so that when the latter is placed in position the other ends of the wires only have to be slipped over the terminals of the components on the baseboard and tightened up. You will notice on the plan that one terminal of the potentiometer is left free. This is, of course, quite in order, since the instrument is used as a variable resistance and not as a potentiometer.

### LIST OF COMPONENTS FOR THE D.C. MAINS UNIT

- One Potentiometer, 5,000 ohms, 3-watt type.
- Two 1-watt type Erie Resistors, 15,000 and 20,000 ohms.
- One 2-watt type Erie Resistor, 1,500 ohms.
- Four Plugs and Sockets, Belling-Lee.
- Connecting wire and systoflex.
- Ebonite Panel, 4¼in. × 3½in. × ¼in.
- Baseboard, 8½in. × 4¼in. × ⅜in.
- One L.F. Choke (25 henries, 50 mA.).
- One 4 mfd. Condenser.
- Two 2 mfd. Condensers, 750 volt test.
- One Bulgin Fuseholder, type F16.
- Two Bulgin Fuses, type V.

Just a word about the components. These are all chosen with due regard for the high voltage of the mains and the comparatively large current they have to handle; therefore, no departure should be made from the specification.

The condensers, in particular, should not be rated at less than 250 working volts, while the main fixed resistor, and the potentiometer, should not be of lower rating than those specified. If an extra tapping is desired on the unit as previously mentioned, then the following extra components will be needed:

1 30,000 Eric resistor (1 watt type).
1 2 mfd. condenser (750 volt test).
1 plug and socket.

These are connected as shown by the dotted outline in the plan and in the circuit diagram.

### Operating Notes

The first thing to do when connecting up is to detach the earth wire from the receiver and to plug it into the extreme right-hand socket of the eliminator. There must be no earth connection to the receiver itself at all. Next connect the H.T. wander-plugs in the appropriate sockets. H.T.+1 gives about 80 volts, H.T.+2 (if you have included it) gives about 100 volts, and H.T.+3 about 150 volts. Turn the control knob on the unit as far as it will go in an anti-clockwise direction, switch on the filament current and plug in to the mains. The set should immediately work. If it does not, reverse the plug in the mains socket. There is, of course, a right way and a wrong way round for the plug. If joined the wrong way, the negative side of the mains connects to the plates of the valves instead of the positive, and so the set will not work. Removing the plug, giving it half a complete turn, and reinserting it will immediately put matters right.

### Regulation

If your set is a two-valver, taking about 10 milliamps, then the variable control will most probably need no alteration; but if the set is a three-valver, taking, say, 15 or 20 milliamps, then about half a turn in a clockwise direction will be required to give the full voltage. A set taking 30 milliamps will need the control right over in a clockwise direction. Remember that an anti-clockwise rotation *decreases* and a clockwise *increases* the voltage to all tappings.

## *PRIZE PROBLEMS*

### Problem No. 440

NASH'S superhet suddenly developed a fault. It was operating satisfactorily on the medium-wave band, but when he switched over to the long-waves, no signals could be received. On checking current consumption, he found that a variation occurred when the set was switched to long-waves, returning to normal on switching back to medium-waves. He eventually found the trouble and rectified it, but what do you think it was?

Three books will be awarded to the first three correct solutions opened. Entries should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 440 in the top left-hand corner, and must be posted to reach this office not later than the first post on Thursday, February 14th, 1943.

### Solution to Problem No. 439.

The trouble with Whitworth's set was due to the breaking down of the decoupling condenser. A short-circuit resulted across the H.T. supply, thus causing an excessive current to flow through the decoupling resistor and the H.T. supply, with a consequent drop in voltage across the smoothed output from the rectifier.

The three following readers successfully solved Problem No. 438, and books have accordingly been forwarded to them: J. Harbisher, 21, Thomas St., North Ormesby; J. Robinson, 7, Horner's Terrace, Church St., Whitby; G. A. Kent, 55, Christchurch Road, Norwich, Norfolk.

# Transformer Couplings

## Correct Methods of Connecting L.F. Transformers

By W. NIMMONS

THE ordinary L.F. transformer is often connected wrongly. The result of this is that the particular set concerned is not giving the quality reproduction of which it is capable. It is the purpose of these notes to show how the transformer should be connected.

It is essential to differentiate between leaky-grid and anode-bend rectification. The "phase" of the signals is different in the two cases, and it is impossible for the transformer to do justice to the signals in both without making an alteration to the connections to the transformer. However, since leaky-grid is the more common of the two the remarks will be confined to that form of rectification.

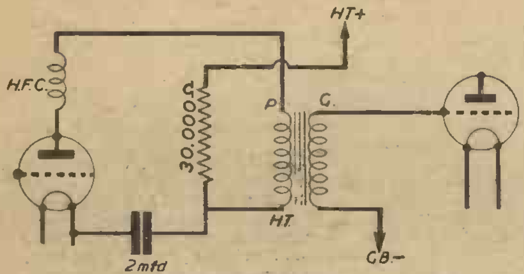



*Fig. 1.—The normal transformer connections when anode de-coupling is incorporated.*

Some years ago there were four markings on the transformer, viz., I.P. and O.P., meaning "in" primary and "out" primary; and I.S. and O.S., which meant, of course, the "in" and "out" terminals of the secondary winding. In some respects this was more helpful than the markings now in common vogue, i.e., P. and H.T. for the primary, and G. and G.B. for the secondary. For it is quite common, as will be shown, that some transformers *should* have the plate terminal connected to H.T. in certain circumstances if the *best* reproduction is desired. It is not intended to deal with two transformers in a cascade amplifier, as this form of construction has been superseded owing to the tendency for the circuit to "howl."

Fig. 1 shows a "straight" transformer coupling between a leaky-grid detector and the output valve, and it will be seen that the anode of the detector valve is thoroughly decoupled, and that the transformer is connected true to its markings. Some transformers seem to be marked in accordance with the procedure which should be adopted when succeeding an L.F. valve, so that the windings are out of step when succeeding a leaky-grid detector. The phase of the signals of a first L.F. stage is the same as that of an anode-bend detector (when succeeding a leaky-grid detector) and such a transformer would be perfectly O.K. if, for example, a stage of resistance-capacity coupling were used between the leaky-grid detector and the first L.F. valve and the transformer were used to couple this valve to the output valve. But when it is used directly after the leaky-grid detector the plate terminal of the transformer should go to H.T. Though the owner of the set may not be conscious of anything amiss, and in fact the set may be perfectly stable, careful listening with the primary leads reversed will show that there is a considerable improvement in the reproduction.

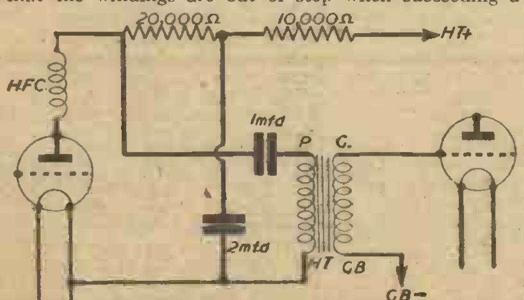



*Fig. 2.—In this case the transformer is parallel-fed, thus eliminating D.C. from its primary.*

**Alternative Methods**

There are two other methods of connecting an L.F. transformer, however, which show a considerable improvement over the straight coupling, namely, parallel-feed and auto-coupling. Figs. 2 and 3 show these two methods. In parallel-feed, as will be seen, the primary is fed through a large condenser from the detector anode, the other end of the primary going to the earth line. In the auto-coupled circuit the condenser goes to a tapping on the whole winding (conveniently arranged by connecting the primary and secondary together).

In most cases the plate marking on the transformer will go to the condenser, in the case of parallel-feed, the H.F. marking going to the earth line. In a few cases, however, depending on the make-up of the transformer, it may be desirable to connect the H.T. marking to the condenser. No definite ruling can be given on this point. It is recommended that a reasonable time should be given to both systems of connection, say a week for each, as it is difficult to judge the results on one transmission alone. Very often, too, it is possible to prefer the inferior results at a first hearing, but when one has become accustomed to the definitely superior reproduction given by a transformer in the correct phase one would not tolerate the other.

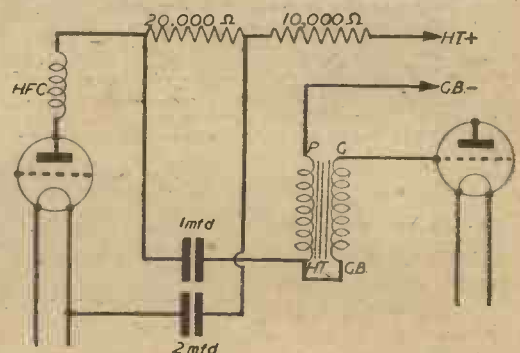



*Fig. 3.—By altering the connections to the transformer, auto-choke coupling is obtained.*

The auto-coupled method is somewhat similar to parallel-feed, but in this case one has to be careful when connecting the primary to the secondary to secure the correct relationship. Here again no definite ruling can be given, since, as we have seen, some transformers are designed to follow a leaky-grid detector while others are designed to come after an L.F. valve. One can begin by connecting the plate terminal to the grid-bias terminal; the remaining two terminals, grid and H.T., go to grid and grid-bias respectively. On the other hand, one might connect H.T. and grid-bias together, thus leaving grid free for grid, and plate for grid-bias. In both cases the connection from the preceding valve via the large condenser goes to the junction between the primary and secondary.

**Varying Ratios**

It is true that one can get two ratios by using one or the other of these methods, i.e., 1-4 or 1-6 with a 1-5 transformer. But both cannot be in the correct phase relationship, and one or the other must give inferior reproduction—perhaps not noticeable on all transmissions, but always there. The piano, the harp, the organ will all show up any false colouring, and it is therefore recommended that a reasonable time should be allowed to elapse before coming to a decision in the matter of the correct connections.

In any case, both parallel-feed and auto-coupling will be found to be a great improvement on the straight transformer coupling, not only on account of the fuller bass response but in respect of the all-round "cleaning-up" of the signals. This is due to the fact that no direct current flows through the transformer primary, but only the L.F. impulses from the preceding valve.

In conclusion, it might be interesting to mention that the best reproduction the writer ever heard was achieved with a Ferranti AF3 parallel-fed transformer, the plate terminal going to the earth line.

# The Useful Life of Valves

SEVERAL queries recently received from readers indicate the fact that many listeners fail to realise that the valve is not a permanent part of a radio receiver, and that, apart from the fact that it gradually deteriorates, accidents in connecting up or testing a receiver may very seriously impair the efficiency and shorten the life of a valve. The queries in question are:

1. "My output pentode glows with a blue incandescence which varies with the music. . . ."

2. "I switched on but no signals or hum came from the loudspeaker. After a few minutes I raised the lid of the cabinet and was surprised to see that the pentode was red-hot. . . ."

The solution to the first query is generally the fact that the receiver is being operated without H.T. for a considerable period of the testing-time whilst the set is being installed, and the result is that the output valve has become "soft." In the second case it eventually transpired in one instance that no loudspeaker was connected to the set, and thus there was no load for the output valve (a mains pentode). Consequently, owing to the considerable wattage dissipation from the screen which resulted, the entire electrode assembly had become red-hot and the life of the valve was not only considerably reduced, but less than half the normal output was obtainable when the receiver was subsequently correctly connected up.

**Correct Operating Conditions**

Most valve manufacturers give a guarantee of a definite life to a valve, and this means that when used under correct operating conditions it should provide for that period the anode current, wattage dissipation, and other characteristics which the makers state for that particular valve. The care which is taken at the factory, not only in assembly but in testing, prevents all but a very few defective valves from finding their way into the hands of the listener.

Therefore, the listener may be reasonably certain that when the valve is plugged into his receiver it will give good service for a definite period of time. Owing to the method by which a valve functions, however, there is a gradual deterioration, or falling-off in performance. This is so slight that it is not noticeable and after, say, six months' use the receiver appears to give exactly the same performance as when first installed. The same remarks apply at the end of the year's use, but by that time, if a set of brand-new valves of exactly similar characteristics is used in place of the old ones, a remarkable improvement in performance will be noticed. We do hear of cases where a constructor proudly boasts that he has had the same set of valves for three years, "and they are still as good as when I first bought them." Unfortunately, this cannot be true, as the valve is what might be called a "perishable" article, that is to say, from the moment the filament or cathode is heated something is being used, and this is not put back in any way, so that in time they must become "worn-out."

**Points to Guard Against**

The useful period of life above referred to may be very considerably shortened if the valve has become damaged due to wrong connection, mechanical shock, etc. Some of the points, although at first sight do not appear to have any effect on the life of a valve but which may prove of great importance, are now given.

In a battery receiver it is essential that the H.T. be applied whilst the filament is alight. When trying out a new circuit, therefore, make quite certain that the anode circuits are complete if the L.T. is switched on. Although running the filaments alone for a few minutes only may not make much difference, if allowed to glow for a long time the valve may become soft. This is because when the normal anode current is flowing there is a kind of "cleaning-up" effect which acts on the residual gases in the valve envelope, and without this useful effect the degree of vacuum is modified, with the result that softening takes place, and in the output valve in particular it is denoted by the blue glow referred to in the opening paragraphs.

In the mains receiver it is not usually possible to run one supply without the other, but in the event of a broken H.T. supply circuit the same remarks apply.

When first installing a mains receiver, or when carrying out experiments, take particular care to plug the valves into the correct holder. At first it may not appear to be a very serious matter if the wrong holder is employed, but a moment's thought will show that in some cases serious damage can be done. Take, for instance, the case of an A.C. receiver employing a directly-heated pentode. If an ordinary triode is plugged into this holder there will be a positive voltage of about 150 to 200 applied to the cathode (the centre pin) with disastrous results.

**Overloading**

Another little-known point relates to overloading a modern high-slope valve. In the case of an output pentode of this type the application of a very large signal will cause considerable transient anode-voltage surges, and if an inductive anode load is being employed these may rise to as much as five times the steady anode feed voltage. This may cause what is known as a "flash-over" inside the actual valve, breaking down insulation, impairing the vacuum, and in an extreme case actually causing the glass envelope to fracture.

Other points, such as incorrect voltages caused by wrong connection or broken-down resistances and condensers, will, of course, occur to the average constructor, and it should be unnecessary to point out that short-circuits, either accidental or intentional, can result in irreparable damage, both to valves and other components.

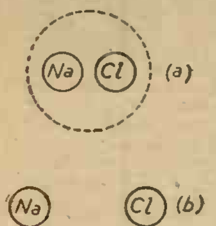
# Elementary Electricity and Radio—1

## The First of a New Series of Articles Explaining the Fundamental Theory of Electricity and Radio

By J. J. WILLIAMSON,

ALL matter can be resolved to molecules, atoms and electrons and protons. In Fig. 1 a molecule of common salt (sodium chloride) is shown; a molecule being defined as "the smallest part of a substance that can exist whilst still retaining its chemical properties." Thus, splitting our molecule of salt gives us two entirely different particles or atoms of substances which are completely unlike common salt, i.e., sodium and chlorine.

Taking a simple atom, helium (Fig. 2), we see that it is built up of electrons and protons. Protons are positive and electrons negative in electrical charge. Likes repel, unlikes attract; thus a proton repels a proton, but attracts an electron, and vice versa. The electrons revolve around the nucleus in a definite orbit and are therefore called "orbital" electrons. The nucleus of an atom is always positive, thus in Fig. 2 we have four protons and two electrons, giving a total charge of two positive charges, which account for the presence of the two orbital electrons, making the atom neutral as a whole. The electrons in the nucleus are known as "bound" electrons.



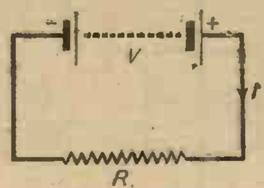




*Fig. 1.—(Above) Showing how the chemical properties are altered when the molecule is split up. Fig. 3.—(Right) Illustrating Ohm's Law.*

### Free Electrons

In most substances orbital electrons are often "freed" from the parent atoms by disturbing forces, and wander haphazardly in the relatively vast spaces of the atomic atmosphere, until recaptured by atoms deficient in orbital electrons (positive ions). If these free electrons can be made to drift in one general direction, all the effects of an electric current appear. Therefore, an ordered drift of free electrons is an electric current.

### Conductors and Insulators

Obviously, the greater the number of free electrons available, the greater can be the drift of those free electrons, i.e., the greater the current possible. Therefore, a conductor is a substance which is rich in free electrons, whilst an insulator is poor in free electrons.

### Electron or Electro-moving Force

Electro-moving force or E.M.F. is analogous to a pump's pressure in a water system; the pressure of water-moving force causing the flow. The force or pressure in an electric circuit is maintained by molecular and atomic differences, in the case of E.M.F. being provided by chemical means, and by magnetic effects in the case of dynamos.

The Unit of Pressure or E.M.F. is the Volt.

### The Unit of Quantity

In just the same way that a pint of water contains a definite number of drops, so does one coulomb of electricity represent $63 \times 10^{17}$ electrons.

The Unit of Quantity is the Coulomb.

### Rate of Flow

To some readers a pint of liquid may not mean much; what really matters is the rate of flow or the number of pints consumed per hour. As these readers must agree, the effects of different "rates of flow" are very definite. We could express a pint per hour as P/H and give the resultant units a name. In the same way Coulombs per second gives us the *Rate* of flow of the free electrons and the resultant units we call amperes. An increase of current does not imply an appreciable change of *speed* at which the electrons are moving, but refers to a greater *number* in movement, i.e., more electrons become "free" with an increase of potential difference.

$$\text{i.e.,}\quad Q \Big/ \frac{(Coulombs)}{t\,(Seconds)} = I \;(Amperes).$$

Thus the unit of rate of flow or current is the ampere.

### Resistance and Ohm's Law

If we compare the pressure (*Volts*) with the rate of flow (*Amperes*) in a circuit, we shall find that when the voltage increases so does the amperage increase in the same proportion.

i.e., $V \propto I$.
thus: $V/I = $ a constant.

The constant, or relationship between voltage and amperage, in a circuit is a measure of the opposition the circuit offers to the electron drift, and is termed the resistance of the circuit, denoted by the symbol $R$, and measured in ohms ($\Omega$—omega).

The Unit of Resistance is the Ohm.

The relationship $R = V/I$ is called Ohm's Law, and can be stated in words as:

The current in a circuit is directly proportional to the voltage and indirectly proportional to the resistance. i.e., $I = V/R$, also $V = IR$.

In Fig. 3 we have $R = 10$ ohms, $V = 40$ volts. Therefore, by Ohm's Law, the current which 40 volts would drive through a resistance of 10 ohms would be:

$I = V/R = 40/10 = 4$ amperes.

In Fig. 3, let $I = 6$ amperes, $R = 9$ ohms; thus the

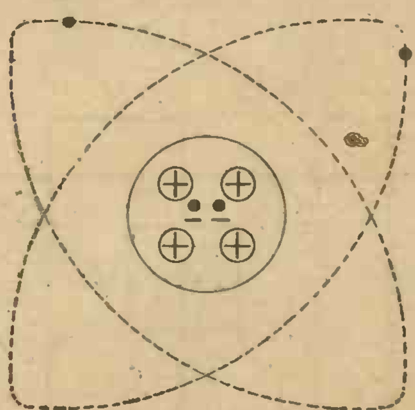


*Fig. 2.—An atom of helium. The nucleus contains protons and two "bound" electrons.*

voltage necessary to drive 6 amperes through 9 ohms is ($V=IR$), 54 volts.

In Fig. 3, let $I=20$ amperes, $V=10$ volts; thus the resistance in the circuit which permits 20 amperes to flow when 10 volts are acting, must be ($R=V/I$), ½ ohm.

### Practical Definition of Resistance

Resistance can be expressed in more practical terms than $V$ and I; for example, the length of the path through which the current travels ($l$); the material ($\rho$-*Rho*), and the cross-sectional area of the current's path ($A$).

Obviously the longer the path of the current the greater the opposition encountered; whilst the greater the cross-sectional area the more electron drift is possible, thus the resistance must be smaller.

The factor $\rho$ accounts for the natural resistance of the material, i.e., number of free electrons available, or rather, a measure of the lack of free electrons; and is obtained by placing a voltage across a standard size cube of the material to be tested, noting the current which passes, and then using Ohm's Law to give the resistance, the resulting value being termed the specific resistance for that substance,

i.e. $\rho$ for Copper $=0.63\times10^{-6}$ ohms.
Lead $=7.8\times10^{-6}$ ohms.

From the foregoing:—

$$R=\rho l/A=\frac{\text{(Specific Resistance} \times \text{Length)}}{\text{(Cross-Sectional Area)}}$$

The resistance of materials alters with temperature changes, thus $\rho$ is usually taken at 20 deg. C. and a temperature correction applied for other values.

### Current-carrying Capacity of a Conductor

Certain practical considerations now become necessary. For example, how much current can a conductor carry?

The current-carrying capacity of a conductor is largely determined by the resistance of that conductor, inasmuch as the passage of current through that resistance involves the generation of heat and that the amount of heat that can be tolerated is limited by the melting-point of the wire, if low; or the danger of fire or damage to the wire's insulation. Thus, the lower the resistance of a wire the more the current that can flow without causing excessive heating.

From the formula, $R=\frac{\rho l}{A}$, it can be seen that if we wish to increase the current-carrying capacity of a wire or cable, we must (1) make it thicker, or (2) use a material of lower specific resistance. The length of the cable is usually determined by the purpose for which the cable is required.

### Fuses

A fuse consists of a piece of wire, the current-carrying capacity of which is purposely limited to a predetermined "safe" value. The amount of heat generated in the wire for a given current is so calculated that the temperature of the wire reaches its melting-point when the current increases beyond the "safe" value.

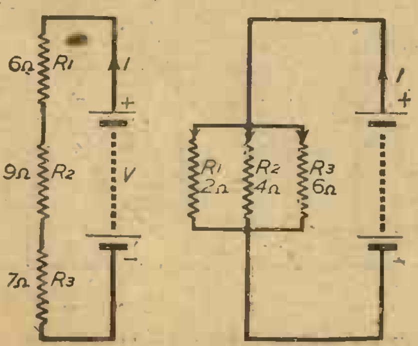



*Fig. 4.—Resistors in series and (right) parallel.*

As will be seen, if the fuse is placed in an electric circuit in such a way that all the current flowing must pass through it, then as soon as the current flowing reaches a dangerous value the fuse will melt and effectively break the path of the current, thereby safeguarding any apparatus included in the circuit. Thus, we have only to replace a short piece of fuse wire, instead of some expensive piece of equipment.

### Methods of Connecting Up Apparatus

There are two methods possible in connecting up pieces of apparatus, namely, series and parallel connections.

Instruments in a series circuit have a common current flowing through them.

Instruments connected in parallel have a common voltage acting across them.

The resistances in Fig. 4 (*a*) are in series; in Fig. 4 (*b*) in parallel.

An ammeter placed anywhere in (*a*) would read the same value, but not in (*b*).

A voltmeter placed *across* any of the resistances in (*b*) would read the same, but not in (*a*).

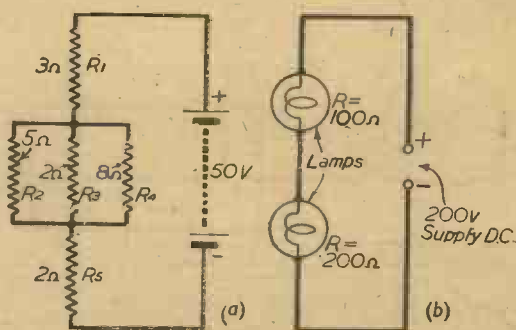



*Fig. 5.—Illustrating series and series-parallel connections.*

### The Addition of Resistances in Series or Parallel

When resistances are connected in series, the total resistance in the circuit is the sum of the individual resistances. In Fig. 4 (*a*) the total resistance is 22 ohms.

Resistances connected in parallel have a total resistance defined as:

The reciprocal of the total resistance is equal to the sum of the reciprocals of the individual resistances:

$$\text{i.e. } \frac{1}{R_t}=\frac{1}{R_1}+\frac{1}{R_2}\text{ etc.}$$

In Fig. 4 (*b*)

$$\frac{1}{R_t}=\frac{1}{2}+\frac{1}{4}+\frac{1}{6}$$

$$=\frac{11}{12}$$

$$\text{but } \frac{11}{12}=\frac{1}{R_t}$$

$$\text{therefore } R_t=\frac{12}{11}=1\frac{1}{11}\text{ ohms.}$$

### Potential Drop Around a Circuit

If we have a series of resistances, as in Fig. 4 (a), and calculate from Ohm's Law the voltage "dropped" or available across each, we get

$I\times R=12$ $I\times R_2=18$ $I\times R_3=14$

showing that the voltage of the battery or supply is divided around the circuit in proportion to the values of resistances encountered. These differences of pressure across the resistances are referred to as $IR$ drops or *P.Ds.* (potential differences).

*(To be continued.)*

# A Component Tester

## Details of a Simple Unit for the Constructor

By F. G. RAYER

IF used as directed, the novel unit here described is capable of a surprisingly large number of tests. It will immediately show if condensers—of any normal capacity—are open, or partially short-circuited. Resistances up to 6 MΩ may be tested for open circuit; similar high resistances, such as inter-electrode leakage in valves, will also be unmistakably shown. There is no possibility of confusing capacity with resistance or vice versa in any component or circuit under test. The unit can be built cheaply and easily, and when the user is familiar with its mode of operation the apparatus is extremely simple to use.

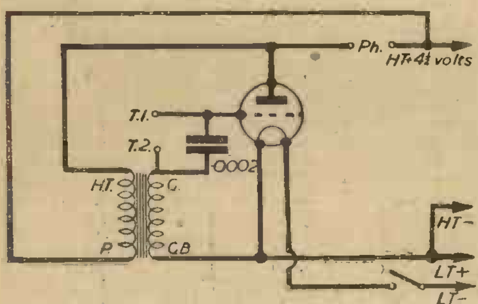



*Fig. 1.—The L.F. oscillator which forms the basis of the tester. It is inexpensive and simple to construct and, as this article explains, it has many uses.*

### Circuit Details

The circuit of the unit is depicted in Fig. 1; it is a simple L.F. oscillator. It should be noted that the .0002 mfd. fixed condenser must be of the mica-dielectric type. The transformer connections shown are correct for the Ferranti type A.F.3; with other makes the primary connections may need to be reversed.

A 4.5 volt battery is used for the high-tension supply, and a 2-volt accumulator provides the necessary filament voltage. Alternately, a 3-volt dry battery can be used with a 10 ohm series resistance (this presuming the filament rating of the valve to be .1 amp.). If a wooden case is used the point T.1 must be insulated from the wood—connecting point T.1 to the wooden case will cause the instrument to give indication of the leakage caused.

### Operation

Two insulated test-prods should be connected to the points marked T.1 and T.2. Upon switching on the unit a steady purring sound should be heard in the phones. The H.T. voltage should be adjusted until this result is obtained. Tests are based upon the following facts: Any resistance connected across the test-prods will increase the frequency of the oscillations; any capacity will decrease the frequency of the beats—unless the condenser in question leaks. A few trials with the instrument will demonstrate the results obtained:

Apply the prods to a 5 MΩ leak. The oscillations will become a steady drone, if they do not the leak is open-circuited. It will be found that leaks of, say, 2 and 3 MΩ can easily be distinguished apart. If a condenser of, say, .0001 mfd. is contacted the frequency of the beat will fall; if it does not the condenser is open-circuited; if it rises the condenser leaks. A few tests with odd condensers and resistances will show the operator what to expect in relation to various components.

### Receiver Testing

The following are some of the tests which can be carried out in conjunction with a receiver such as that shown in Fig. 2. All batteries should be disconnected from the receiver under test. The oscillations given below are taken from an actual receiver, for examples. Test prods contacting:

Earth and point 1 = 7 beats in 5 seconds.
Earth and point 2 = Nearly 3 beats per second.
Earth and point 3 = Beat every 4 seconds.
Across speaker output = 5 beats per second.
Across secondary of L.F. transformer = High whistle.
Across detector grid leak and grid condenser; H.F.C.; anode resistance, etc.—these all give distinctive notes which prove the components to be in order or otherwise.

Switches may be tested for leakage when in the "open" position. If the prods are applied to the primary of the transformer used with a moving-coil speaker it will audibly oscillate if in order.



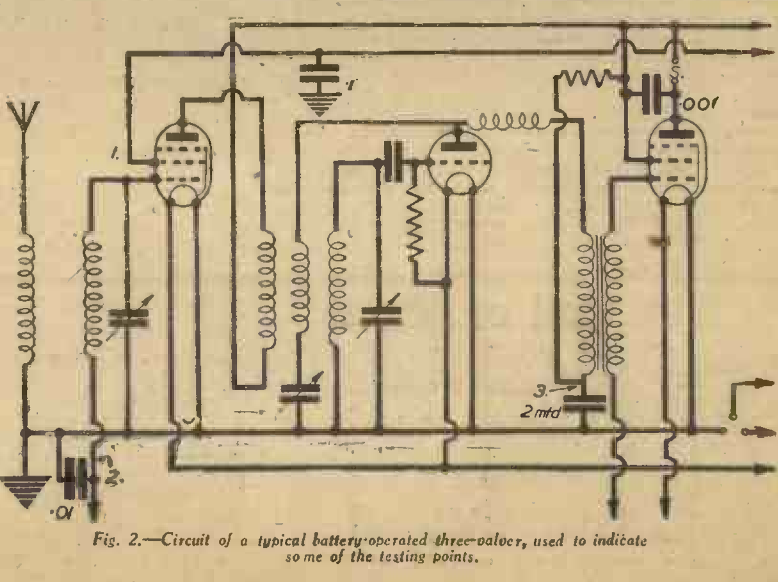



*Fig. 2.—Circuit of a typical battery-operated three-valver, used to indicate some of the testing points.*

# ON YOUR WAVELENGTH

*By THERMION*

**The Mathematics of the Major Scale**

MR. K. SPROXTON, of London, thinks that a number of questions on the major scale which I asked in the November, 1942, issue, can be easily answered, but we may have to wait a long time for the answer to some of the others. He thinks, and I agree, that a chair of musical psychology at one of our universities is very long overdue. He says that the leading European authority on this subject was Helmholtz, rightly called the Father of Sound. In this country Prof. Gladstone will probably rank as the leading exponent of mathematics. Prof. Gladstone was the son-in-law of Ramsay MacDonald. There does not seem to be any explanation which would account for the arrangement of the major scale. The intervals used appear to be arranged quite arbitrarily, but one cannot deny that they seem quite natural to us. Ninety-nine per cent. at least of the melodies enjoyed by Europeans, and people of similar culture, are written in the diatonic scale—either major or minor. He goes on to say that I imply that there should be a sharp between E and F (also between B and C), but these notes are, in fact, only a semitone apart, so that to put a note in between would mean introducing quarter tones. It is curious that in some of the less civilised parts of Europe—Scotland, for instance—even semitones were until quite recently hardly used. Were Scottish ears not delicate enough to detect such a small change of frequency as a semitone? If you disbelieve this statement, sing over to yourself some good Scottish air like "Ae Fond Kiss" or the better-known "Auld Lang Syne," and notice that there is no interval in either melody less than a whole tone.

**Bach**

THE octave from C is divided into equal periods on a properly tuned keyed instrument, always remembering that it is a question of ratios and not of actual distances. The real inventor of "equal temperament" does not appear to have been identified, but the pioneer was, of course, Bach, who championed this system against the claims of the rival systems of "mean tuning" and "just intonation," which latter systems remained in use in this country for more than a century after Bach's death—so slowly did news travel in those days. Bach it was who showed that by slightly flattening the fifths, and grossly sharpening the thirds, all keys could be made available to a player on a keyed instrument.

Bach clinched the argument with his famous "48 Preludes and Fugues"—the musician's "Bible"—in each half of which he proceeds systematically through every possible major and minor key from C to B.

Bach and his forerunners probably had no knowledge of the underlying mathematics of "even temperament." It was a matter of trial and error, solved in a business-like way and giving the desired results.

We do not need the help of professors to grasp some of the simplest of the mathematical difficulties. Three major thirds make an octave, which is the two-to-one ratio, and the only ratio which must be kept exact. Now major thirds are in the ratio of five to four. We can, therefore, test for ourselves whether three five-to-four ratios give us the octave or two-to-one ratio.

Starting from C the major thirds would be:

C—E—G sharp—C,

and, if we call C—1, then E must be 5/4, G sharp (to be in the same ratio) must be 25/16, the top C will be 125/64. This clearly will not do at all, as the octave from 1 must be 2 (128/64). This is why the tuner has to sharpen all thirds almost to the limit of tolerance. The human ear, even when it has a very imperfect sense of absolute pitch, is extraordinarily fastidious about any harmonic irregularities. The actual discrepancy between the true ratio and the compromise which the tuner must use looks small on paper. If we start with a frequency of 100, then theory demands that the first major third shall be 125. Actually, the tuner will make it 126 (or very nearly), and in three such jumps, all of the approximate ratio of 126/100, we reach the perfect octave. (Note that the experienced tuner sharpens even the octaves in the top register. If he did not, then for some obscure reason, the instruments would sound dull and insipid.)

**Stroboscopic Methods**

ONE development of tuning can be predicted with confidence. It is almost certain to be controlled by stroboscoping methods in future. At present it takes seven years to make a good tuner, and it should be possible to curtail considerably this long apprenticeship with improved apparatus.

There is, however, a great amount of research to be done before we can hope to understand even some of the simplest phenomena associated with music.

Well, it has been a most interesting discussion, and I hope the facts I have been able to elicit for the correspondent who raised the matter will satisfy him.

**Taffy's Tirade**

PRESS Item.—Thermion says: Heaven help us if we speak in the Welsh lingo or patois. Such lingo is more likely to promote wars than peace. I am merely being facetious, of course, but you get my meaning!

For shame for you-arself, Mistarr Thermion!
'Teet to gootness! And why wass you porn?
Wass you not know that Wales, sirrr,
Wass Wales pefore England wass porn?
Llanvairpwllgwyngwllwyndrobll-
Gogerochllantysillioggogoch!
There wass a language, look you!
One word, but it means quite a lot!
There wass Druids and Bards
Before editorrs came,
So they tell me, and that's why you-ar mad!
I shouldn't wondarr because you wass jealous,
And write things that Welshmen think bad;
We think that you ought to be punished,
And such critics ass you we should squelch!
A horrible sentence you richly deserve,
To publish you-ar paparr in Welsh!

Chorus of furious and indignant Welshmen: Inteet to gootness, this wass perfectly right, look you! Nevarr wass such ruteness to Wales pefore, so they tell me. Horrible pains to you, Mistarr Thermion, and many of them! And if effer you try to speak one word of our peautiful Welsh language we hope that it preaks you-ar nasty rude Sassenach jaws for you whateffer!

"TORCH."

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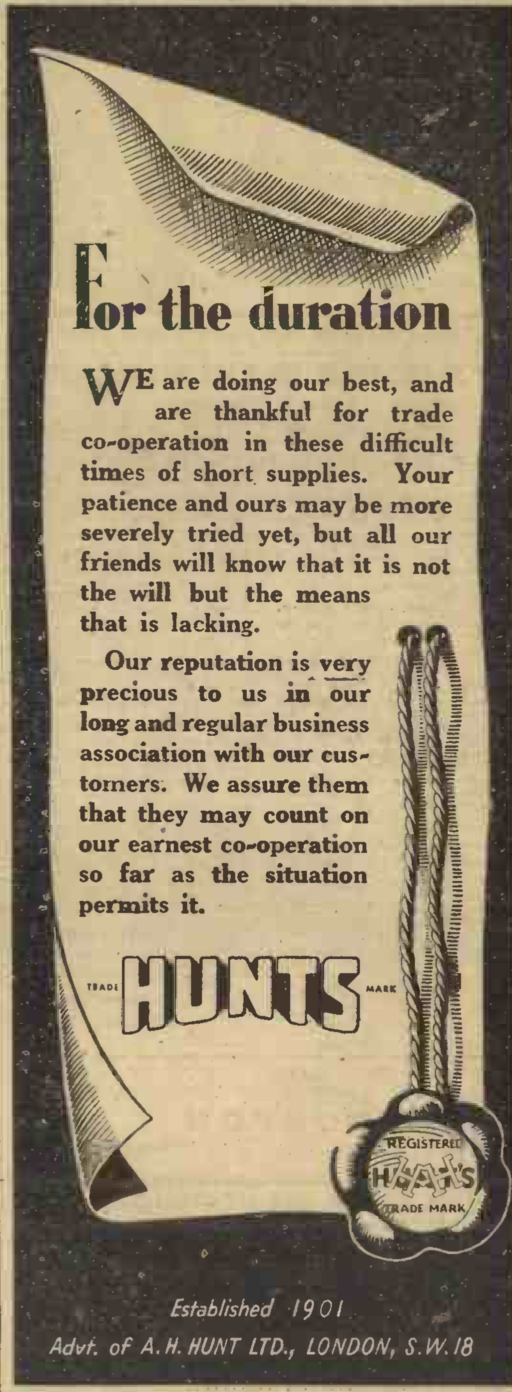


# Transmission Lines

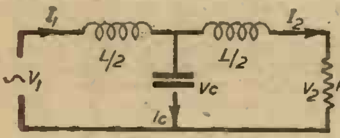
## Phase Relations and Current Considerations. By S. A. KNIGHT

BEFORE proceeding with transmission lines proper it is perhaps necessary to briefly run over the phase relations and the phase lag experienced in a typical low-pass T-section, described in detail in the previous article.

Consider Fig. 1 and its vector representation Fig. 2, drawn with $V_1$ and $I_1$ in phase and $V_L$ equal to $wL/2\ I_1$, leading $I_1$ by 90 degrees. Completing the parallelogram, it becomes clear that $OB$ represents $V_c$ since $V_1$ is, by Kirchoff, the vector sum of $V_2$ and $V_c$.

$V_2$ is in magnitude equal to $V_1$ and the voltage discharged across the second half of the coil is $wL/2\ I_2 = wL/2$. $I_1 = V_2$. Therefore the triangle $OBC$ can be drawn, since we already have one side and know the lengths of the other two.

Having thus obtained $V_2$, $I_2$ can be drawn in phase with it.



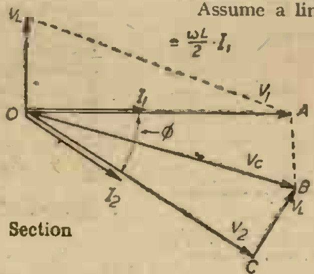




*Fig. 1.—A low-pass "T" section filter together with Fig. 2, its vector representation of phase relations.*

### Factors deciding $\Phi$, the Phase Lag per Section

$$\tan \Phi/2 = V_L/V_1$$
$$= wL/2.\ I_1 \div I_1 R_k$$
$$\therefore \tan \Phi/2 = wL/2R_k$$

### Transmission Lines

We are primarily concerned with the particular manner or properties evidenced by long lines; lines, that is, which are comparable in length with the wavelength of the transmission they convey, i.e., a line 50 miles in length is short when conveying 50 cycle supplies, since the corresponding wavelength is very roughly 3,700 miles, but a line 12ins. long conveying 1,000 megacycles is a long line, since it is approximately 1 wavelength long.

Consider a line of infinite length. If a generator is attached to it, in general a current will flow, i.e., the generator experiences a load when the line is attached, this load being $zk$ where

$$zk = V_1/I_1$$

Thus, the line does not behave as an open circuit; each element of it has resistance, leakance, capacitance and inductance, and these are distributed; that is, they are not located at any specific points along the line. Consequently, it is possible to represent each element of the line electrically as in Fig 3, a and b. The second figure is clearly a low-pass filter section with losses, and if these latter are neglected the figure becomes as in Fig. 4, where the line is represented by a ladder network.

When an infinite line is connected to a generator the generator experiences a load $zk$, as we have seen. If now we cut from the line a finite portion $AB$ of any length and the remainder of the line is reconnected to the generator, the impedance the generator looks into will still be $zk$. If the generator is attached to the finite portion, however, the input impedance will not be $zk$. It can be made so by (1) replacing the rest of the line, (2) terminating the line with $zk$.

Now (2) is true no matter what the length of the finite portion, since this portion is effectively a series of $LP$ filter sections, and $zk$ is that impedance which will properly terminate such sections. With this proper termination the generator cannot distinguish between an infinite line and a finite line so terminated. The properties of an infinite line can, therefore, be manifested by a properly terminated finite line.

Assume a line to have inductance $L$ per unit length and capacitance $C$ farads per unit length. Then, taking a very small length of the line $dl$ (neglecting resistance and leakage), we have (Fig. 5):

$$zk = \sqrt{L/C - w^2L^2/4}$$

which equals $Rk$ provided the frequency is less than $1/\pi\sqrt{LC}$

So, for the network shown:

$$zk = \sqrt{L.dl/C.dl - w^2L^2.\ dl^2/4} = Rk$$

provided the frequency is less than $1/\pi\sqrt{L.dl.\ C.dl}$

Therefore, as $dl$ tends towards zero, $zk$ tends to $\sqrt{L/C} = Rk$ provided the frequency is less than $1/\pi\sqrt{L.O.}$, i.e., is less than infinity.

This means that a loss-less line can pass all frequencies without attenuation, though, in practice, attenuation does become severe at very high frequencies because of the losses neglected in the above simple treatment.

If resistance and leakage are considered it can be shown that:

$$zk = \sqrt{R + jwL/G + jwC}$$

$R$ and $G$ being resistance and leakage, respectively.

### Phase Lag

Since a line acts as a $L.P$ $T$-section ladder network, each section of it will cause a phase lag, i.e., a time delay. We have seen that

$$\tan\Phi/2 = wL/2Rk$$

Therefore, for a line

$$\tan\Phi/2 = w\sqrt{LC}/2$$

so, taking a small portion over which $\Phi$ will be small, $\Phi$ will be 360 degrees when the distance between the points is one wavelength.

### Dielectric Effect on the Phase Lag

If the wires of the lines are separated by air the velocity of propagation along them is very little different from that in free space, therefore a wavelength on the

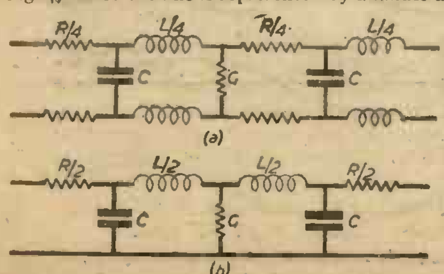



*Fig. 3 (Left).—The elements of a line expressed in electrical form.*

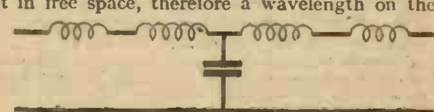


*Fig. 4 (Top Right).—The line representation becomes a ladder network if losses are ignored.*

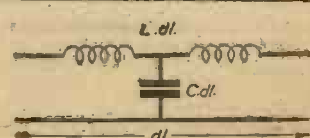



*Fig. 5 (Bottom Right).—Shows the equivalent of a very small length of line.*

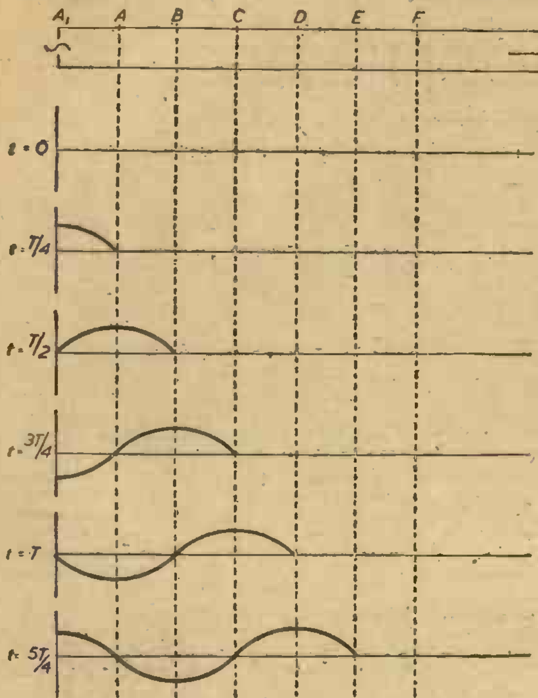



*Fig. 6.—Depicting the build up on a line of a simple travelling wave.*

wires is equal to a wavelength in free space. If, however, the conductors are embedded in a dielectric, $C$ is increased to $KC$, where $K$ is the dielectric constant. So since $\Phi = w\sqrt{LC}$ the phase change per any length is $\sqrt{K}$ times what it would have been for air spacing. Therefore for a 360 degree phase shift we require a length of line $1/\sqrt{K}$ of what we had before, consequently the wavelength in a dielectric is:

$$\lambda K = \lambda air/\sqrt{K}.$$

So the velocity along a line having dielectric $K$ is $1/\sqrt{K}$ of the velocity in air.

**Travelling Waves**

Let the generator mentioned before be connected to the line at the instant $t=o$. Then in a quarter of a periodic time (1) The potential at $A_1$ (Fig. 6) rises to its maximum value, and (2) The condition that previously existed at $A_1$ has now reached $A$. Hence the potential distribution along the line will be as that depicted.

After a further $T/4$ period the condition at $A$ will have advanced to $B$; that at $A_1$ to $A$, whilst the potential at $A_1$ will have fallen to zero.

If now we take any potential such as $A$, and consider how the voltage thereat varies, we see that in a periodic time it undergoes a complete sinusoidal cycle of voltage variation. And also any other point undergoes a similar cycle differing from that at A only in phase. (The amplitude will be everywhere the same if the line is considered loss-less.)

Under such conditions a simple travelling wave is said to exist on the line.

**Reflection on Transmission Lines**

In the case of a finite line the travelling wave will eventually reach the termination. In general the termination will absorb part only of the energy of the wave, the remainder returning to the generator, thus forming a reflected travelling wave. If the termination is such that the energy can be absorbed at the same rate as it is delivered, no reflected travelling wave will be set up. Therefore in this case only a simple forward travelling wave will exist—that is, a line so terminated will behave in a similar manner to an infinite line.

Hence the termination to produce this condition is *Rk*.

In dealing with reflection it will be simplest to consider first of all the extreme cases when the termination can absorb no energy whatsoever,

**A Line Open Circuited and λ in Length**

When the generator is first connected to the line it causes a travelling wave to move along the line. This wave reaches the termination which, being an open circuit, cannot accept any of the energy of that travelling wave, since the current at the termination must always be zero. Thus a reflected wave returns towards the generator.

The current at the open circuit being zero, the returning current wave suffers a reversal of phase. Now if we suppose that the generator has an internal impedance *zk* (*Rk*), it will absorb the whole of this reflected wave. the current at any point on the line then being the resultant of the two travelling wave currents. If these are added point by point along the line the current will have the following characteristics:

(i) The amplitude of the current variations with time is different at different points along the line.
(ii) At certain points the current is always zero. These points are called nodes and occur at the termination and at distances $\lambda/2$, $\lambda$, $3\lambda/2$, etc., from it.
(iii) At certain other points the amplitude of the current variations is a maximum. These points are called antinodes and occur at distances $\lambda/4$, $3\lambda/4$, $5\lambda/4$, etc., from the termination.
(iv) Any two points are either in phase or antiphase with one another (Fig. 7).

**Voltage Waves for the Previous Case**

When the travelling wave reaches the termination in this instance the energy contained in the magnetic field must be zero, since the current is zero.

*(To be continued)*

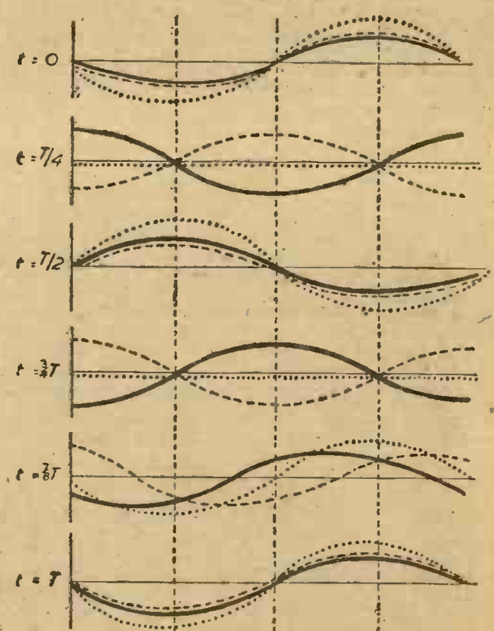
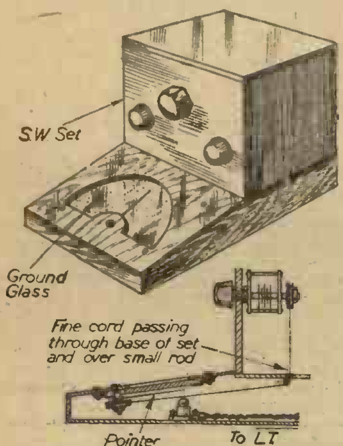



*Fig. 7.—Showing the production of current standing waves from the travelling and reflected components.*

# Practical Hints

### A Novel Tuning Dial

THE tuning dial, as shown in the sketch, and which I have designed for use with a short-wave set, is constructed with plywood, and the rear portion forms a stand for the set. The dial is formed with a piece of ground glass (rough surface upwards) illuminated from below.



*An illuminated tuning dial for a short-wave set.*

The tuning indicator is mounted just below the ground glass, and consists of a pointer attached to a small wheel which is coupled to a similar wheel attached to the tuning condenser, so that the pointer makes a 180 degree rotation with the condenser. The advantage of using ground glass is that it forms an excellent writing surface for either pencil or ink, and it is therefore quite a simple matter to calibrate the dial. During tuning operations stations can be marked on the dial or notes made in pencil, and these can easily be removed with a damp cloth when they are no longer required.—A. O. GROOM (Amersham).



### Tone-arm Adjustments

I RECENTLY bought an old gramophone, and made several modifications to the tone-arm.

The original tone-arm and head was much too heavy, so I fitted a counterbalance device, as shown in Fig. 1, which is self explanatory. This arrangement in no way interferes with the lateral movement of the sound-arm. The spring C is placed in such a position as to give the desired decrease in weight for the minimum exertion on the spring. The rod can move sideways out of the two shoulders (S), and is held in position by a vertical pin, the idea being that the spring can be relaxed when not in use.

I also fitted a pick-up to the lay-out, counterbalancing it, as shown in Fig. 2. The weight is arranged so that the pick-up head rests on record level, giving the required counter-balancing effect. A screwed rod is introduced through the two holes of the old condenser plates to keep the bakelite rod tight against the top of the tone-arm. The rod and weight can be removed in a few seconds, and the lid shut down when it is desired to use the arrangement as a gramophone instead of a playing desk.—ALAN MCGUGAN (Belfast).

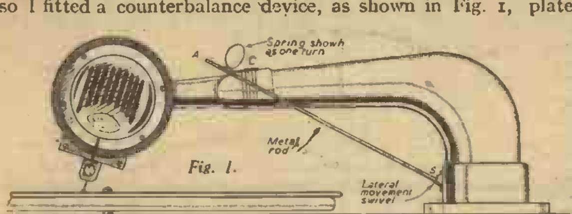


*Fig. 1.*

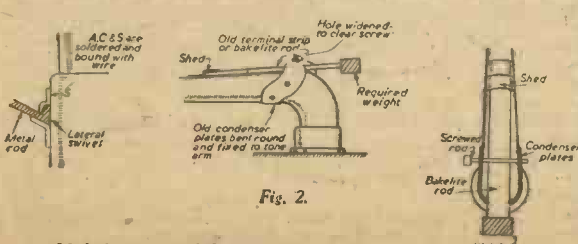


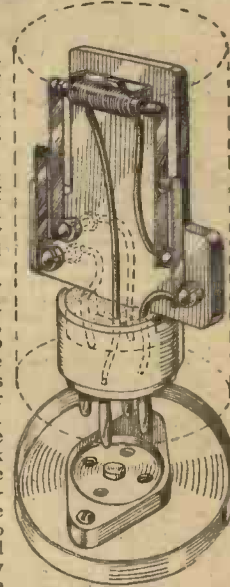
*Fig. 2.*

*Methods of counterbalancing a tone arm.*

### A Half-wave Vibrator

IN view of the H.T. battery shortage and the difficulty of obtaining certain components, I have evolved the following easily-constructed 2-volt self-rectifying half-wave vibrator. It overcomes, in a very simple manner, what is one of the chief difficulties of a home-constructed unit, viz., the setting of the low tension and rectifying make and break on a common reed.

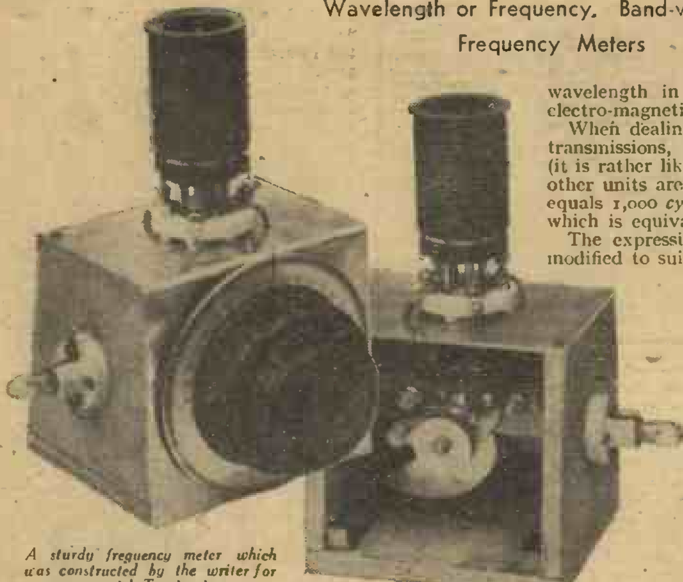
The construction is clearly shown in the sketch. It is built up on an old 4-pin valve base, suitably cut away at the top edge to allow the shaped piece of ebonite on which the unit is built to "float" on a rubber disc. This disc is about ¼in. thick, and is a tight fit in the valve base. The ebonite back plate has a small tag at the bottom edge which is received by the disc. The four connecting wires to the valve pins are carried through the rubber by drilling suitable holes. The electro-magnet, which is wound with two layers of 22 D.C.C. wire over a piece of oiled silk is ⅞in. long, was cut from a 6in. nail, as was also the reed ends, which are 3/16in. long. The reeds are 1⅞in. long, and are cut from thin brass, as are the back contact strips. Two pairs of old car ignition contacts are soldered to the centres of the reeds. Contact strips and reeds are mounted by soldering into the slots of BA round-head bolts suitably positioned on the back plate. The electro-magnet is mounted by soldering to a small bracket bolted to the back. Adjustment is carried out by bending the contact strips, the points being just closed with no current flowing. A suitable can, an old tin in my case, completes the vibrator. The lid is cut away for the valve-holder and mounted underneath it. It is earthed to the L.T. negative. There is little mechanical noise when in use.—M. L. MARTIN (York).


*An ingenious half-wave vibrator.*

# Frequency and Frequency Meters

Wavelength or Frequency. Band-width Separation. Scale Calibration. Frequency Meters

By L. O. SPARKS



*A sturdy frequency meter which was constructed by the writer for use with Tx circuits.*

BEFORE the introduction of tuning scales calibrated in wavelengths, it was usual to refer to a particular station as being, say, 90 on the left-hand and 87 on the right-hand dial. Such observations conveyed little or no information to anyone other than the owner of the set, and only then if certain dial settings were known to correspond to definite wavelengths. Consequently, identifying a station by its wavelength was a matter involving guesswork plus a certain amount of luck, especially as the transmitters did not adhere too closely to their allotted wavelengths.

When the component manufacturers of this country agreed on, and accepted, definite specifications for various components, it became an easy matter to construct a receiver incorporating a tuning scale calibrated in wavelengths. Modern receivers are fitted with tuning scales showing station names and wavelengths, thus making station identification an easy matter. For medium and long waves this is quite satisfactory, but for short-wave transmissions it is not so good, owing to defects which become obvious under operating conditions.

### Wavelength or Frequency

When tuning a receiver to a given station, it is necessary to know the wavelength or frequency. Given either of these, the other can be determined, as they are interchangeable. To qualify this statement, it is assumed that the speed or velocity of the waves is known, otherwise the frequency value will not provide any clue as to wavelength or vice versa. Fortunately, the speed of electro-magnetic waves is a convenient one, so far as calculations are concerned, as it is the round figure of 300,000,000 metres per second. If, therefore, the wavelength of a transmission is known, its frequency can be determined by dividing 300,000,000 by the wavelength. Similarly, the wavelength will be given, if frequency is known, by dividing 300,000,000 by the frequency. This is more conveniently written as:

$$f=\frac{300,000,000}{\lambda} \text{ and } \lambda=\frac{300,000,000}{f}$$

when f equals the frequency in cycles per second, λ the wavelength in metres, and 300,000,000 the speed of electro-magnetic waves in metres per second.

When dealing with the frequencies involved in radio transmissions, cycles per second become cumbersome (it is rather like expressing a ton in pounds), therefore other units are used, namely, the *kilocycle* (kc/s), which equals 1,000 *cycles per second*, and the *megacycle* (mc/s), which is equivalent to 1,000,000 *c/s*.

The expressions for f and λ given above must be modified to suit these units, and they now become:

$$f\ (kc/s)=\frac{300,000}{\lambda} \text{ and } \lambda=\frac{300,000}{f\ (k/cs)}$$

$$\text{or } f\ (mc/s)=\frac{300}{\lambda} \text{ and } \lambda=\frac{300}{f\ (mc/s)}$$

When making any of these simple calculations it is very necessary to remember which units are being used for frequency, otherwise misleading results will be obtained.

### Medium and Short Waves

A wavelength of 500 metres is equivalent to a frequency of 600,000 c/s or 600 kc/s; 400 metres is 750 kc/s, and 300 metres 1,000 kc/s. This shows a frequency difference of 150 kc/s between 500 and 400 metres, and 250 kc/s between 400 and 300 metres.

Turning now to short-wave transmissions, a wavelength of 15 metres has a frequency of 20 *mc/s* or 20,000 *kc/s* or 20,000,000 *c/s*. Higher up the wavelength scale, but *lower down* the frequency band, 20 metres is equivalent to 15 mc/s; 30 metres, 10 mc/s, and 50 metres, 6 mc/s. If we examine the wavelength differences between these transmissions in terms of frequency, we find that between 15 and 20 metres there is a frequency band-width of 5 mc/s, i.e., 5,000,000 c/s. Between 20 and 30 metres, 10 mc/s, and between 30 and 50 metres 4 mc/s.

It will be noticed that as the wavelength increases the frequency band-width between the wavelengths taken decreases, and this becomes more pronounced the higher the wavelength, as reference to the medium-wave figures will show. On that band, the 100 metres separating 500 and 400 metres gives a frequency separation of only 150,000 c/s, compared with 5,000,000 c/s for the 5 *metre* difference between 15 and 20 metre bands.

### Frequency Band-width

For normal transmission of telephony, etc., a frequency band-width of approximately 10 kc/s is necessary. This figure has nothing to do with the frequency of the carrier wave, i.e., the actual wavelength of the station; it merely denotes the frequency channel occupied by the transmission will be 10 kc/s wide. It is not proposed to discuss why this is so in detail in this article, but the following brief outline might make the matter more clear to those not familiar with the subject. Assuming a station is transmitting on a wavelength of 300 metres —1,000 kc/s—and, for the purpose of this example, assume that the carrier wave is being *modulated* by a single note of, say, 1,000 *c/s*. The actual transmission under this condition will then consist of *three* frequencies, namely, 1,000 *kc/s*, which is that of the *carrier*, and two more equivalent to 1,000 *kc/s plus* 1,000 *c/s* (1 *kc*) and 1,000 *kc/s minus* 1 *kc*. To give exact figures, there would be the carrier frequency—1,000 kc/s, another frequency of 1,001 kc/s, and a third of 999 kc/s, thus a certain frequency band-width will be occupied by the modulated transmission. At the receiver end, "demodulation" by the detector takes place, and the modulation frequency is separated from that of the carrier. The former—the 1,000 c/s note—passes through the L.F. stage(s) and operates the 'phones or speaker, while the carrier frequency is—briefly—filtered away.

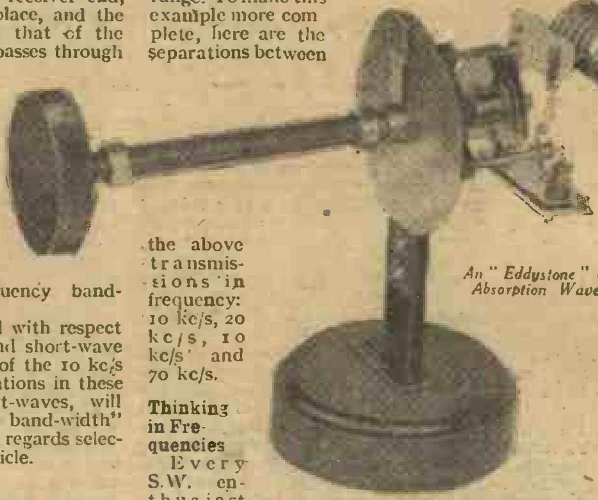
We have seen that a transmission handling speech and music requires a frequency channel of, say, 10 kc/s *irrespective* of the frequency of the carrier wave. This requirement, therefore, controls the separation (wavelength) between stations necessary to avoid interference, and imposes certain factors on the designers of receivers, as regards selectivity in terms of frequency band-width.

If this 10 kc/s band-width is considered with respect to the operating frequency of medium and short-wave stations, it will be obvious that the ratio of the 10 kc/s band-width to the carrier frequency of stations in these two bands, i.e., the medium and short-waves, will differ greatly. This ratio or "proportional band-width" is closely related to resonant circuits as regards selectivity, but more about that in a future article.

**Tuning Scales**

To return to tuning dials, it is hoped that sufficient has been said about frequency and wavelength to show that if a medium or long-wave receiver had its tuning scale calibrated in frequencies, the scale would be much more crowded—thus making accurate setting more difficult—than if it had been marked off in wavelengths.

On the short-waves, the reverse is the case; even allowing for the 10 kc/s separation between adjacent transmitters, wavelengths in any one S.W. band vary by 1/10th and 1/100th of a metre, that it becomes practically impossible to calibrate the tuning scale on such receivers in wavelengths. This is particularly noticeable on some commercial all-wave models, where the most popular S.W. bands are indicated by extremely short lines. Taking at random a few of the transmissions within the 31 metre band, there are stations operating on 30.90 metres; 30.86 metres; 30.80 metres; 30.77 metres and 30.55 metres. These, in terms of wavelength have a separation of 0.04; 0.06; 0.03; and 0.22 metres respectively. But if considered in frequencies, a very different impression is obtained, and from which one is able to get a more accurate idea of the relative position of the transmissions in the frequency and tuning range. To make this example more complete, here are the separations between the above transmissions in frequency: 10 kc/s, 20 kc/s, 10 kc/s and 70 kc/s.



An "Eddystone" U.S.W. Absorption Wavemeter.

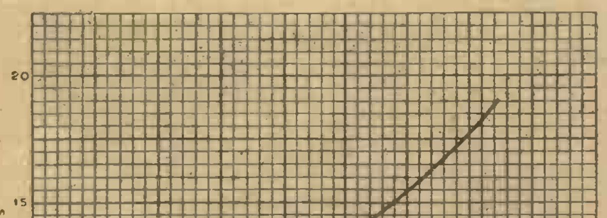
**Thinking in Frequencies**

Every S.W. enthusiast should become familiar with the frequencies embraced in the various S.W. bands, and get in the habit of thinking and logging in frequencies rather than metres. It is possible to procure frequency/wavelength tables, and a copy should always be within reach when using the Rx or entering reports in the log-book. A good plan is to calibrate the tuning dial of the receiver in frequencies; if a band-spreader control is used, it is advisable to prepare a dial divided into several scales to correspond to various settings of the band-setting condenser, and, of course, the coil in use. Many ingenious devices have been produced to assist in rapid and fairly accurate station identification, but in these days of component shortage, it is up to every S.W. amateur to design and construct a dial which will give a reasonable scale length. Such work can be very interesting, and it is not so difficult as it might at first appear.

**Frequency Meters**

One piece of apparatus which is really essential for satisfactory S.W. work, is a frequency meter, as it allows quick and accurate identification of a transmission so far as its operating frequency is concerned.

It is not always possible to hear the call-sign and frequency of a station, owing to interference and/or fading corresponding with the announcement. At other times, it is not convenient to "hang on" to a transmission until the details are given, therefore, in either of these cases, it is quite possible that the operator misses logging a previously unheard station or fails to check up on his log. Nothing is more annoying, especially during these days when most of us have had to curtail our hours at the Rx; a well-made frequency meter will eliminate those blank spaces in the frequency column in the log-book, and save a great deal of time by rendering it unnecessary to hold a transmission until the details are given. There are various types of frequency meter, some extremely simple in construction and others more elaborate, but whichever type is considered, provided it is well made and a reasonable amount of care taken with its calibration, it will prove to be one of the most useful pieces of gear in a S.W. installation.




*Showing how dial readings are plotted against frequencies to form a graph from which intermediate valves can be determined.*

(*Continued on page* 113.)

# The Care of Batteries

## How to Maintain Them in Proper Condition

THE a'l-important subject of the care of batteries in war-time was stressed in an instructional film recently shown by The Edison Swan Electric Co., Ltd. The need for the conservation of batteries which are required for every vehicle and vessel of war was emphasised. The following notes cover the chief points outlined in the film, and should be of particular interest to all users of accumulators at the present time.

That battery, quietly working away in obscurity ; do you *ever* think of it, except when it starts to give you trouble ? It is not much to look at, and even if you take off the stoppers and pry inside, it is not so interesting as taking the back off a watch ; you should see only the light glinting on the electrolyte. Outside, it is black and plain ; ugly, if you like. That is a car battery, but even if your stock in batteries runs to an accumulator or two, with transparent containers you can easily see through, what do you see but grey plates, edges of brown and grey plates, terminals, acid, probably a few bubbles on the top ? If your battery is not in good condition even the plates will be discoloured. Very dull !

Does your battery ever inspire you to say to yourself : "This is the faithful little servant that starts my car, raises my traffic indicators, sounds my horn, keeps my lamps burning and my plugs sparking. It is the very life of my car" ? And what of the other cells—those which give life to your radio, make your bells ring or give you emergency lighting ? Do you ever give them a grateful thought ? The fact is, you do not realise that those batteries do so much for you until they fail . . . and that is all your fault, usually.

### Chemical Action

How does a battery do all this so regularly and then suddenly go "phut" ? After all, the electricity which charging puts into it does not stay there ; it goes in one side and out of the other just as all our words of warning have gone into the heads of many battery slave-drivers. There is no electricity stored in that battery at all. It is called a storage battery, yet it does not store anything except acid and its own parts. The plates and the acid in conflict set up chemical action and it is this action alone which *creates* electricity as it goes—when it is wanted—just when you "switch on." For by switching on you set that chemical action in motion.

*Sealing the cells. After the groups of plates are placed in the compartments, bakelite covers are placed on top and the whole sealed with bituminous compound.*

Now if a battery depends upon chemical action for its life, quite certainly—as even the schoolboy chemist knows—it is self-destructive. All chemical action is self-destructive. Destruction starts as soon as a battery is charged, and upon the rate of destruction depends absolutely the life in hours of your battery. That rate of destruction you can control, advance or retard according to your treatment of the battery. Unless the instructions of the manufacturer are carried out that rate of destruction will be rapid.

Competent authority tells us that 85 per cent. of battery casualties are caused by neglect ; neglect which falls broadly under three headings, undercharging, overdischarging, evaporation. Let us investigate this, and for the purposes of our investigation concentrate on the car battery. Car batteries are the most frequently abused because they are out of sight, they wear out slowly and generally give the owner every opportunity to take mean advantages. The rules applying to car batteries apply equally to all other forms of batteries when it comes to care and attention.

### Undercharging

First, then, undercharging. This means that, for one or more of several reasons, your car battery does not receive the electric charge from the dynamo for a sufficient length of time to keep the chemicals functioning properly. It may be through a faulty or dirty dynamo, but two of the most likely reasons are that you do not use your car frequently enough or that you do not take it for long enough runs. That is quite easy to understand. A battery is charged with electricity to keep the chemicals active, and the dynamo on your car should do, in a somewhat less degree of intensity, what the initial and subsequent booster charges at the service station do. To keep this process going satisfactorily you should take your car for occasional runs of 50 miles or so, for with the dynamo spinning merrily for so many revolutions that battery is really on charge and the effect obtained is very like a long drink to a thirsty man.

That is worth remembering because it is a close

*The hydrometer test. The specific gravity reading indicates when the battery is below par, while the operation serves as a dip-stick guide to the amount of electrolyte in the cells.*

parallel. If you had only a few sips of drink every hour or so you would in time be very thirsty indeed, and thus "thirsty" becomes your battery on short runs. It simply must have that occasional long drink of "juice" and woe betide you if it doesn't get it! The plates will buckle, they will become loaded with a layer of sulphate, and their efficiency will drop and drop until the horn squeaks, and the indicators develop the droops and the lamps just glimmer.

If you are unable to make such long runs, your battery must be taken out of the car and given an independent charge. If you are not equipped to do this yourself, the nearest battery service station, or garage, is your best friend.

Overdischarging has a similar effect. But this is caused by extensive use of the electrical accessories on your car, or too much night driving—or both. You are, in effect, taking too much out of your battery to balance what your dynamo can put in. Again—and even more imperative this time—it must have an independent charge.

Still considering these two causes of frequent battery failure, put it this way! If a tank holding 80 gallons of water receives from a supply pipe 15 gallons a minute and loses through a waste pipe 15 gallons a minute, the water in the tank will keep pretty level. That would be similar to the state of a battery could it receive from the dynamo the exact charge necessary to balance its output. But if the tank water supply drops to 10 gallons a minute while the waste pipe outflow remains at 15, it is only a matter of time before the tank empties —that is undercharging. Now, supposing the supply pipe remains at 15 gallons, but a tap is opened in the water system drawing off a further five gallons a minute, again, in time, the tank will empty—that is overdischarging. Two causes with but a single effect.

Technically, there would be a 10 per cent. loss in resistance and there would be probably the same percentage of evaporation in a water tank, but the analogy holds good.

**Evaporation**

Finally there is the question of evaporation. The acid in your battery to which we have already referred, and which is known as the electrolyte, contains a good proportion of lead sulphate. If you allow the electrolyte to fall low enough for the plates to be come exposed, sulphate of lead will be deposited upon those exposed parts and just that proportion of your battery will be ruined beyond redemption. Even though you cover the plates again with distilled water, once sulphation has taken place the battery can never be the same again. So if you allow the electrolyte to fall so low as a third of the way down the plates, one-third of your battery will never work again.

You can stop these faults developing, that is the thing to bear in mind. You can watch your battery and slow down that very disintegrating process by which you get electricity because you are not left to guess what condition your battery is in. There is, indeed, a very handy tool which will tell you all you want to know—the hydrometer. Keep this in mind, that with a hydrometer, conscientiously used once a month, you have the remedy against battery failure and all its attendant irritations.

**Using the Hydrometer**

The hydrometer is a simple thing. It is, to look at, very much like the old fountain-pen filler enlarged. Inside the barrel there is the hydrometer scale which, in turn, looks something like a clinical thermometer with an enlarged end. All that has to be done is simply to unscrew the stoppers from the different cells of the battery, insert the rubber piping at the end of the instrument and suck up the electrolyte by the usual method of squeezing and releasing the rubber bulb at the top.

When you have thus sucked up the electrolyte until the scale floats, like a fishing float, you can take a reading. That reading will be the exact specific gravity of the electrolyte—the tell-tale clue to the state of your battery. If the reading you take is 30 or more points below that specified on the label, or tag, supplied with your battery—it must have an independent charge.

Usually, it will be necessary to test only one cell of any battery to ascertain the condition of all of them, but if you are inclined to feel a little conscientious, by all means try them all; you *may* find something different which would be an indication of a fault in one of the cells. This is only likely to occur in a battery which has been badly treated.—*The Edison Swan Electric Co., Ltd.*

## Frequency and Frequency Meters

(*Continued from page 111.*)

**Absorption Frequency Meter**

The illustration used at the heading of this article, shows one form of absorption frequency or wavemeter which I constructed a few years ago. It represents one of the simplest types, and consists of nothing more than a variable condenser connected in parallel across a coil. The model shown was made for use in conjunction with low-power transmitters, thus the lamp which is connected across a small winding inductively coupled to tuned circuit. When the meter was tuned to the frequency of the circuit under check, the lamp would glow, the brilliancy depending on the amount of H.F. in the circuit.

For use with a receiver, the lamp is not required as the method of operation is as follows. If unscreened coils are in the Rx, the coil of the absorption meter is brought close to one of them (the aerial or H.F. coil) and the variable condenser on the meter adjusted until its circuit is dead in tune with the receiver. The exact point will be indicated by a marked drop in volume in the headphones or speaker, due to the fact that the meter—when in tune—absorbs a certain amount of power from the circuit under test.

An alternative method is to provide the meter coil with a small winding which can be connected in series with the aerial lead to the Rx. This is particularly useful when screened coils are used in the receiver. If a standard type of 4-pin plug-in S.W. coil is employed in the meter circuit (thus allowing a very wide band of frequencies to be covered by simply changing coils) the reaction winding can be used for the aerial coupling. For the most marked results, the receiver should be operating close to the point of oscillation, when the slightest absorption of power will be most quickly indicated.

The beauty of this type of meter is its cheapness simplicity, reduction to a minimum of parts likely to cause errors, ease of calibration and absence of external factors likely to upset its operation. Although it is so simple, it can be as accurate and just as useful as some of its more complicated and costly counterparts.

**Construction**

Little can be said about its construction, as it is simply a matter of mounting a coil holder and variable condenser on a convenient base, and connecting them so that the condenser is in parallel across the coil. As with most S.W. equipment, it is particularly advisable to use a *high-grade condenser* and a *low-loss coil holder* and *coil*.

The dial of the meter can be marked off in degrees and used in conjunction with a series of tables or charts showing the exact frequency corresponding to any dial reading.

As it is unlikely that a signal generator will be to hand, the meter can be calibrated by tuning-in as many transmissions of *known frequency* as possible on each waveband, and using the meter in the manner already described on each signal received. The meter dial reading is noted and used to prepare a simple graph having frequency on the vertical scale and dial readings on the horizontal; it is best to produce a separate graph for each coil.

(*To be continued.*)

# Radio Examination Papers—15

More Random Questions, with Suitable Answers by THE EXPERIMENTERS

**QUESTIONS**

1. *How can an amplifier and two loudspeakers be used as a two-way loudspeaking telephone?*
2. *In what simple manner could you check the efficacy of the A.V.C. system of a receiver?*
3. *How could you distinguish between A.C. and D.C. supplies in the absence of instruments, and if the supply meter were not accessible.*
4. *Explain the principle of so-called "diversity reception" where two separately tuned detectors feed into a common L.F. amplifier.*
5. *What do you understand by sidebands, as applied to radio-telephony transmission and reception? How does the presence of sidebands affect the design and selectivity of a receiver?*
6. *If it were required to provide multipliers for a 0—.5 moving-coil milliammeter, how could these be made and the instrument recalibrated in the absence of a sub-standard meter?*

## 1. Loudspeaking Telephone

In a telephone of this type it is necessary to have an amplifier and two speakers which can be used for reproduction and as microphones. This is not difficult to arrange, when it is borne in mind that a speaker is very similar in principle to a gramophone pick-up. In the case of a moving-coil speaker the speech coil moves about a fixed magnet, whereas with a pick-up an armature moves between the poles of a magnet around which is placed a fixed coil. In both cases, alternating currents can be induced into the coil.

It is evident, therefore, that all we have to do is to provide a switching system so that when one speaker is connected to the output terminals of the amplifier, the other is connected to the input, or pick-up, terminals. By a movement of the switch the two speakers must be reversed. The general method of switching is illustrated in the accompanying diagram, where it will be seen that a two-pole-change-over switch is employed; one of the key or toggle type would be most convenient.

The amplifier shown is of a very simple type, having three triode valves in cascade, and choke-capacity output coupling. The latter is an advantage, since one side of each speaker may be connected permanently to the "earthy" side of the circuit.

If the diagram is examined it may be thought that there is a mistake in that there is no bypass condenser across the bias resistor to the output valve. The by-pass condenser is omitted deliberately to provide a certain measure of negative feed-back. This is an advantage should the lines to the remote speaker be long, since the varying load when changing from one position of the switch to the other does not then have any appreciable effect on the matching. It would be better to provide a more effective system of negative feed-back, and this would certainly be done on an amplifier specially designed for the purpose in question.

If the output stage were a push-pull, Q.P.P. or Class B stage, the method of switching would be slightly more complicated because both leads of both speakers would have to be changed over. That would necessitate the use of a four-pole change-over switch.

With the arrangement outlined, the switch would be at the "control" or amplifier end of the line, and at all times when the "control" speaker were not being used as a microphone, it would be necessary to put the switch in the "receive" position. If desired, additional contacts on the switch could be used to switch the amplifier off when the switch was in the central position (this assumes the use of a key switch). Alternatively, separate single-pole-double-throw switches could be provided—one at each end—for switching the amplifier on and off.

## 2. Testing A.V.C.

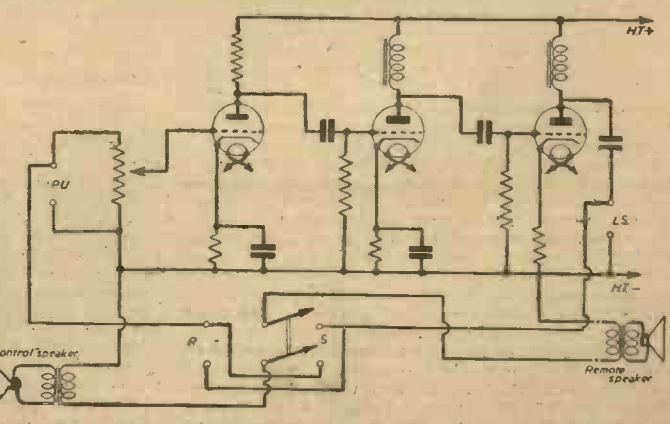
The purpose of A.V.C. is to ensure that the output of the receiver remains constant, irrespective of the input. There are, of course, definite practical limits to the range of operation of A.V.C.

To test the efficacy or range of A.V.C., that is the permissible variation of input for uniform output, it is necessary only to alter the input to the receiver. This is best done by tuning in a strong signal from a comparatively nearby station, using a good aerial. Next, the aerial lead-in should be disconnected from the lead-in terminal. Ideally, there should be no change in signal strength from the speaker, although there is sure to be a marked rise in background level due to the increased valve noise when the bias on the controlled valves is greatly reduced by the A.V.C.

The experiment can be continued by replacing the aerial lead to the set by varying lengths of wire, these being used instead of the normal aerial. Care must be taken that they are well away from other wires, and from the body, which may act as a source of signal pick-up.

## 3. A.C. and D.C.

As every reader knows, the voltage of an A.C. supply is constantly varying from maximum to zero, whereas the voltage of D.C. remains steady. The variation on A.C. cannot ordinarily be detected by watching a lamp or other device connected to it, because the incandescent filament does not "go out" each time the voltage passes through zero. This is because the rapid




*A simple method of switching for two-way loudspeaking telephone working with two speakers and an amplifier. The principle illustrated applies with any amplifier circuit, and that shown is not particularly suited to this purpose.*

change—usually 50 times a second—does not allow time for the filament to cool off. Even if the light did go out 50 times every second, the eye, unaided, would not detect the change.

But if an object such as a light-coloured pencil is moved backward and forward between the eye and a dark surface on which the eye is focused, a peculiar effect can be observed. The pencil will appear to move in a series of jerks, and clear images of it will be seen lagging behind the pencil itself. On D.C. the pencil will appear as a blur. This is the principle of the stroboscope sometimes used to check the speed of a gramophone turntable.

In passing, it should be mentioned that the effect is most readily observed when the lamp is of low wattage rating; better results still are obtained from a neon lamp, which is always to be preferred in conjunction with a stroboscope.

**4. Diversity Reception**

This name is often given to reception carried out by means of two separate detectors (if necessary, each with its own H.F. amplifier) which feed into the same L.F. amplifier and output circuit. The object is to overcome variation in signal strength due to fading.

It is widely known that signals on different frequencies or wavelengths fade and swing at differing rates. Thus, while a signal from a certain place on one frequency is fading, another signal from the same place but on another frequency may be increasing in strength, or swinging.

When any particular station transmits on two frequencies at the same time, then, and our two detectors are each tuned to one of these frequencies, there is a probability that fading will not be experienced in the combined output. This is particularly the case on short waves, and the system is often found of value when listening to many of the American S.W. transmissions.

**5. Sidebands**

When a carrier-wave is modulated by a note of constant pitch, three different frequencies are transmitted. These are the fundamental (or carrier frequency), one equal to the sum of the carrier and audio frequencies, and one equal to the difference between the carrier and audio frequencies. Thus, instead of the transmission being on a single frequency—as is generally supposed—it covers a band of frequencies; the two bands on each side of the carrier frequency are known as sidebands.

Let us take an example of a broadcasting station working on a carrier frequency of 1 megacycle/sec. or 1,000 kc/s and modulated by a 10,000 c/s note of constant pitch. Radiated from the transmitting aerial there will be three "signals" or frequencies; they are 990, 1,000 and 1,010 kc/s. This means that the transmission would cover a band of 20 kc/s or 20,000 c/s on the tuning dial.

But in broadcasting the pitch of the modulation is not constant; it varies from zero to something like 20,000 c/s. This means that the width of the sidebands is constantly varying, but that a total width of 40 kc/s is necessary to accommodate the transmission. If a receiver is to give faithful reproduction the tuning circuits must be so designed that they will give an even response over the frequency band mentioned.

In practice, stations on the medium-wave band are normally spaced by 10 kc/s, and it is arranged that the frequency range of the modulation shall be curtailed so that overlap is not experienced. Sometimes, however, a certain amount of "chatter" may be heard due to the (variable) upper sideband frequency of one station beating with the lower sideband frequency of another one adjacent to it in the frequency allocation. This effect is described as "sideband splash," due to the type of noise produced. To allow for proper reception of the sidebands, the selectivity of the receiver must be deliberately reduced, preferably by the use of a band-pass filter.

**6. Meter Shunts**

If the full-scale reading of a milliammeter is to be doubled, the meter must have in parallel with it a resistor which will pass half the total current in the circuit. This means that the value of the resistor must be equal to the resistance of the meter itself. If the full-scale reading is to be multiplied by three, the parallel resistor must have a value equal to half the resistance of the meter—and so on.

When the meter resistance is known (it is sometimes marked on the scale) it is necessary only to make resistors of certain calculated values. If use is made of wire of which the resistance per yard is known this is not a difficult matter. A simpler method, however, is to wire the meter in a circuit through which is passing, say, 4 mA, for a 5 mA meter, and then to put a resistor in parallel and to vary this until the scale reading is just 2 mA. A start can be made by winding a length of fine, insulated copper or resistance wire round a pencil stub, and noting the effect of this on the meter reading. If the reading is too high, it means that the length of wire can be reduced; if it is too low, it means that a greater length of wire is required.

It can normally be assumed that the resistance of the meter is 100 ohms—a customary figure. If, then, reference is made to the wire data on pages 77 and 78 of the "Radio Engineer's Pocket Book," the approximate length required can easily be ascertained. A few simple tests will then suffice to determine the exact length necessary for the scale to give the required readings.

# "REVEILLE" BY LOUDSPEAKER

NO bugle reveille awakens the aircrew cadets at a north of England centre where they are awaiting dispatch to training centres. Instead, a voice from a loudspeaker bids them rise and prepare for their daily duties. The camp radio announcer has to get up a little earlier. This station is "radio conscious," for it has its own internal broadcasting system which plays a very useful and entertaining part in the life of the station.

**Camp Broadcasts**

In their spare time the cadets organise three daily broadcasts to the camp, with programmes of instruction, entertainment and news. Each broadcast lasts about an hour, and although this requires a good deal of preparation and foraging for talent the organisers are seldom at a loss to fill the bill. The station dance band is always a popular turn. New arrivals often include former professional entertainers. The programmes are supplemented by other interesting items, such as station news, queries and answers on Service matters, competitions, general knowledge, and talks on subjects such as aircraft recognition—always helpful to the cadets in their training.

The novelty of the system stimulates interest in the corporate life of the station and in Air Force matters. It plays a helpful part in training, too, for aeronautics is, of course, the leading topic. The microphone is open to anyone who can provide something to interest his comrades. The chef, for instance, will reply over the "air" to any criticisms, or an officer may talk to the cadets about discipline. These informal talks, it is found, often produce results where there is a tendency to overlook the more formal type.

The organisers of this novel broadcasting studio hope that shortly they will have an opportunity to put one of their programmes over a much wider area, on a B.B.C. wavelength.

*For the Beginner*

# The Double-diode-triode

## A Non-technical Description of the Functions of the D.D.T. Valve

THE first essential in a detector valve is that it should be a good detector. This sounds a very obvious statement, but it is a fact which is very often lost sight of because we have become so accustomed to the three electrode detector valve, which does other things besides detecting, that we are rather apt to neglect the detecting action proper.

In essence, the process of detection is simply that of half-wave rectification. Let us explain. Fig. 1 is the familiar representation of a modulated radio signal. The little waves vibrate at radio frequency—some hundreds of thousands or even several millions of times a second—and it is the *variations in strength*, as shown by the varying height of the waves, which constitutes

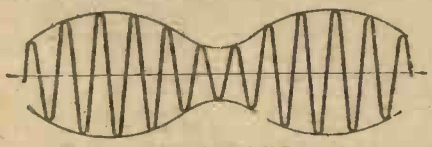


*Fig. 1.—A modulated H.F. signal.*

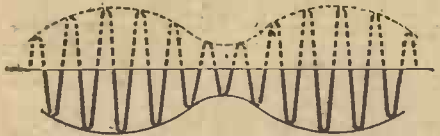


*Fig. 2.—The result of half-wave rectification, the negative half-cycles have been suppressed.*

the audio frequency signal. Now the "positive" and "negative" half waves follow each other so rapidly that, from the mechanical point of view they cancel each other out, so that, were they applied directly to a pair of telephones, the net effect on the diaphragm would be nil, and no sound would be forthcoming.

### Suppressing the Negative Half Cycles

If, however, we apply the incoming signal to a device which allows current to pass in one direction but not in the reverse direction (see Fig. 2) the "negative" half cycles will be suppressed, and the so-called "rectified" signal will then appear as shown in Fig. 3. The signal is now in a form suitable to operate a telephone instrument or, after further amplification, a loudspeaker.

It is just that phrase, "further amplification" which makes efficient detection so difficult. The original Fleming two electrode valve, and the crystal detector, are purely half-wave rectifiers, and give no amplification whatsoever. Under the most favourable conditions, the output of such a detector can only operate headphones, and that only on fairly strong signals. Moreover, this output generally is not sufficient to operate a power valve or pentode, so that if a loudspeaker is required to be used, two low frequency amplifying valves must be employed.

When the three-electrode valve was developed, it was found possible to employ it in such a way that it acted both as a detector and as an amplifier at the same time. Two methods are available. In the anode bend detector the valve is biased to the bottom bend of its characteristic. It amplifies the positive half-waves of the high frequency signal fully, but the negative half-waves are amplified very little. The valve thus acts as a high frequency amplifier and detector combined.

Alternatively, in the leaky grid detector, the grid and filament act as a half-wave rectifier, suppressing or partially suppressing one half of each signal wave, after which all three electrodes come into play to amplify the signal at audio frequency.

### Not Perfect

Although this sounds very satisfactory and efficient, it must be admitted that the arrangement is not perfect. Neither arrangement gives 100 per cent. rectification, so that the result is something less than perfect undistorted reproduction. The reason, of course, is that the conditions for good amplification are not ideal for perfect rectification. It is true that in a well designed wireless receiver, carefully adjusted as to operating conditions, detection with a three electrode valve can reach a high standard of excellence, but it is equally true that in many sets, more care has been taken to obtain a big degree of amplification in the detector stage than in ensuring distortionless rectification. Recently more attention has been paid to detection proper. Owing to the increased sensitivity of modern valves, a high degree of amplification in the detector stage is not quite so vitally important, and it is now quite common for a "diode" to be used as a detector or rectifier. Fig. 4 shows this principle. The "anode" of the diode rectifier may be, and usually is, the grid of a normal three-electrode valve, the anode of which is not used in this circuit.

A diode valve is merely a rectifier, and if it is employed, all amplification in a receiver must be obtained from high frequency and low frequency stages. For greater efficiency, two diodes are sometimes used to give a species of push-pull detection.

### Saving Space and Cost

But diode rectification, although giving wonderful freedom from distortion, does necessitate the use of an

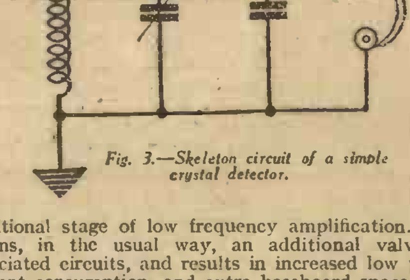



*Fig. 3.—Skeleton circuit of a simple crystal detector.*

additional stage of low frequency amplification. This means, in the usual way, an additional valve and associated circuits, and results in increased low tension current consumption, and extra baseboard space, all of which cost money. What is required, therefore, is a method of combining diode detection with low frequency amplification in one valve, thus saving space and cost, and at the same time it is desirable to avoid the unsatisfactory features of the three-electrode detector in which one set of electrodes have to serve the dual purposes of detection and amplification. For it is due to this double use of one set of electrodes—this compromise between two sets of conflicting conditions, that the triode detector just falls short of perfection.

The solution of the problem has been found and valve designers have succeeded in developing a valve which combines in one bulb one or two diode elements for detection, and also either a triode or tetrode (four-electrode valve) for use as a low frequency amplifier. Not only this, but the two parts, although enclosed within one bulb, act entirely separately, so that working conditions for each part can be adjusted independently so as to ensure the highest efficiency for both functions.

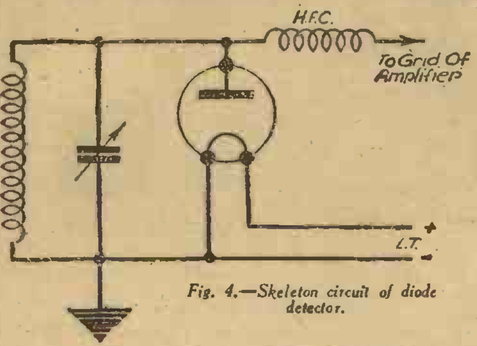



*Fig. 4.—Skeleton circuit of diode detector.*

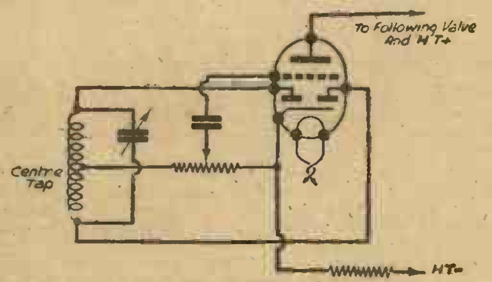



*Fig. 5.—Fundamental circuit for using double-diode-triode as full-wave detector and L.F. amplifier. For the sake of clearness all decoupling components have been omitted.*

## Valve Details

For the sake of economy in low tension supply, a single cathode can be employed and shared in common by all the elements of the valve. For the diode portion—whether one or two diodes are incorporated—the anode for each will consist of a metal ring or rectangle surrounding but not touching the cathode. Above the diode anodes a metal screen is fitted, to shield the triode portion from the diode. The amplifying section of the valve consists of a grid and anode, arranged very similarly to the electrode system of the ordinary indirectly-heated three electrode valve. Those valves in which the amplifying element is of the four electrode variety have, of course, two grids instead of one.

There are several different ways in which valves of this type may be employed, and some of these are indicated. As the double-diode-triode type of valve seems the one most popular, the diagrams reproduced in Fig. 5 and 6 refer to this class of valve.

## Fundamental Circuits

In the first diagram, the valve is employed as a full wave rectifier and a low frequency amplifier. The drawing is self explanatory and it is easy to trace the detector arrangement and the way in which the combined output of the two diodes is led to the grid of the amplifying portion. A more useful way of applying the double-diode-triode, however, is that shown in Fig. 6, where only one of the diodes is employed for detection (as a half-wave rectifier). The second diode is used for applying the automatic gain control or volume control biasing voltage to previous high frequency stages fitted with variable-mu valves. Several variants of this automatic volume control circuit are possible, some of which are capable of adjustment so that a delayed action occurs, whereby no extra biasing voltage is applied to the variable-mu valve or valves until the signal has reached a predetermined minimum strength. In another circuit the triode portion also plays a part in the automatic volume control, for the biasing voltage itself is amplified so that a small variation in signal strength will give a comparatively large control voltage.

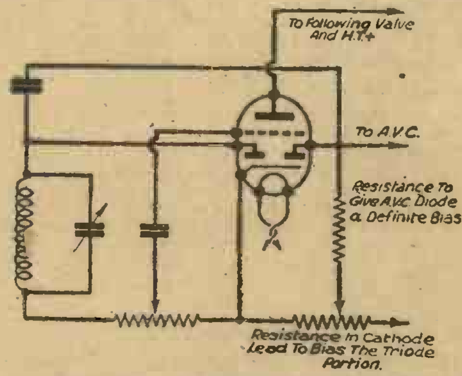



*Fig. 6.—Fundamental circuit for using double-diode-triode on half wave rectifier, L.F. amplifier and delayed automatic volume control valve.*

# Christmas Messages to Troops Overseas

DURING Christmas week message programmes to British and Dominion forces serving overseas were radiated all over the world from the underground studio of a London theatre used as headquarters by the B.B.C. Empire Entertainment Unit.

Greetings from wives, parents and children were sent out to British soldiers, sailors and airmen; Dominion and Colonial service personnel now in Britain sent messages back home in the B.B.C's regular short-wave programmes. Servicemen in this country called their comrades serving in the Middle East.

Troops serving in India and Ceylon heard their relatives in "Calling British Forces in India." West Indians in the Forces in this country spoke to their families at home in "Calling the West Indies." Australians and New Zealanders' messages were broadcast in "Anzacs Calling Home." Members of the Australian forces took part in "Boomerang Club" for Australia. South Africans and Rhodesians in Britain greeted their families in "Songtime in the Laager." In the programmes "Calling the British Forces in Gibraltar" and "Calling the British Forces in Malta," respectively, men stationed at "the Rock" and the George Cross Island heard the voices of their dear ones. Maltese in Britain sent greetings to their people in "Maltese Miscellany," and Cypriots in "Calling Cyprus."

## Empire Radio Party in London

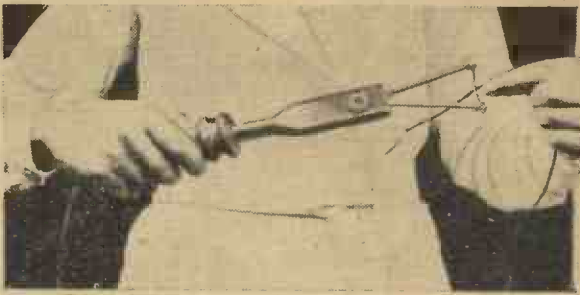
From the weekly radio party at the Overseas League, Servicemen were heard by their comrades in the Middle East. "Anzac Hour" also carried good wishes to the Middle East—to Australians and New Zealanders from their cobbers in London.

British troops also heard their "requests" played and sung in "Palestine Half-Hour" as well as in "Forces Favourites." Other messages to the Middle East, as well as to India, were sent out in Sandy Macpherson's programme.

# A Handy Wire-stripper

## A Useful Labour-saving Tool for the Constructor and Service Man

By "Ninejay"



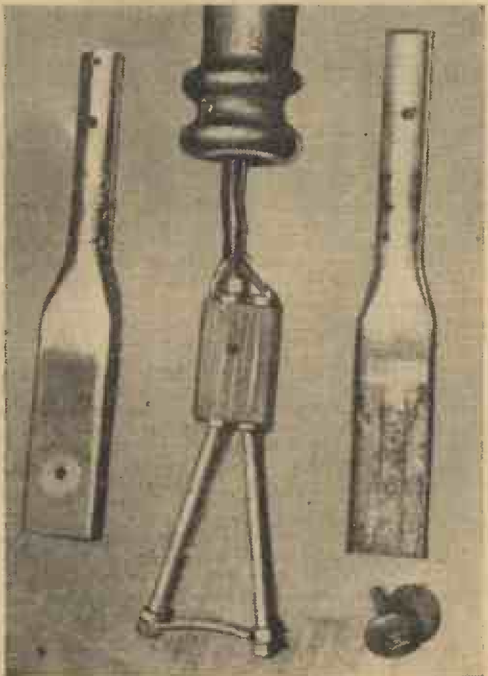
*The electric wire-stripper in use. It eliminates the possibility of damaging the conductor.*

WHEN a very tough covering has to be removed from a fine wire the need for a good wire-stripper is felt. A penknife or an old safety razor blade, which is so often used for removing the insulation, has the disadvantage of occasionally severing the wire or some of the strands. Even if the wire is not damaged, the result is not always too satisfactory so far as a neat end of the covering is concerned. The wire-stripper described strips the wire without putting the slightest stress on it, and this is a decided advantage when handling very fine gauge wires. Also, it is possible to strip wire in inaccessible places where, if other means were used, a good deal of trouble and a waste of time would be experienced before the operation was completed.

### Operation

The stripper uses a piece of resistance wire heated to a red heat, which will burn through the insulation of any wire normally used for radio work, with the exception of the asbestos covering of line-cords. To remove insulation it is only necessary to burn through the insulating covering right round the wire and then simply pull off the severed part. Should there be any loose cotton strands left, the stripper will expeditiously char them off. By using this simple device an extremely neat job can be done without leaving any clue as to the method used. It will cut through insulating sleeving as quickly as a pair of scissors, and in no instance has the stripper caused the insulation to catch light during the extensive service it has given the writer.

A transformer with an output of approximately 6 or 7 amps., at about 2 volts is required to heat the wire. In the stripper shown in the photographs, there was a loss of 1 volt in the lead from the transformer and 1 volt was dropped across the resistance wire.



*Before final assembly. The resistance wire anchored to the metal rods, ready for the covers to be fixed in position.*

### Construction

No constructional details are given, as the photographs are really self explanatory. The writer happened to have in the junk box an old electric soldering iron, which made the construction of the stripper a simple matter, the whole thing being made in less than an hour. If an old soldering iron is not available, it should not be very difficult to devise some alternative form of construction. The two rods to which the resistance wire is anchored were got from an old lead-in tube. It was necessary to thread with a 2 B.A. thread in the places where the nuts are shown. Brass rod suitable for a 3 or 4 B.A. thread would, if used, raise the efficiency, as being lighter, they would absorb less heat from the wire. On the other hand, if the wire is run at too high a temperature, it is very easily broken. A piece of an old 1,000-watt electric fire element provided the resistance wire. In the *interest of safety, it is advisable to earth* one side of the secondary in order to leave stripper free from all chances of electric shock.

# A Refresher Course in Mathematics

By F. J. CAMM

(Continued from page 82, January issue.)

## Trigonometry—Areas of Surfaces

**Rule of Pythagoras**

As the square of the base added to the square of the height equals the square of the hypotenuse, it follows that if we know the length of two sides of a right-angled triangle we can calculate the length of the third side. In Fig. 1 let the length of the base be 3ins., and the height 4ins. Then:

$$\text{Hypotenuse} = \sqrt{3^2+4^2} = \sqrt{9+16} = \sqrt{25} = 5$$

If we were given the lengths of the hypotenuse and one other side we *subtract* from the square of the hypotenuse the square of the other known side, and the *square root* of the answer is the length of the third side. If the two known sides are the hypotenuse and the base:

$$5^2-3^2=\text{height}^2$$
$$25-9=\text{height}^2$$
$$\text{height}=\sqrt{16}=4$$

Similarly, knowing the hypotenuse and the height:

$$5^2-4^2=\text{base}^2$$
$$25-16=\text{base}^2$$
$$\text{base}=\sqrt{9}=3$$

Often, however, we are given the angle and the length of one side, and we then make use of the trigonometrical ratios — sine, cosine tangent, etc.

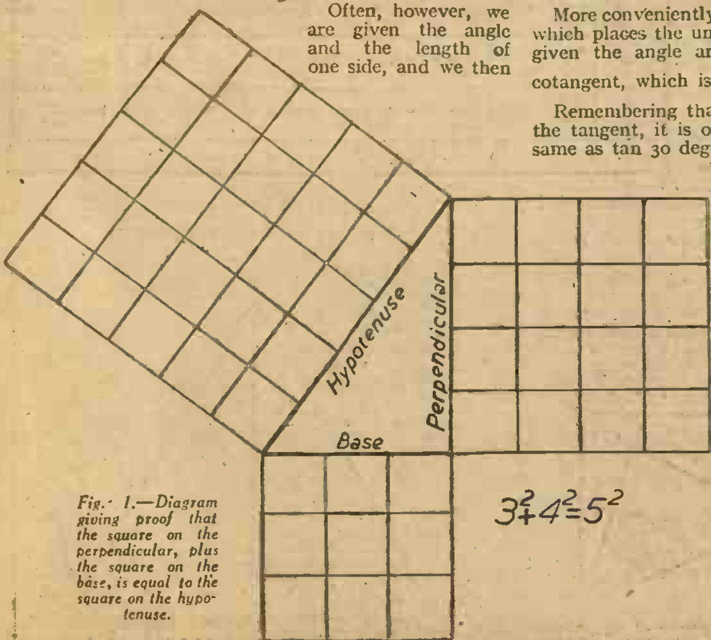



*Fig. 1.—Diagram giving proof that the square on the perpendicular, plus the square on the base, is equal to the square on the hypotenuse.*

For example, we are given the angle $a$ as 60 degrees, Fig. 2, and the length of the base as 3ins. We have seen that $\tan a = \frac{\text{Perp}}{\text{Base}}$, or:

$$\tan a = \frac{BC}{AB}$$

Consult a table of *natural tangents*, and read off the tangent of 60 degrees. It is found to be 1.7321. Therefore:

$$1.7321 = \frac{BC}{3}$$

By cross multiplication:

$$AB = 3 \times 1.7321 = 5.1963$$

Similarly, if we were given the perpendicular, and the angle as 60 degrees:

$$1.7321 = \frac{5.1963}{AB}$$

Hence:

$$AB \times 1.7321 = 5.1963$$
$$AB = \frac{5.1963}{1.7321} = 3$$

More conveniently, it is always wise to select a function which places the unknown side as a numerator. Thus, given the angle and the base, we should select the cotangent, which is, as we have seen, $\frac{\text{Base}}{\text{Perp}}$.

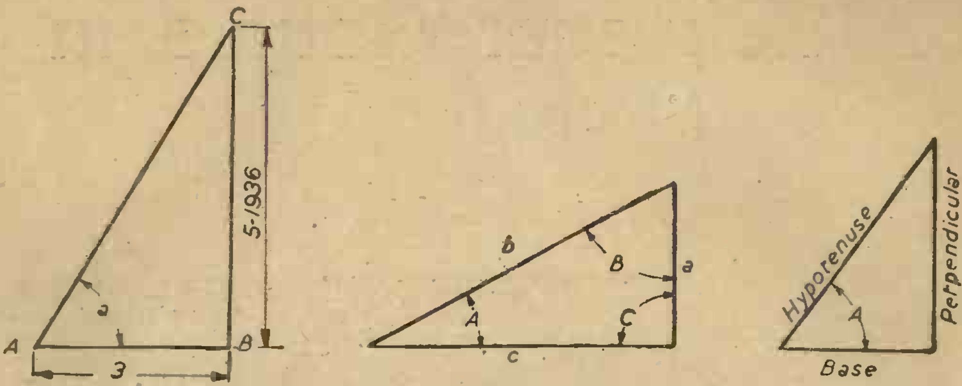
Remembering that the cotangent is the reciprocal of the tangent, it is obvious that cotan 60 degrees is the same as tan 30 degrees (in other words, 90 degrees − 60 degrees), and, by consulting the tables we find that tan 30 degrees is .5774. Therefore:

$$.5774 = \frac{AB}{5.1963}$$
$$AB = .5774 \times 5.1963 = 3.000$$

If we were given the angle and the perpendicular, and required to find the hypotenuse, we should use the cosecant of the angle. if the hypotenuse and angle were given and required to find the perpendicular we should use the sine; if the hypotenuse and angle were given and we required to find the base we should use the cosine, and if the base and angle were given and we required to find the hypotenuse, we should use the secant.

As the sine and cosecant are reciprocals,

$$\text{cosec } 60^\circ = \frac{1}{\sin 60^\circ}$$




*Figs. 2, 3 and 4.—Right-angle triangles.*

As the cosine and secant are reciprocals,

$$\cos 60° = \frac{1}{\sec 60°}$$

$$\tan 60° = \frac{2}{\cot 60°}$$

As the tangent and cotangent are reciprocals,

Thus, the sine of any angle is the same as the cosine of 90 degrees minus that angle. The cosine of any angle is the same as the sine of 90 degrees minus that angle. The tangent of any angle is the same as the cotangent of 90 degrees minus that angle. These rules hold in the converse—that is to say:

$$\text{cosec } A = \sin (90° - A)$$
$$\sec A = \cos (90° - A)$$
$$\cot A = \tan (90° - A)$$

Now memorise the following rules:

Given the angle and the hypotenuse, multiply the latter by the sine to obtain the perpendicular.

Given the angle and the perpendicular, multiply the latter by the cosecant to obtain the hypotenuse.

Given the angle and the hypotenuse, multiply the latter by the cosine to obtain the base.

Given the angle and the base, multiply the latter by the secant to obtain the hypotenuse.

Given the angle and the base, multiply the latter by the tangent to obtain the perpendicular.

Given the angle and the perpendicular, multiply the latter by the cotangent to obtain the base.

We can now construct a table, and in this connection reference should be made to Fig. 3.

There are many standard trigonometrical formulæ which are derived from the standard functions of angles. I give the more important of them here:

$$\tan 45° = 1$$
$$\sin^2 \theta + \cos^2 \theta = 1$$
$$\sec^2 \theta = 1 + \tan^2 \theta$$
$$\text{cosec}^2 \theta = 1 + \text{cotan}^2 \theta$$
$$\text{vers } \theta = 1 - \cos \theta$$
$$\sec \theta = 1 \div \cos \theta$$
$$\text{coversin } \theta = 1 - \sin$$

| Parts Given. | Parts to be Found. | | | | |
|---|---|---|---|---|---|
| | A | B | $a$ | $b$ | $c$ |
| $a$ & $c$ | $\sin A = \frac{a}{c}$ | $\cos B = \frac{a}{c}$ | | $b = \sqrt{c^2 - a^2}$ | |
| $a$ & $b$ | $\tan A = \frac{a}{b}$ | $\cot B = \frac{a}{b}$ | | | $c = \sqrt{a^2 + b^2}$ |
| $c$ & $b$ | $\cos A = \frac{b}{c}$ | $\sin B = \frac{b}{c}$ | $a = \sqrt{c^2 - b^2}$ | | |
| A & $a$ | | $B = 90° - A$ | | $b = a \times \cot A$ | $c = \frac{a}{\sin A}$ |
| A & $b$ | | $B = 90° - A$ | $a = b \times \tan A$ | | $c = \frac{b}{\cos A}$ |
| A & $c$ | | $B = 90° - A$ | $a = c \times \sin A$ | $b = c \times \cos A$ | |

$$\text{cotangent } \theta = 1 \div \tan$$
$$\text{cotangent } \theta = \cos \div \sin$$

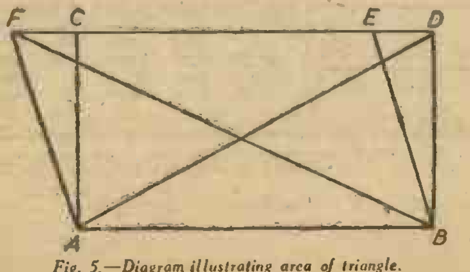



*Fig. 5.—Diagram illustrating area of triangle.*

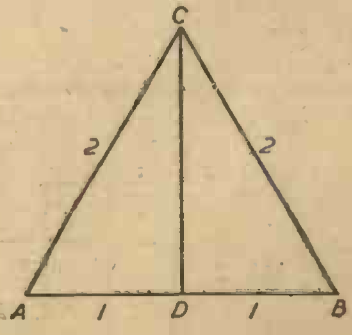



*Fig. 6.—Area of equilateral triangle.*

(Continued on page 123.)

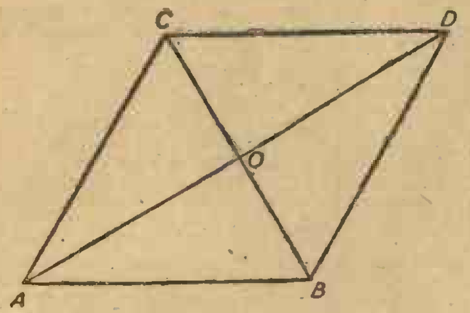



*Fig. 7.—Area of rhombus*

$$\begin{aligned}
\text{Tan} \times \text{cotan} &= 1 \\
\sin^2 + \cos^2 &= 1 \\
\sin 0^\circ &= 0 \\
\cos 0^\circ &= 1 \\
\sin 30^\circ &= \frac{1}{2} \\
\cos 60^\circ &= \frac{1}{2} \\
\cos 30^\circ &= \frac{\sqrt{3}}{2} \\
\sin 45^\circ = \cos 45^\circ &= \frac{1}{\sqrt{2}} \\
\sin 60^\circ &= \frac{\sqrt{3}}{2} \\
\sin 90^\circ &= 1 \\
\cos 90^\circ &= 0 \\
\sin 15^\circ &= \frac{\sqrt{3}-1}{2\sqrt{2}} \\
\cos 15^\circ &= \frac{\sqrt{3}+1}{2\sqrt{2}} \\
\tan\theta \times \text{cotan}\,\theta &= 1
\end{aligned}$$

Here are some examples which the reader should work out, and verify the answers. The examples all relate to Fig. 4.

The angle A is 27 degrees and the base is 3.25. Find the hypotenuse (remember that the secant = 1 ÷ cos). Answer: 3.6476.

Angle A is 47 degrees and the perpendicular is 4.45. Find the base. Answer: 4.1496.

Angle A is 64 degrees, and hypotenuse is 7.38. Find the perpendicular. Answer: 6.6331.

Angle A is 31 degrees, and the base is 2.18. Find the perpendicular. Answer: .8369.

Angle A is 71 degrees, and the perpendicular is 3.74. Find the hypotenuse (remember cosecant = 1 ÷ sin). Answer: 3.0955.

These examples should be varied, and the other sides of the triangle calculated, to check the previous answers.

### Area of Triangles and Quadrilaterals

The foregoing should enable the reader after a little practice to be able to calculate the lengths of sides of triangles and to calculate angles. As every triangle contains 180 degrees it is a simple matter in a right-angle triangle, where one of the angles is 90 degrees and the other is known, to calculate the third angle. For example, if one of the other angles is 30°, 90° plus 30° = 120°, and 180° − 120° gives the third angle as 60 degrees.

I will now deal with the area of triangles and quadrilaterals. The various forms of triangles and quadrilaterals have already been given. First draw the rectangle ABCD (Fig. 5), and then construct on it the parallelogram ABEF. It is obvious that the area of the rectangle and of the parallelogram are equal because parallelograms on the same base and of the same *altitude* must equal one another. It is also obvious that the triangle ABD is one half the area of the rectangle ABCD. It is also apparent that the triangle ABF is one half the area of the parallelogram ABEF. It follows, therefore, that the two triangles ABD and ABF must also be equal in area. Expressed as a rule: *The area is equal to half the product of the base and the altitude in each case.* Expressed in the more usual way:

$$\text{Area of triangle} = \tfrac{1}{2}\,(\text{base} \times \text{altitude}) = \tfrac{1}{2}\,ab.$$

Thus, if we know two sides of a right-angle triangle, we can find the area. For example, a right-angle triangle has sides of lengths 6, 8, and 10ft. respectively. Obviously the longer side must be the hypotenuse, so we ignore that and multiply 6 and 8 together, dividing the result by 2. The area of the triangle will therefore be:

$$\tfrac{1}{2}\,(6 \times 8). = \frac{48}{2} = 24 \text{ sq. ft.}$$

If the right-angle triangle has two equal sides, so that the two obtuse angles are 45 degrees, then it is also an *isosceles* angle.

An *equilateral* triangle has sides of equal length, and therefore each angle must be 60 degrees, that is to say 180 degrees divided by 3.

If each side of the equilateral triangle is 2ins. long the area will be AD x CD. We must calculate CD by Pythagora's Rule. (Fig. 6.)

$$AD^2 + CD^2 = AC^2$$
$$CD = \sqrt{2^2 - 1^2}$$
$$= \sqrt{3}$$

Therefore, *when one angle of a right-angle triangle is 60 degrees the three sides are in the ratio of 2, 1, and $\sqrt{3}$ to one another*. Hence, the area of the triangle ABC = $\tfrac{1}{2} \times 2 \times \sqrt{3} = \sqrt{3}$. We see, hence, that to calculate the area of an equilateral triangle *we must know the vertical height.*

We can also calculate the area of a triangle if we know the length of the three sides by applying the formula:

$$\text{Area} = \sqrt{s\,(s-a)\,(s-b)\,(s-c)}$$
$$\text{Where } s = \frac{a+b+c}{2}$$

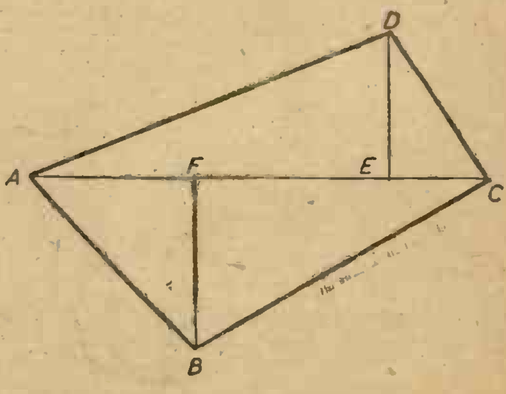



*Fig. 8.—Area of quadrilateral.*

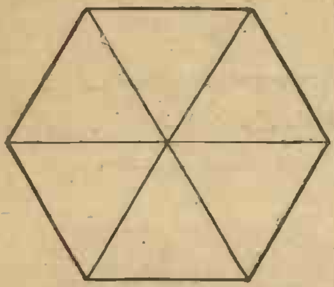


*Fig. 9.—Area of regular hexagon*

and $a$, $b$, $c$, are the lengths of the sides respectively. In other words *the length of each side is subtracted from half the sum of the sides and the three remainders are multiplied together. The result is multiplied again by half the sum of the sides, and the square root of the product is extracted to obtain the area.* This *rule also applies to right-angle triangles.*

In the right-angle triangle dealt with in the previous example, in which the sides were 6ft., 8ft., and 10ft., respectively:

$$s=\frac{6+8+10}{2}=12$$

$$\text{Area}=\sqrt{12\,(12-6)\,(12-8)\,(12-10)}$$
$$=\sqrt{12\,(6)\,(4)\,(2)}$$
$$=\sqrt{576}$$
$$=24 \text{ sq. ft.}$$

### Area of Rhombus

It is important to remember, as will be seen from Fig. 7, that the *diagonals of a rhombus intersect one another at right-angles.* It will be observed from this illustration that OB represents the height of the triangle ABD, and OC the height of the triangle ADC. From this we deduce that *the area of a rhombus is equal to the area of the two triangles.* This equals:

$$\tfrac{1}{2}(AD\times OB)+\tfrac{1}{2}(AD\times OC)$$
$$=\tfrac{1}{2}(AD\times BC)$$

It will be seen, therefore, that *the area of a rhombus is equal to half the product of the two diagonals.* It is important to remember that *all the sides of a rhombus are equal in length.* In examinations it is usual to give the length of a diagonal and the length of one side, from which the student is asked to calculate the area. This is done using the rule given previously, calculating the area of the triangle ABD and multiplying by 2.

### Area of Quadrilaterals

All four-sided figures are known as *quadrilaterals* whatever the lengths of their sides (Fig. 8). Divide the figure into two triangles; obviously the area of the quadrilateral is the sum of the areas of the two triangles. Perpendicular to AC erect the lines FB and ED, thus creating right-angle triangles ABF and ECD. Obviously the area of the triangle ACD $=\frac{1}{2}$ (AC $\times$ DE), and the area of ABC $=\frac{1}{2}$ (AC $\times$ FB). It follows that the area of the quadrilateral $=\frac{1}{2}$ AC (FB + DE).

Reduced to a rule, *the area of the quadrilateral is equal to half the product of one of the diagonals and the sum of the two perpendiculars.*

### Area of Polygons

A figure having more than four sides is known as a *polygon*, and it is well to learn the correct names of figures having various numbers of sides.

A three-sided figure is a *triangle.*

A four-sided figure (*square, rectangle, parallelogram, trapezium, rhombus*) is known as a *quadrilateral.*

A five-sided figure is known as a *pentagon.*

A six-sided figure is known as a *hexagon.*

A seven-sided figure is known as a *septagon* or *heptagon.*

An eight-sided figure is known as an *octagon.*

A nine-sided figure is known as a *nonagon.*

A ten-sided figure is known as a *decagon.*

An eleven-sided figure is known as an *undecagon.*

A twelve-sided figure is known as a *duodecagon* or *dodecagon.*

A fifteen-sided figure is known as a *quindecagon.*

Two lines which intersect one another are known as an *angle.* A six-sided figure as shown in Fig. 9 contains six equal equilateral triangles, and thus the figure is a *regular hexagon.* Obviously the area of the figure is six times the area of one triangle. It will be found from previous reasoning that the area of a hexagon

$$=6\times\frac{a^2}{4}\sqrt{3}$$

$$=\frac{3}{2}\,a^2\sqrt{3}$$

where $a$ = length of one side.

As the square root of 3 and the square root of 2 frequently occur in calculations, they should be memorised. The square root of 2 is 1.414, and the square root of 3 is 1.732. A shorter rule for the area of a hexagon is: 2.598 (Length of side)$^2$.

It follows that if we know the area of a hexagon we can find the length of the side. For example, if the area of a hexagon is 480 sq. ft. we have:

$$480=2.598\,a^2$$

$$\text{Therefore}\quad a^2=\frac{480}{2.598}$$

$$a=\sqrt{\frac{480}{2.598}}$$

$$a=\sqrt{180.47}$$

$$a=13.44\text{ft. (approx.)}$$

To find the area of an *irregular polygon* divide the figure into a number of triangles, calculate the area of each triangle, and add the results together.

### Area of Trapezium

To find the area of a trapezium divide the figure into two triangles, ABC and ACD (Fig. 10), and calculate the areas in the ordinary way. The altitude of the triangles may be found by erecting a line from C, perpendicular to AB. It will be found after a few examples have been worked out that to obtain the area of a trapezium it is only necessary to *multiply the sum of the parallel sides by one-half the perpendicular distance between them.*

(*To be continued.*)

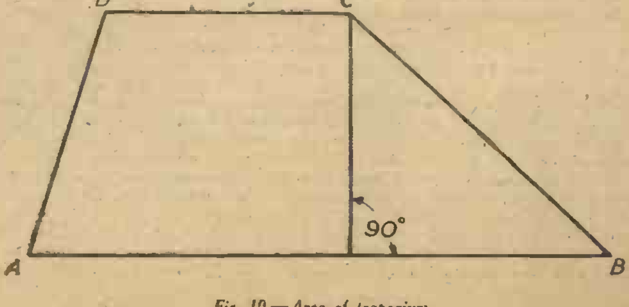



*Fig. 10.—Area of trapezium.*

# BRITISH LONG DISTANCE LISTENERS' CLUB

## A SHORT-WAVE STATION REGISTER

**This is Your Chance to Take an Active Part in Some Interesting S.W. Work by Helping to Compile a Complete Register of S.W. Stations**

THE need for a complete list of the short-wave transmissions of the world is great; every S.W. enthusiast requires accurate information to which he can refer for verification and completion of his logging. For a register to be of practical use, it must contain everything connected with the transmission and reception of a station, and we feel that the time has now arrived when the structure of such a list or register can be commenced.

The work involved in such a venture is likely to be heavy and prolonged, but we are of the opinion that the results will be of such great service to all S.W. enthusiasts that the time and labour spent on the task will amply be repaid.

In these days of staff shortage, it is impossible for our checking station to undertake the work single-handed; the logging of any one transmission in, say, London, is not, in itself, any criterion of reception of the same station in Glasgow or Cornwall. To secure and compile comprehensive data, therefore, it is necessary to have the enthusiastic support of a band of keen amateurs, and we are confident that such a band is to be found in the ranks of the B.L.D.L.C. Are you prepared to volunteer for this service? We know that listening time is, for most of us, somewhat drastically cut, owing to more pressing activities these days, but even so, the Rx is usually brought into action on one or more days (or nights) a week. After all, there are very few better means of securing mental and physical relaxation, at least so far as radio amateurs are concerned, than a spell at the controls of the Rx.

If you are keen on S.W. listening, and if already you have compiled a reasonable log, then you can play an important part in this necessary service, by keeping us informed of the stations you log from now on. We wish to be quite fair about the matter; as the work progresses, it will not always be as easy as it sounds, as it is quite possible that some correspondence will be involved and that we may ask you to spend a certain amount of time checking one or more particular transmissions. However, we shall do our utmost to make everything as easy as possible, but more about that when we get all the "B.L.D.L.C. Checking Stations" in operation.

### An Efficient Station

TO undertake the work, it is, of course, necessary to have an efficient station. This does not mean that a multi-valve receiver must be in use, but it does mean that the whole installation must be capable of putting up a very good show as regards DX, and, equally essential, the owner/operator must have sufficient skill to get the best from the apparatus available. It so often happens that a good 0-v-1 outfit in experienced hands will produce a fine log, therefore, it is not possible to make any ruling regarding Rx's.

Some members appear to get the best results on a certain frequency band; others get much better signals from the stations "down under," while another group of members find that they are able to work all continents with remarkably consistent success. These individual characteristics can be put to good use. It is highly probable that we shall ask some members to concentrate on, say, definite frequency bands; others will be requested to report on transmissions from Australia, China, Africa, etc., while those who can rope in all continents might well be expected to act as additional "checks" on transmissions already reported. By these means we shall be able to get the most comprehensive and accurate data to pass on to all members, while those undertaking the work will still be able to obtain the maximum interest from their particular field of activity. There will not be any stipulations about fixed periods of listening, or any irksome regulations to hamper the spirit of co-operation. If, as we anticipate, a large number of members take part in the proposed activities, there will be few of the twenty-four hours of each day and night during which no "checking station" is at work. If you are interested, and if you wish to be one of the band of S.W. enthusiasts who is going to check up on the world's S.W. transmissions, then get in touch with us by return.

### Details Required

TO enable us to get some idea of your station, your capabilities and past DX work, please give—as briefly as possible—the following details:

- Name, Membership No. and address of station.
- Type of Rx in use. (Number of valves, circuit, mains or battery.)
- Type of aerial and its direction.
- Best reception on/from. (State frequency band or country if this applies. If good all-round working is obtained, say, All Continents.)
- Time of day you normally operate your Rx.
- Number of hours at Rx during a week. (Approximately.)
- Pick of your log during, say, the last month or two.
- How long you have been a S.W. enthusiast.

When supplying the above details, there is no need to write out question and answer: just write the answers—briefly—below each other in the same order as the questions. Don't let your enthusiasm run away with your pen and write a long letter full of details not wanted at this stage. You need a register of short-wave transmissions to help you with your work, but, to all practical purposes, it is impossible for you alone to compile all the details necessary to make it complete. Co-operate, therefore, with other enthusiastic members and Headquarters, and help to build up a reliable and comprehensive short-wave register for the use of all members, through the medium of the B.L.D.L.C. pages each month.

### R.S.T. Code

A MEMBER—E. H. Trowell, No. 5,932, of Sheerness—has some interesting things to say concerning the use of the various codes used when making a report on a transmission.

"In reply to Member 7,065, R. W. Iball, on the question of report codes in the January, 1943, issue, I should be glad if you would confirm and publish the following remarks.

"The R.S.T. report code was devised by an American amateur, W2BSR, and is in general use among amateurs the world over for reporting on the 'readability,' 'signal strength' and 'tone' of telegraphic transmissions. The QSA-QRK code is an official code and was adopted at the Cairo Convention in 1938, and details of this code may be obtained from the 'Handbook to Wireless Operators' published by H.M.S.O. This code is generally used for telephony transmissions. Whilst Member 7,065 attempts to correct others in his letter, he is himself wrong. His mistake, and the mistake of many other members when reporting on a station, is to give a code signal of R6 or even R7, R8 or R9. There is no such thing as R6, 7, 8 or 9, as the R scale in the R.S.T. system finishes at R5, and in the official QSA-QRK system the QRK code finishes also at QRK5. A report under the R.S.T. system would be R.S.T. 599x for the perfect signal and under the QSA-QRK official system it would be QSA5-R5 T9. (The x represents a crystal-controlled note.) In the latter code it is usual to omit the Q and K in the QRK code unless the QRK code is being used on its own, then the Q and K are added to avoid confusion with the R code in the R.S.T. system.

"I hope that I have cleared up any misunderstandings about the report codes and I think that it would be a good idea if you published an article explaining in detail the two systems.

"Re Member 7,214, Alan McGugan's query on BNBI, I think he will find that this is WNBI.

"In conclusion I should like to say how I appreciate 'Thermion's' remarks on the 'Anti-slush Front,' and I trust that he will continue in his efforts to abolish the 'song-plugging' attitude which is in force in the U.S.A. and is now creeping into the B.B.C. services. Also I should like to compliment everybody concerned in the production of PRACTICAL WIRELESS for the way they have surmounted the many difficulties encountered during the production of a journal in war-time."

Members who contemplate taking part in the short-wave register movement might make sure that they are familiar with the codes mentioned in 5,932's letter, as they play a very important part in the writing up of log-sheets. However, we shall have more to say about it at a later date.

**Littleworth, Stafford**

HERE are some extracts from a letter we have received about our design P.W. 88. The writer is Member 8,047, P. W. Boulton.

"Since last writing you I have constructed an 0-v-1 short-waver, with which I have logged quite a number of stations, the R being excellent in operation. The circuit is the one published in the October issue of PRACTICAL WIRELESS, Blueprint No. P.W. 88, 'Simple Short-wave One-valver.'

"After testing the set I added an L.F. stage, transformer coupled, and the volume obtained is now ample on all bands. Later I fitted a band spreader, and that made the tuning much easier. Many thanks to your fine paper, PRACTICAL WIRELESS, for turning out such a good circuit.

"Well, my next effort was a multi-range meter, and after a hard struggle I managed to collect the necessary parts and get on with the job.

"By the way, I have photographed my 'den,' but the prints are not really suitable for publishing, so as soon as I can get another film for my camera I shall try again, and hope to have better luck. The apparatus I am now constructing is a power pack, but this is far from complete, owing to the shortage of components. There's just one other point before I sign off, and that is, please keep PRACTICAL WIRELESS at its present size; it is more handy and easier to bind.

"I recently joined the A.T.C., and I think it is very interesting."

**A Useful "Mike" Stand**

L. COLE, of Swaythling, No. 6,410, has made a handy microphone housing and stand from odds and ends. He gives full details in his letter, which appears below.

"Here are the details of a microphone housing and stand which I made from spare parts out of my junk box. The microphone itself consists of a telephone inset 2½in. diameter which fits into the head of a discarded torch. Before fitting inset in casing, I made two holes the size of the fixing screws on a headphone bracket, one on each side of torch head, ⅜in. from its front. I next fitted inset inside torch head and bolted headphone bracket in position. For the support I removed 8in. rod from inside an aerial lead-in tube, removing terminal and replacing it in reverse position to give more support to microphone bracket. Complete this section by fitting nut to end of rod, thus holding bracket and microphone firm. At the other end of rod I fitted a large-threaded washer, and then passed the remainder of threaded portion of rod through (in my case a metal stand from an old hanging clock), but a wooden base will do equally as well. When this instrument is connected to pick-up sockets via a suitable microphone transformer and a 4½-volt battery, it is very sensitive and will pick up a voice anywhere in a medium-sized room."

**Any Reports**

J. BAILEY, No. 7,064, of Bury, makes his first contribution to this page—for which many thanks—and seeks information about a S.A. transmission:

"I wish to compliment you on the way PRACTICAL WIRELESS has managed to keep appearing, and to be as bright and interesting as it is during these, shall we say, difficult times. May it keep its high standard in the coming year.

"This is my first attempt at writing you, as my DX log is hardly worth shouting about, owing to pressure of work and Civil Defence duties, etc., but I have one query. On Sundays November 22nd and 29th, I heard what I presume to be the South African station Johannesburg, operating on approximately 33 metres. The reception strength was very good—about 8 (?); but as I am without any up-to-date record of this station I wonder if any other member has heard it. I can recommend the programme as being good entertainment. They give a sponsored programme from 5.30 p.m. G.M.T., followed by record requests, the news in Afrikander, and then the news in English at 6.45 G.M.T., closing at 7 p.m. G.M.T. No station identification.


*The "mike" housing and stand made by L. Cole. The sketch shows that it is a neat and business-like arrangement.*

"The only other stations in my log include the usual crop of W's—WGEA, WRUL, WCW, WIWO, WRCA, WDO, WMB1—Helsinki in the 30-metre band, and U.S.S.R. and Radio-Assam on the 26.16 and 31.92 metres.

"My RX outfit is Hallicraft Sky Champion with an inverted L antennæ W.N.W."

**New Hampshire**

MEMBER 7,217, R. E. Tautz, of New Malden, seeks details of the transmission mentioned below.

"Can you or any member supply me with information about a short-wave station operating from Dublin, New Hampshire? It broadcasts on Thursday nights only, between 21.30 hours and 22.00 hours, about 19.7 metres, to Dublin, Ireland.

"I logged it on 27-8-42 at 21.45 hours with fairly good reception."

**Finally**

GIVE our opening remarks careful consideration and get in touch with us by return.

# Impressions on the Wax

## Review of the Latest Gramophone Records

**Columbia**

I BEGIN with that impressive work by Tchaikowsky, "Hamlet" (Fantasie-Overture), which, in four parts, is recorded on *Columbia DX*1101-1102. The performance is by Constant Lambert, with the Hallé Orchestra, and he gives us another example of his complete understanding of Tchaikowsky's work. The music is rich in melody, and a delightful waltz theme is cleverly woven into the composition, which reaches an exhilarating finale with a typical Tchaikowsky march. Students of Tchaikowsky will understand what I mean when I say that much of his music has a peculiar touch of melancholy, which, perhaps, was common to his outlook. His "Symphony No. 4 in F Minor," Op. 36, which is recorded in ten parts on *Columbia DX*1096-1100, is a striking example of Tchaikowsky's moods or temperament. The first of the four movements is both poignant and hopeless, but in the third we are given a gay tone picture of a tipsy peasant and a street song, while in the distance is heard a military band. Jumping to the finale, this opens in a boisterous manner, and introduces a Russian folk melody, but as the fifth record approaches its end, one cannot miss the air of melancholy which descends as the symphony comes to a close. The Hállé Orchestra, under the baton of Constant Lambert, make a wonderful recording of the whole work.

Isobel Baillie, soprano, has selected for her recording on *Columbia DX*1103, Recit: "Shall Pales be the Last" (Diack), Aria: "Flocks in Pastures Green Abiding." Miss Baillie gives a most enjoyable performance.

Here is a record which is issued for the benefit of the Welfare Funds of the three Services, and although this in itself is sufficient justification to purchase it, its subject is closely associated with this time of the year. The record is *Columbia DX*1104, and its title is "Cinderella"—two parts. It is listed as "An All-Star Souvenir of the 1942 Forces Pantomime," and believe me it is. I recommend it to all.

Turning now to the 10in. records, there is a fine piano duet by Rawicz and Landauer on *Columbia DB*2102. They play in beautiful style the two Slavonic Dances, Nos. 1 and 8, by Dvorak, arranged Rawicz and Landauer.

John McHugh, tenor, gives a fine rendering of "Waiting For You" and "To the Land of My Own Romance," with orchestral accompaniment, on *Columbia FB*2870.

The Albert Sandler Trio always provides pleasant listening, and this month—on *Columbia DB*2101—one is able to enjoy "Jealousy" and "Mitzi."

Victor Silvester and his Ballroom Orchestra have selected a fine slow fox trot and a waltz for his recording on *Columbia FB*2872. The pieces are entitled "Not a Cloud in the Sky" and "Where the Waters Are Blue."

Felix Mendelssohn and his Hawaiian Serenaders offer "Waltz Time in Hawaii," Parts 1 and 2, on *Columbia FB*2871. Some popular melodies nicely orchestrated.

**H.M.V.**

A FEW months ago there was a broadcast concert of contemporary American music, and included in the programme was one work which made a great impression on the musical public and the leading musicians. It was "Symphony No. 3" by that modern American composer, Roy Harris, who, incidentally, was, at one time, a student of Arthur Bliss, director of music of the B.B.C.

Serge Koussevitzky and the Boston Symphony Orchestra have made an outstanding recording of this symphony on *H.M.V. DB*6137-6138—three parts.

The popularity of the Kentucky Minstrels goes without saying, and their latest record—*H.M.V. C*3313—is, I think, one of their best. They give a fine performance of Doris Arnold's arrangements of "The Better Land," soloist is Denis Wright; conductor Leslie Woodgate.

John McCormack, tenor, accompanied by Gerald Moore at the piano, makes another splendid recording on *H.M.V. DA*1829 when he sings, "Oh! Could I But Express in Song" and "Plaisir D'Amour."

From the Dance Bands I have selected "It Costs So Little" and "Only You," both fox trots played by Joe Loss and his Orchestra on *H.M.V. BD*5781; and Glenn Miller and his Orchestra playing "Let's Have Another Cup of Coffee" and "Chip Off the Old Block" on *H.M.V. BD*5784.

"Hutch" sings "Just Around the Corner" and "Where the Waters Are Blue," *H.M.V. BD*1027.

Walt Disney's "Bambi" gave us some fascinating music, and the H.M.V. recording of "Little April Showers" and "Love is a Song," on *BD*1021, should have a wide appeal, especially among the children.

**Decca**

THE four movements of Schubert's "Sonatine," Op. 137, No. 3, are contained on *Decca K*1074-1075. They are played with great understanding and expression by Ida Haendel—solo violin—with Adela Kotowska at the piano. On the second side of *K*1074, the same artists record the Ballet Music from 'Rosamunde," Schubert, arr. Kreisler.

Vera Lynn—accompanied by Mantovani and his Orchestra—offers "When the Lights Go On Again" and "Twilight Waltz," on *Decca F*8241.

Anne Shelton—with orchestral accompaniment—asks "Why Can't It Happen To Me," and then tells us that "It Costs So Little," on *Decca F*8243.

Ambrose and his Orchestra—on *Decca F*8242—has recorded "Nightingale," and "My Serenade," a slow rumba and slow fox-trot respectively.

Music While You Work Series, Nos. 9 and 10, consist of Nos. 1 and 2 of "Talkie Hits Revival Medley," on *Decca F*8238.

**Parlophone**

RICHARD TAUBER, tenor, has made a very fine recording in Latin, and with choir, of "Panis Angelicus" and "Ave Maria." *Parlophone RO*20517.

"Tin Pan Alley Medley, No. 51," by Ivor Moreton and Dave Kaye, is on *Parlophone F*1957.

Geraldo and his Orchestra give us two good numbers on *Parlophone F*1953. They are "Who Wouldn't Love You" and "Love Is A Song." A nice record.

The Organ, the Dance Band and Me, are particularly good on *Parlophone F*1955, on which they have recorded "It Costs So Little" and "When the Robin Sings His Song Again," two very pleasing fox-trots.

**Rex**

JACK SIMPSON and his Sextette, playing "Don't Do It Darling" and "The Sleep Song," on *Rex* 10162, complete my selections this month.

**Brunswick**

BING CROSBY—with Vic Schoen and his Orchestra—sings in true Crosby manner, "Conchita, Marquita Lopez," on *Brunswick* 03390*A*. On the other side, 03390*B*, this time with Dick McIntire and his Harmony Hawaiians, "The Singing Sands of Alamosa."

Russ Morgan and his Orchestra have made a good recording of "Nightingale," and is well supported on the other side of the disc by Guy Lombardo and his Royal Canadians playing "Idaho." These two performances are on *Brunswick* 03407 *A* and *B*. Fred Waring and his Pennsylvanians have taken two numbers from "Yankee Doodle Dandy"—namely, "Mary's a Grand Old Name" and "Over There." The number is *Brunswick* 03408 *A* and *B*.

# Open to Discussion

**The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).**

## "P.W." in West Africa

SIR,—I have just received your interesting journal for November, which helps to keep in touch and make the wheels go round in this land of sunshine, mosquitoes and a thousand and one of nature's other pests.

I get PRACTICAL WIRELESS sent out from the U.K., but am afraid it is not always possible to obtain a copy here.

We manage to keep in touch (battery permitting) through a commercial 5-v. superhet which gives reasonable all-round reception, although the outsize in electrical storms in West Africa do not help matters.

During normal hours of listening the main short-wave stations of the U.K. and U.S.A. and one or two strong French signals come in with fair background noise, but we generally manage to sort things out.

To keep a strong signal with as little background as possible, after a lot of experimenting with all types of aerial, a vertical rod, 10ft. in length, approximately 20ft. above ground, appears to give the best results, with a fair amount of attention to earthing.

Your journal has plenty of reading matter and gets around before going to "earth."

With all best wishes to your paper and for its continuance.—L. MARSH (West Africa).

## An Inexpensive Meter

SIR,—I am sure many readers, including myself, were interested in the article on an "Inexpensive Meter" in the January issue of PRACTICAL WIRELESS. No doubt many readers have by now tried to construct the bobbin, and I expect that they have all had the same difficulty as myself in handling that fine wire. However, after much experimenting I have constructed the meter, and other readers may find my hints and dodges useful.

First, I had great difficulty in getting any fine copper wire at all, and then I couldn't get the right gauges, so I dismantled an old L.F. transformer which had a large bobbin, and this saved me doing any winding at all. By connecting the primary and secondary turns together at one end I already have a dual-range instrument in the making.

Next, instead of using a bristle, as suggested in the article, I have used a thin strip of aluminium foil cut from the core of a faulty electrolytic condenser, and shaped appropriately. The rest of the instrument is on the same lines as the one illustrated in PRACTICAL WIRELESS, and the finished meter is most satisfactory.

In conclusion, I should like to point out that the bobbin is about 2in. wide in my case, as compared with ¾in. given in the article. This gives a more uniform field at the centre, and allows of larger scale deflections without introducing errors due to large movements of the compass needle.—C. G. B. DUBOIS (Bristol).

## Stations HCJB and WRUL

SIR,—I read with interest the letter of J. W. Macvey in the December issue on HCJB, and would like to add a little more about that transmitter.

The new HCJB transmitter, at the present time, has a four-element, close-spaced rotary beam fed by a 500 ohm line delta-matched. The antenna is two half-waves high, the entire mast being rotatable. The mast weighs approximately 2 tons, and is 95 ft. high. The general practice of a buried copper wire-fixed ground is used. The transmitter tube line-up is a 42 oven-crystal oscillator, supplying a pair of 807 push-pull doublers, driving a pair of 100THs in parallel, and feeding a push-pull stage 450TLs. The final RF stage is a push-pull F129B Federal tubes designed for television operation. The modulator is a resistance impedence coupled driver, making it produce 18DBs of inverse feedback into the audio final, which is a pair of F891s. The transmitter has the conventional protection of overload relays and automatic power switches.

Also, here is the latest schedule from WRUL:

(Times are Eastern War Time). Dial 15.35 Mc/s, 11.79 Mc/s, or 6.04 Mc/s (beamed for Europe and Australia). 4.30 p.m., World News; 4.45 p.m. (Mondays, Wednesdays and Thursdays), With Our Listeners; (Tuesdays and Fridays), Inspirational Period; 5 p.m., Friendship Bridge; 5.15 p.m. (Mondays, Wednesdays and Fridays), for Australia; (Tuesdays, Thursdays and Sundays), for American Forces Abroad; 5.30 p.m., (Mondays, Wednesdays and Fridays), What America is Thinking. Dial 6.04 Mc/s, 9.70 Mc/s, or 11.73 Mc/s (beamed for Western Hemisphere). 6.45 p.m., World News; 7 p.m., Music for the Dinner Hour; 7.15 p.m., Dramatised American History on Monday, and Vagabond Traveller on Wednesday; 7.30 p.m. (Tuesday), World of Science; (Thursday), World of Books; (Friday), Fight for a Free World; 7.50 p.m., Sports Commentary by James Britt, of MBS.

News from XGOY on 25.21m. at 9.30 p.m. B.S.T. VLG3 Melbourne on 25.62m. at 7.55 a.m.; and VLQ5, Sydney, 30.99m. at 7.55 a.m.—B. G. MEADEN (Liverpool).

## S.W. Listening

SIR,—I have conducted some correspondence with A. W. Mann, and we have quite removed the difference of opinion which existed between us. Mr. Mann suggested that I might inform you of the fact. Incidentally, the S.W. receiver of mine in question *does* tune below 9 metres with the standard coil of 9 metres advertised minimum—8.44 metres to be exact.

I thank you for your kind attention, and hope PRACTICAL WIRELESS will continue to receive its highly deserved success.—F. G. RAYER (Gloucester).

## Midget Receivers

SIR,—I am particularly interested in designs for midget receivers, and feel that your present policy of giving more latitude in the specifications might well be continued after the war. I, personally, as a constructor of rather modest means, am only too pleased to get circuits in which spare components I have by me can be worked in.

May I mention that I particularly look for articles on theory, such as those by S. C. Murison and S. A. Knight, and I greatly enjoy the present series by "The Experimenters." Wishing PRACTICAL WIRELESS continued success.—W. D. E. WHITE (Watford).

# Replies to Queries

## RULES

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we can not, for obvious reasons :—

(1) Supply circuit diagrams of complete multi-valve receivers.
(2) Suggest alterations or modifications of receivers described in our contemporaries.
(3) Suggest alterations or modifications to commercial receivers.
(4) Answer queries over the telephone.
(5) Grant interviews to querists.

A stamped, addressed envelope must be enclosed for the reply. All sketches and drawings which are sent to us should bear the name and address of the sender.

Requests for Blueprints must not be enclosed with queries as they are dealt with by a separate department.

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. The Coupon on page iii of cover must be enclosed with every query.

### Special Circuits

**"I have collected a quantity of various components (see enclosed list) and I would like you to supply me with a sketch diagram of a circuit designed around the parts. A three- or four-valve set would suit."—H. F. (Lewisham).**

SEE Query Rules. We cannot prepare and draw diagrams of circuits to suit individual requirements. We refer you to "Sixty Tested Wireless Circuits," price 6s. 6d. post paid, and the list of our Blueprints given in the back of each issue of PRACTICAL WIRELESS.

### Two-valve Portable

**"I am very interested in the small 2-valve set described in the October issue by R.A.F. Member 5,560, and I wish to know if it is possible to get more complete constructional details?"—J. S. W. (Herts).**

THE set to which you refer is a modification of one originally described in the February (1942) issue, under the title "Small Portable Receivers." As we cannot undertake to supply complete details by letter, we would suggest you try to secure a copy of the issue mentioned.

### Universal Hall Mark

**"I obtained from you recently the blueprint P.W. 47 of the 'Universal Hall Mark.' Could you inform me of the size and type of mains dropping resistance and of the type of valves used in this circuit?"—J. W. A. (Surrey).**

AS the specified mains resistance is not obtainable, we would suggest, that you endeavour to secure a Bulgin Type, MR67. The valves used in the original design were: Tungsram H.P. 2118, R. 2018, P.P. 4118, P.P. 4118 and P.V. 3018.

### S.W. Reception on Frame

**"It being inconvenient to erect an outside aerial, I have for a considerable time studied your valuable periodical with a view to discovering a circuit for S.W. working on a frame aerial. I shall be extremely obliged if I may hear whether it is possible to operate a set thus for S.W.; if so, should a connection still be made to earth and should a second stage of H.F. be incorporated either tuned or choke coupled?"—R. A. G. (Herts).**

WE do not recommend the use of a frame aerial for normal amateur work, owing to the very low pick-up obtained. If it is not possible for you to erect an outside aerial, then we would suggest that you experiment with a simple aerial arrangement erected around the room in which the receiver is used. If you suspend a wire around three sides of the room so that it is, at least, one foot clear of the walls and ceiling, it is quite possible that you will obtain very satisfactory results. As height plays an important part in the efficiency of any aerial system, best results will, of course, be obtained if the receiver is used in a room above ground level.

### 0-V-1, Etc.

**"I should be much obliged if you would enlighten me on the following :**

**"What does 1-V-1 and 0-V-1 stand for?**

**"Does a good one-valve short-wave set give a reasonable performance with the absence of amateur stations?**

**"I have two screened coils, which have their wave-change switches ganged. Can you give me the connections and/or the maker of the coils? The coil numbers are F.C. 1109 and F.C. 1110."—B. J. G. (Wilts).**

THE expressions 1-V-1 and 0-V-1 have been explained in detail in several past issues. They are used to denote the valve sequence of a circuit. The capital V always denotes the detector valve, and the figure preceding it the H.F. valves, and that following it the L.F. valves. The first example means that the receiver consisted of one stage of H.F. amplification plus a detector and one L.F. stage.

A good one-valve short-wave receiver is capable of putting up a very satisfactory performance.

We cannot determine the make or type of coils from the details provided.

### Wattage

**"I would be very much obliged if you could supply me with a formulae to solve my problem. I wish to find out the 'watt' output of my two-valve amplifier. Is it an Ohms Law problem?"—J. M. (Essex).**

WE are not sure from your letter whether you are referring to the wattage consumption as regards H.T., or the wattage output of the receiver as regards the speech and music. If it is the former, then it is merely a matter of multiplying the total H.T. current consumption by the applied H.T. voltage, bearing in mind the necessity to express the current as a fraction or decimal part of an ampere.

The calculation of the A.C. wattage output is rather too involved for us to describe here; therefore we think it would be better if you accepted the valve-makers' figures.

### W.M. S.W. Converter

**"I have purchased one of your blueprints. It is the W.M. A.C. Short-wave Converter (WM408).**

**"I have all the necessary components, with the exception of the valves. I find, however, that the types are not stated. The first valve appears to be an A.C. S.G. type. The second one, however, is of the multi-electrode type. I wonder if you could tell me the type of valve this is?**

**"Also, does the set's mains unit drive the Converter or does it have its own mains unit?"—R. J. L. (Surrey).**

THE valves required for the Converter are one Cossor MSG/HA and one Osram X41. It is advisable to use a separate small mains transformer to supply the heaters of these valves, but it should be possible to obtain the H.T. from the receiver, or from a normal 120-volt H.T. battery.

A complete list of the components, and some interesting details concerning this Converter, will be found in our January, 1943, issue of PRACTICAL WIRELESS, to which reference should be made.

### 2CHW's Circuit

**"With reference to 2CHW's theoretical circuit, J1 and J2 are open and closed circuit jacks respectively. If this is so, what are they, their make and cost? Also, could you please tell me where the two points for the loudspeaker or 'phones are? Would you suggest screening the H.F. stage from the L.F. stage?"—S. K. (Shelthorpe).**

THE two components J1 and J2 are single-circuit closed and single-circuit jacks respectively. Messrs. F. H. Wilson, of 51-52, Chancery Lane, London, W.C.2, might be able to supply suitable types. The first one is used to plug in the headphones when the full output of the receiver is not required, while the second is used when the four valves are required in circuit. It was not found necessary to employ any screening between the H.F. and the detector stage in the original model.

### Blueprint Details

**"I wish to get blueprints and appropriate issues of these sets named below: 'The Signet Two,' 'The Student Three' and the 'Fury Four Super.' Will you please give me some information concerning them?"—E. C. L. (Selly Oak).**

THE "Signet Two" is an efficient little two-valver for battery operation, utilising an ordinary triode for the detector and a power valve in the output.

The "Student Three" was designed around a chassis and cabinet, which were supplied by Messrs. Electradix Radios. Its circuit is Det. and 2 L.F.

The "Fury Four Super" is a good circuit for range and selectivity. It incorporates two H.F. stages, plus Det. and L.F.

# Classified Advertisements

## LITERATURE, MAPS, etc.

**DETECTION.** New theory, experiments, circuits. 44-page booklet, 2/- post free.—D'Arcy Ford, Gandy Street, Exeter.

**RADIO SOCIETY OF GREAT BRITAIN** invites all keen experimenters to apply for membership. Current issue "R.S.G.B. Bulletin" and details, 1/-.

**AMATEUR** Radio Handbook (300 pages), paper cover, 4/-; cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9; cloth, 5/-.—16, Ashridge Gardens, London, N.13.

**WEBB'S** Radio Map of the World. Locates any station heard. Size 40" by 30", 4/6, post 6d. On linen, 10/6, post 6d.—Webb's Radio, 14, Soho Street, London, W.1. GERard 2089.

## MORSE & S.W. EQUIPMENT

**"H.A.C."** Short-wave Receivers. Famous for over ten years. Improved one-valve model now available. Complete kit of precision components, accessories, with full instructions—only 16s., postage 6d. Easily assembled in one hour. Catalogues free on request.—A. L. Bacchus, 109, Hartington Road, London, S.W.8.

**FULL** range of Transmitting Keys, practice sets and other equipment for Morse training.—Webb's Radio, 14, Soho Street, London, W.1. 'Phone: GERrard 2089.

## RECEIVERS AND COMPONENTS

**RELIANCE RADIO SERVICE**
**8, Kennington Park Road, S.E.11.**
**'Phone: REL. 2331.**

**MAINS TRANSFORMERS.** All the following have 220-245 v. primaries, secondary 350-0-350 v., L.T. 6.3 v. C.T. 1½ amp., 5 v. 2 amp. £1. As above, but with 6.3 v. 2 amps., 25/-. Another with 350-0-350 v. secondary, L.T. windings, 2.5 v. 6 amp. C.T. and 5 v. 2 amp., 25/-. Also one with 700-0-700 v. secondary, L.T. 10 v. 2 amp. and 13 v. 2 amp., 25/-.

**MIDGET L.F. CHOKES.** Well-made manufacturer's type, 2/6.

**TUNING CONDENSERS.** Midget type 2X.0005 mfd., 3/-. Also 2X.0005 mfd. and 3X.0005 mfd., 2/6 each. Please add 1/- if you require slow motion.

**TUBULAR CONDENSERS.** Wire end, 12 assorted, our selection, 2/6.

**SWITCH SECTIONS.** Wafer type, brand new, 3/- per doz.

**AERIAL ELIMINATORS.** Brand new, simple to connect, 1/6 each.

**SHADOW TUNERS.** Philco make. 2/- each.

**MIDGET COILS.** M.W. and L.W. on one former, these are super with iron core to medium coil. 2/6 each.

**VALVE HOLDERS.** U.S. type, 7- or 4-pin, 6d. each. English type 5- or 7-pin, 7d. each. 4-pin baseboard type, 2/6 doz.

**TUBULAR FUSES.** 1 amp. Brand new stock. 3/- doz.

**H.T. ELIMINATORS.** Brand new. 220 v. A.C. input. There are three tappings on the output. Det., S.G., H.T. 120 v. Maximum output 120 v. at 75 m.a. Special price to P.W. readers. 40/- each.

*(Continued top of next column.)*

**VALVES.** We have a small stock of 6V6GT and 6K7G, both at 12/10 each.

**MOVING COIL A.C. METERS.** These are made by famous manufacturer. 2in. flush fitting, scale marked 0 to 500 m.a. 30/- each.

REGRET NO C.O.D. POSTAGE MUST BE INCLUDED.

**RELIANCE RADIO SERVICE**
**8, Kennington Park Road, S.E.11.**

**COULPHONE** Radio, New Longton, Nr. Preston. Brand new goods only. P.M. Speakers with transformer, 8in. Rola and Celestion, 24/6. 5in. Rola, 21/-. Electrolytics, 500v. 8 mfd., 5/6, 8+8 mfd., 9/6. 50 mfd. 50 v., 3/3. Erie 1 watt resistors, all value 9d. each. Push-back wire, 100ft. coils, 6/-. Barreter resistors, 6/-. Parafeed L.F. Transformers, 4 : 1, 4/9. Tinned copper wire, ½lb. reel, 2/3. Mains Transformer, 350-0-350, 100 m.a., 6.3 v. 3 a., 5 v. 2 a., 25/-. Resin-cored solder, 1lb. reels 4/6. S.A.E. for stock list.

**LONDON CENTRAL RADIO STORES**

**B.T.S.** Padders, ceramic base .0002 mfd., 3/6 each. Trimmers .00004 mfd., 3/6. Brass Tuning condensers .00025 mfd., 4/6.

**AMERICAN** Octal base valve-holders, Mazda type, brand new, 6d. each.

**PHILIPS** 0.1 mfd. 5,000 v. w. condensers, metal-cased, brand new, 10/6 each.

**FLEXIBLE DRIVES** for remote control. Approx. 2ft. long. 4/- each.

**ELECTRO-MAGNETIC COUNTERS.** Resistance 500 ohms. 1-1999, size 4½ x 1½" x 1¼", 5/6.

**VARIABLE CONDENSERS.** 2 and 3-gang. Die cast frames in first-class condition, 6/9 and 7/3 each.

**TRIMMERS.** Twin trimmers on ceramic base, new, to clear, 6d. each, 5/- doz.

*(Continued overleaf.)*

**COIL FORMERS.** Cardboard and Paxolin. Assorted sizes, 2/9 doz.
**VALVES.** Stock of Mullard TSE 4's, 17/6 each.
**TELEVISION** diode valves. Unused Mullard EA50, 69 mm. x 12 mm. overall, 6.3 v. heater at .15 amp., 10/6 each.
**CHASSIS.** Special line of beautifully polished chassis, 12" x 8½" x 3", a really super job, 4/- each. All drilled for valves, etc.
**PUSH-BACK** Wire Flex, ideal for wiring receivers, etc., 1/6 8-yard coil.
**VOLUME CONTROLS.** Wire wound, 1 ohm, 3/6 each. Carbon type, 100,000 ohms, 250,000 ohms, 500,000 ohms, 1 megohm, 4/6 each.
**VALVEHOLDERS.** Chassis mounting, 7-pin. 6d. each; 5/6 doz.
**PHILIPS** Mica-dielectric .0003 mfd. Reaction condensers, 2/- each.
**SISTOFLEX.** 3 mm., 4 mm., 5 mm. 3d. each per yd. length, 2/6 doz. yards. 8 mm., 5d. yd. length, 4/6 doz. yds. 16 mm., 7d. yd. length, 6/6 doz. yds.
**PAXOLIN PANELS.** Thin panels, 5/6 doz.
**T.C.C.** Tubular Electrolytic 2 mfd. 50 v. working, 2/6 each. B.1 50 mfd. +50 mfd. +2 mfd. Block electrolytics, 4/6 each.
**EX-TELEVISION** manufacturer. Heavy duty mains transformer. Input 240 v. A.C. tappings at 5,000 v. 5-8 milliamps., and for supplying filament of Mullard HVR 2 (6.3 v. at .65 amps.). Shrouded in metal box, 10/6 each, carriage forward.
**VARIABLE RESISTANCES.** Well-made resistances with wiping contact. Will carry about 10 watts. Brand new, first quality. Price 6/6 each.
**PHILIPS DIAL LAMPS.** 240 v., 15 watts. Miniature screw cap. 1/6.
**SPEECH COIL RIBBON WIRE.** Enamelled copper. Gauge approx. 20 thou. by 5½ thou. Per 1 lb. reel, 3/-.
**SINGLE R.A.F. EARPHONES,** resistance 750 ohms D.C. approx., 4/- each; ex-Govt. low-resistance single earphones 2/6 each; microphone buttons, well-known make, 2/- each.
**DECORATIVE CABINET GRILLES,** 4-bar, 14½" x 1¼" wide. Solid brass chrome-plated, 2/6 each. Heavier quality, 3/6. Also Rectangular Speaker Grilles, 7½" x 5½", 1/6.
**SEE ADVT. PAGE 122. ADD POSTAGE. NO C.O.D. ORDERS.**
**LONDON CENTRAL RADIO STORES 23, LISLE STREET, LONDON, W.C.2.** 'Phone: Gerrard 2969.

**SOUTHERN** Radio's Wireless Bargains:—
7/6.—Assorted Components contained in attractive permanent box. 2 Volume Controls, 12 Assorted Condensers, 9 Assorted Valve Holders, 6 Resistances, Choke, Wire, Plugs, Circuits, etc. 7/6, postage 7d.
25/-.—Assorted Parcel of useful components including Tubular Condensers, Resistances, Sleeving, Trimmers, Knobs, Volume Controls, Switches, etc., etc. 25/-, postage 1/1.
8/-.—12 Assorted Tubular Condensers to 6 mfd. 50 working, 8/-.
10/6.—12 Fixed Condensers, sizes including 1 and 2 mfd., 10/6.
9/-.—Gross Assorted Screws and Nuts, complete, 9/-.
6/-.—Gross Soldering Tags including spade ends, 6/-.
**ORMOND LOUD SPEAKER UNITS.** Largest 4-pole type 6/6, smaller unshrouded type, 3/-.
**ACE P.O. MICROPHONES** complete with transformer ready for use, 6/6.
**GOODMAN** 8" Permanent Magnet Speakers 21/-, postage 1/-.
**TUNGSRAM** H.R. 210 General Purpose Battery Valves, 4/9.

*(Continued top of next column.)*

**TELSEN** Radio Magazines. No. 6 complete with 4 circuits 9d. Wireless Crystals (Dr. Cecil) 6d. each, 5/6 per doz., with Catswhisker, 9d. each, 8/- doz. Permanent Detectors, 2/6. Binocular H.F. Chokes, 1/6. 75 ft. Wire suitable for aerials (covered), 2/6. Small Powerful Circular Magnets, 1½" diameter ⅜" thick, 1/6 each, 15/- doz. Bakelite Morse Practice Keys, 4/-. Buzzers, 4/-. Engineers' Wire Brushes, 10d. Many bargains for callers. Post Orders postage extra. All Goods Guaranteed.
**SOUTHERN** Radio Supply Co., 46, Lisle Street, London, W.C. Gerrard 6653.



**FRED'S RADIO CABIN.**
**FUSES,** glass, 1¼ inches long, 2 amp. and 1½ amp., 3/- doz.
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**TRIMMERS.** 100 m.mfd. small type on paxolin base, 4d. each, 3/9 dozen. New.
**PUSH BUTTON,** 6-way, no knobs—a really fine job, 2/- each. New.
**CONDENSERS.** "Plessey" 4-gang screened, 6½" x 3¾", 4/6, 3-gang 6½" x 3¾" unscreened, 2/6. All brand new and include trimmers. Fine geared drive, about 50-1 .0005 mfd. straight, 3-gang for flexible or direct drive, 4/6.
**TRIMMERS.** 4 on bank 1-400 m.mfd., 6d. each.
**STANELCO** Electric Soldering Irons. Made by Standard Telephones, with special bit for radio service work, 21/- each. Also "Henley" Irons, new, 13/- each. Resin-cored solder, 4/- lb. reel.
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**SLEEVING.** 3½d. per yard length. 1 doz. lengths, 3/-. Braided sleeving 8d. per yard length, 7/- doz. lengths.
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**TRIMMERS,** 50 m.mfd., 3d. each. Also 250 m.mfd., 3d. each.
**MICROPHONE** Inserts, ex G.P.O., 2/3.
**VOLUME CONTROLS,** less switch, new, ½ meg., ¼ meg., 3/3 each.
**COPPER WIRE,** tinned, 20 gauge, 1/- ½ lb. reel.
**VOLUME CONTROLS,** few only, various sizes, some with switch, 1/- each.
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**T.C.C. TUBULAR** Wire-end condensers, brand new, .00015 mfd., .0002 mfd., .00025 mfd., .0003 mfd., .0004 mfd., .0006 mfd., 6/- doz.
**KNOBS.** 2¼" Brown Bakelite, ¼" spindle 2 grub screws, 1/-.
**Postage must be included. No C.O.D.**
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**400 VALVES** for disposal. EBL1, 1D5, AC/TP, U50, U14, MKT4, PEN4DD, KT63, HL13C and practically all types in stock at List Price plus postage.—Radio Supply, 27, High Street, S. Walden, Essex.

**MORSE** key and buzzer complete in polished wooden case, 10s. post paid.—16, Chesterton Road, Birmingham, 12.

**FIVE-VALVE** A.C. Superhet, less valves, plus speaker and cabinet. £3.—V. Holt, Hopgarden, Eton, Windsor.

## TUITION

**LEARN MORSE CODE** the Candler way. See advertisement on page 127.

**"RADIOLOCATION."**—Students of both sexes trained for important war-time Radio Appointments. Also for peacetime careers in all branches of Radio and Television. Boarders accepted. Low inclusive fees. College in ideal peaceful surroundings. 2d. stamp for Prospectus. —Wireless College, Colwyn Bay.

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# Practical Wireless
# BLUEPRINT SERVICE

## PRACTICAL WIRELESS

*No of Blueprint.*

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Blueprints, 6d. each.
1937 Crystal Receiver .. — PW71
The "Junior" Crystal Set .. — PW94*

### STRAIGHT SETS. Battery Operated.

**One-valve : Blueprints, 1s. each.**
All-Wave Unipen (Pentode) .. — PW31A
Beginners' One-valver .. .. — PW85*
The "Pyramid" One-valver (HF Pen) .. .. .. .. — PW93*

**Two-valve : Blueprint, 1s.**
The Signet Two (D & I F) .. — PW76*

**Three-valve : Blueprints, 1s. each**
Selectone Battery Three (D, 2LF (Trans)) .. .. .. — PW10
Summit Three (HF Pen, D, Pen) — PW37
All Pentode Three (HF Pen, D (Pen), Pen) .. .. — PW39
Hall Mark Cadet (D, LF, Pen (RC)) — PW48
F. J. Camm's Silver Souvenir (HF Pen, D (Pen), Pen) (All-Wave Three) .. .. .. .. — PW49
Cameo Midget Three (D, 2 LF (Trans)) .. .. .. — PW51
1936 Sonotone Three-Four (HF Pen, HF Pen, Westector, Pen) — PW53
Battery All-Wave Three (D, 2 LF (RC)) .. .. .. — PW55
The Monitor (HF Pen, D, Pen) .. — PW61
The Tutor Three (HF Pen, D, Pen) — PW62
The Centaur Three (SG, D, P) .. — PW64
F. J. Camm's Record All-Wave Three (HF Pen, D, Pen) .. — PW69*
The "Colt" All-Wave Three (D, 2 LF (RC & Trans)) .. — PW72*
The "Rapide" Straight 3 (D, 2 LF (RC & Trans)) .. .. — PW82*
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen) .. — PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen) .. .. — PW84
F. J. Camm's "Sprite" Three (HF Pen, D, Tet) .. .. — PW87
The "Hurricane" All-Wave Three (SG, D (Pen), Pen) .. — PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet) — PW92

**Four-valve : Blueprints, 1s. each**
Beta Universal Four (SG, D, LF, Cl.B) .. .. .. .. — PW17
Nucleon Class B Four (SG, D (SG), LF, Cl. B) .. .. — PW34B
Fury Four Super (SG, SG, D, Pen) — PW34C
Battery Hall-Mark 4 (HF Pen, D, Push-Pull) .. .. .. — PW46
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B) .. .. — PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC)) .. — PW90*

#### Mains Operated

**Two-valve : Blueprints, 1s. each.**
A.C. Twin (D (Pen), Pen) .. — PW18*
A.C.-D.C. Two (SG, Pow) .. — PW31*
Selectone A.C. Radiogram Two (D, Pow) .. .. .. — PW19

**Three-valve : Blueprints, 1s. each.**
Double-Diode-Triode Three (HF Pen, DDT, Pen) .. .. — PW23
D.C. Ace (SG, D, Pen) .. .. — PW25
A.C. Three (SG, D, Pen) .. .. — PW29
A.C. Leader (HF Pen, D, Pow) .. — PW35C*
D.C. Premier (HF Pen, D, Pen) .. — PW35B
Unique (HF Pen, D (Pen), Pen) .. — PW36A
Armada Mains Three (HF Pen, D Pen)) .. .. .. — PW38
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen) — PW50
"All-Wave," A.C. Three (D, 2 LF (RC)) .. .. .. — PW54*
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen) .. .. — PW56
Mains Record All-Wave 3 (HF Pen, D, Pen) .. .. — PW70

**Four-valve : Blueprints, 1s. each.**
A.C. Fury Four (SG, SG, D, Pen) — PW20
A.C. Fury Four Super (SG, SG, D, Pen) .. .. .. — PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull) .. .. .. — PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull) .. .. .. — PW47

### SUPERHETS.

**Battery Sets : Blueprints, 1s. each.**
F5 Superhet (Three-valve) .. — PW40
F. J. Camm's 2-valve Superhet .. — PW52

**Mains Sets : Blueprints, 1s. each.**
A.C. £5 Superhet (Three-valve) .. — PW43
D.C. £5 Superhet (Three-valve) .. — PW42
F. J. Camm's A.C. Superhet 4 .. — PW59
F. J. Camm's Universal £4 Superhet 4 .. .. .. .. — PW60
"Qualitone" Universal Four .. — PW73*

**Four-valve : Double-sided Blueprint, 1s. 6d.**
Push Button 4, Battery Model ..
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### SHORT-WAVE SETS. Battery Operated.

**One-valve : Blueprint, 1s.**
Simple S.W. One-valver .. .. — PW88*

**Two-valve : Blueprints, 1s. each.**
Midget Short-wave Two (D, Pen) — PW38A
The "Fleet" Short-wave Two (D (HF Pen), Pen) .. .. — PW91*

**Three-valve : Blueprints, 1s. each.**
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The Prefect 3 (D, 2 LF (RC and Trans)) .. .. .. — PW63*
The Band-Spread S.W. Three (HF Pen, D (Pen), Pen) .. — PW68*

### PORTABLES

**Three-valve : Blueprints, 1s. each.**
F. J. Camm's ELF Three-valve Portable (HF Pen, D, Pen) .. — PW65
Parvo Flyweight Midget Portable (SG, D, Pen) .. .. — PW77*

**Four-valve : Blueprint, 1s.**
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### MISCELLANEOUS

Blueprint, 1s.
S. W. Converter-Adapter (1 valve) — PW48A*

## AMATEUR WIRELESS AND WIRELESS MAGAZINE

### CRYSTAL SETS.

Blueprints, 6d. each.
Four-station Crystal Set .. .. — AW427
1934 Crystal Set .. .. .. — AW444
150-mile Crystal Set .. .. — AW450*

### STRAIGHT SETS. Battery Operated.

**One-valve : Blueprint, 1s.**
B.B.C. Special One-valver .. — AW387

**Two-valve : Blueprints, 1s. each.**
Melody Ranger Two (D, Trans).. — AW388
Full-volume Two (SG det. Pen).. — AW392
A Modern Two-valver .. .. — WM409*

**Three-valve : Blueprints, 1s. each.**
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Lucerne Ranger (SG, D, Trans).. — AW422
£5 5s. Three De Luxe Version (SG, D, Trans) .. .. — AW435*
Transportable Three (SG, D, Pen) — WM271
Simple-Tune Three (SG, D, Pen) — WM327
Economy Pentode Three (SG, D, Pen) .. .. .. .. — WM337
"W.M." (1934 Standard Three (SG, D, Pen)) .. .. — WM351*
£3 3s. Three (SG, D, Trans) .. — WM354
1935 £6 6s. Battery Three (SG, D, Pen) .. .. .. — WM371
PTP Three (Pen, D, Pen) .. — WM389
Certainty Three (SG, D, Pen) .. — WM393
Minitube Three (SG, D, Trans) .. — WM396*
All-wave Winning Three (SG, D, Pen) .. .. .. .. — WM400

**Four-valve : Blueprints, 1s. 6d. each.**
65s. Four (SG, D, RC, Trans) .. — AW370
Self-contained Four (SG, D, LF, Cl. B) .. .. .. — WM331
Lucerne Straight Four (SG, D, LF, Trans) .. .. .. — WM350
£5 5s. Battery Four (HF, D, 2LF) — WM381
The H.K. Four (SG, SG, D, Pen) — WM384
The Auto Straight Four (HF, Pen, HF, Pen, DDT, Pen) .. .. — WM404*

**Five-valve : Blueprints, 1s. 6d. each.**
Super-quality Five (2 HF, D, RC, Trans) .. .. .. .. — WM320
Class B Quadradyne (2 SG, D, LF Class B) .. .. .. — WM344
New Class B Five (2 SG, D, LF Class B) .. .. .. — WM340

#### Mains Operated.

**Two-valve : Blueprints, 1s. each.**
Consoelectric Two (D, Pen) A.C. — AW403
Economy A.C. Two (D, Trans) A.C. — WM286

**Three-valve ; Blueprints, 1s. each.**
Home Lover's New All-Electric Three (SG, D, Trans) A.C. .. — AW383*
Mantovani A.C. Three (H.F. Pen, D, Pen) .. .. .. — WM374
£15 15s. 1936 A.C. Radiogram (HF, D, Pen) .. .. .. — WM401

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Harris Jubilee Radiogram (HF, Pen, D, LF, P) .. .. .. — WM386

### SPECIAL NOTICE

THESE blueprints are drawn full size. The issues containing descriptions of these sets are now out of print, but an asterisk beside the blueprint number denotes that constructional details are available, free with the blueprint.

The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

### SUPERHETS

**Battery Sets : Blueprints, 1s. 6d. each.**
'Varsity Four .. .. — WM395*
The Request All-Waver .. — WM407

**Mains Sets : Blueprints, 1s. each.**
Heptode Super Three A.C. .. — WM359*

### PORTABLES

**Four-valve : Blueprints, 1s. 6d. each.**
Holiday Portable (SG, D, LF, Class B) .. .. .. — AW393
Family Portable (HF, D, RC, Trans) .. .. .. .. — AW447
Tyers Portable (SG, D, 2 Trans) — WM367

### SHORT-WAVE SETS. Battery Operated

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S.W. One-valver for America .. — AW429*
Roma Short-Waver .. .. — AW452

**Two-valve : Blueprints, 1s. each.**
Ultra-short Battery Two (SG, det Pen) .. .. .. .. — WM402*
Home-made Coil Two (D, Pen) .. — AW440

**Three-valve : Blueprints, 1s. each.**
Experimenter's 5-metre Set (D, Trans, Super-regen) .. .. — AW438
The Carrier Short-waver (SG, D, P.) .. .. .. .. — WM390

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A.W. Short-wave World-beater (HF, Pen, D, RC, Trans) .. — AW436
Standard Four-valver Short-waver (SG, D, LF, P) .. .. .. — WM383*

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#### Mains Operated

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**Four-valve : Blueprints, 1s. 6d.**
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### MISCELLANEOUS.

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Enthusiast's Power Amplifier (1/6) — WM387
Listener's 5-watt A.C. Amplifier (1/6) .. .. .. .. — WM392*
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De Luxe Concert A.C. Electrogram (1/-) .. .. .. — WM403*
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PRACTICAL WIRELESS, FEB., 1943.

Published on the 7th of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, Strand, London, W.C.2, and printed in England by THE NEWNES & PEARSON PRINTING CO., LTD., Exmoor Street, London, W.10. Sole Agents for Australia and New Zealand : GORDON & GOTCH, LTD., South Africa : CENTRAL NEWS AGENCY, LTD. Subscription rates including postage : Inland 10s. 6d. per annum ; Abroad 10s. per annum. Registered at the General Post Office for the Canadian Magazine Post.